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New finds of ichnofossils from the Middle Cambrian of the Barrandian area (Czech Republic)

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Abstract. The base of the Jince Formation provided, besides the already reported "high-energy" trace fossils, also representatives of the ichnogenera *Palaeophycus*, *Planolites*, and *Teichichnus*. They point to standard, diverse use of substrate characteristic for the Early Palaeozoic Cruziana Ichnofacies. The find of *Nereites* at Vystrkov (*Eccaparadoxides pusillus* Zone) is the first record of this important ichnotaxon in the Cambrian of the Barrandian area and implies the possibility that other traces preserved only as convex hyporeliefs (e.g. *Cruziana*) may also be recognized in the Jince Formation.

Key words: Middle Cambrian, Ichnofossils, ichnology, taxonomy, new taxa, synonymy, fossiliferous localities, Barrandian

Introduction

The paper of Mikuláš (2000) on the Middle Cambrian ichnofossils of the Barrandian area helped fossil collectors to understand trace fossils as notable palaeontological phenomena, which can be exemplified by several new finds that broaden the hitherto known spectrum of ichnotaxa. The aim of this contribution is to describe and interpret these finds.

Recently, junior authors of this report concluded a detailed palaeontological study of a succession of sandstones and greywackes, several metres thick, at the base of the Jince Formation at the locality of Vinice near the town of Jince. Fauna of this interval points, according to Fatka et al. (1992), to the earliest Middle Cambrian. Mikuláš (2000) described the following ichnoassemblage from this interval: *Planolites* isp., *?Monomorphichnus* isp., *?Cruziana* isp. and *Diplocraterion* isp. The new study yielded finds of *Teichichnus*? isp. (isp. nov.), *Palaeophycus striatus* and *Planolites* isp. J. Valíček obtained another two interesting trace fossils: *Nereites missouriensis* from Vystrkov near Jince – asphalt precoating works (locality 2b-c of Mikuláš 2000) and *Planolites* isp. from the locality of Týřovice-pit (small quarry above the road from Týřovice to Luh) in the area of the Skryje-Týřovice Cambrian belt within the NW flank of the Barrandian area. All the new finds are described herein in Systematic ichnology.

Systematic ichnology

Nereites MacLeay 1839
Type ichnospecies: *N. cambriensis* MacLeay 1839

Nereites missouriensis (Weller, 1899)
Pl. II, fig. 4

Synonymy: See Uchman (1995)

Material: A sole find from Vystrkov – asphalt precoating works (*E. pusillus* Zone).

Description: A straight, biserial row of circular knobs preserved in hyporelief in dark greyish-green micaceous shale. Preserved part of the row is 18 mm long and 1.7–1.9 mm wide, bearing 22 knobs altogether.

Remarks: The described specimen represents a preservational variant of *Nereites* reported by numerous previous authors as *Neonereites biserialis* (cf. Uchman 1995). The ichnotaxon belongs to presumable epi-faunal feeding traces (cf. Fillion and Pickerill 1990). Till the end of the Palaeozoic, *Nereites* characterizes deep-water Nereites Ichnofacies (cf. Frey and Pemberton 1984) but during the Cambrian it occurred in shallow-water settings (Crimes 1987, Fillion and Pickerill 1990).

Palaeophycus Hall, 1847
Type ichnospecies: *Palaeophycus tubularis* Hall, 1847

Palaeophycus striatus Hall, 1852
Pl. II, fig. 3

Material: A sole specimen from the Jince-Vinice locality (basal beds of the Jince Formation).

Description: Straight, horizontal, secondarily flattened, unbranched tunnel with wall lining, 11–12 mm wide and 35 mm long. Wall surface is covered with straight, regular rounded ridges (6 ridges in trace width). The tunnel is preserved as full relief in calcareous siltstone.

Remarks: The find was determined as *P. striatus* according to criteria given by Pemberton and Frey (1982). Tunnels of *Palaeophycus* represent dwelling burrows of presumed predators and suspension feeders.

Planolites Nicholson, 1879

Type ichnospecies: *Planolites beverleyensis* (Billings, 1862).

Planolites isp.
Pl. II, figs 1–2

Material: One specimen from the Jince-Vinice locality (basal beds of the Jince Formation). One specimen from the Týřovice-pit locality (greyish-green Skryje Shale).

Description: A simple, straight, indistinctly bounded tunnel-like trace, having numerous large, well-preserved body fossils in the fill. Of these fossils, four are represented by shells of undetermined hyolithid genus and species; other ones include one cranidium of the trilobite *Ornamentaspis* sp., one cephalon of *Ellipsocephalus vetustus* (Pompeckj, 1895), and finally five cranidia of *Kingaspis? brdensis* Fatka et al., 1992. The remaining, small and fragmentary bioclasts belong to undeterminable disarticulated exoskeletons of trilobites. The preserved part of the trace is 11 cm long and 1.8–3.0 cm wide. The bioclasts are randomly orientated in the trace fill.

The specimen from the Týřovice-pit locality shows many similarities, having preserved length of 65 mm and average width 12 mm; bioclasts in the fill include at least four cranidia of *Sao hirsuta* Barrande, 1846, and one cephalon of *Phalagnostus nudus* (Beyrich, 1845).

Remarks: Accumulations of body fossils in the fill of trace fossils represent a still neglected ichnologic and taphonomic problem. While these finds are well known in the Ordovician strata (cf. Mikuláš and Kordule 1998), in the Cambrian, the phenomenon just starts to appear showing specific and non-recurring features (the ichnogenus *Rejkovicichnus*; cf. Mikuláš 2001). For this reason, the finds of *Planolites* may provide useful information for future research.

Interpretation: Composition of the fill of the described specimens resembles the ichnospecies *Rejkovicichnus necrofilus* Mikuláš et al., 1996, described from the Cambrian of the Jince area (the Potůček locality, subzone *Litavkaspis rejkovicensis*). However, they differ from this ichnotaxon in their random orientation of bioclasts. Tunnel-like traces with randomly orientated bioclasts can be classified as *Planolites* Nicholson sensu Pemberton and Frey (1982) and subsequent authors. The trace is another example of numerous varieties of accumulations of body fossils in clusters or rows, which can be found in close relationship with bioturbation, or they show no relations to trace fossils (e.g. Bromley 1996). These are frequently found in the Cambrian and Ordovician sediments of Bohemia (see Mikuláš 2001 for references). These accumulations can be divided into several categories according to the composition and size of bioclasts, their sorting or non-sorting or their spatial relationship to ichnofossils. These were interpreted by previous authors as agglutinated tubes of "worms" (Prantl 1948), remains of arrangement of epiplankton on algae (Pek 1977, Havlíček et al. 1993), faecal material (Mikuláš et al. 1996), or a substrate for microbe cultivation (Mikuláš 2001). In the described example of *Planolite*s isp., the interpretation is very unsafe. A future study announced by P. Kraft (pers. communication 2001) should explain this problem and provide a general classification of clusters of body fossils.

Teichichnus Seilacher, 1955

Type ichnospecies: *Teichichnus rectus* Seilacher, 1955.

Teichichnus? isp. (isp. nov.)
Pl. I, figs 1–2

Material: Two specimens in one sample of greywacke from the Jince-Vinice locality (basal beds of the Jince Formation).

Description: Large endichnial burrows, forming straight, vertically orientated walls, composed of trough-like bodies approximately parallel to bedding, orientated downwards with convex-down bottoms (i.e. a retrusive spreiten-structure). Longitudinally, the troughs are moderately curved forming a very broad "U". Fills of individual troughs are homogeneous and do not differ macroscopically from the surrounding rock. Surfaces of troughs are smooth with the exception of a conspicuous rib along their axes, which divides the troughs into two lobes. The total preserved length of the two traces is 98 mm and 72 mm, width 12 mm and 10 mm, maximum vertical diameter 30 mm.

Remarks: The ichnogenus *Teichichnus* is interpreted, like most spreiten structures, as a result of repeated movement (e.g. locomotion, sediment-feeding) along a certain path; the structure is formed by a characteristic vertical shift of the tracemaker between consecutive moves. None of the hitherto described representatives of *Teichichnus*, (cf. Schlirf 2000, Mikuláš 2000) is characterized by bilobate shape. Two lobes characterize the ichnofossil *Cruziana* d'Orbigny that is typically generated by trilobites as an exichnial burrow; however, *Cruziana* usually does not form spreite and its surface is decorated by oblique scratches. In the described case, we may presume that a sediment-feeding trace is concerned; the bilobate shape suggests that the tracemaker might belong to trilobites using a specific burrowing technique, which did not leave oblique scratches.

Conclusions

The base of the Jince Formation contains (in agreement with the benthic faunal assemblage) not only high-energy traces where high energy represents the main ecological stress. New finds (*Palaeophycus, Planolites, Teichichnus*) point to a standard, diverse use of substrate characteristic for the Early Palaeozoic Cruziana Ichnofacies (e.g. Frey and Pemberton 1984). The find of *Nereites* at Vystrkov (*Eccaparadoxides pusillus* Zone) represents the first occurrence of this important ichnotaxon in the Cambrian of the Barrandian area and implies the

possibility that some other traces preserved in convex hyporeliefs only (e.g. *Cruziana*) may be also recognized in the Jince Formation.

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Plate I

↑ Plate I
1–2. *Teichichnus?* isp. (isp. nov.); Middle Cambrian, basal beds of the Jince Formation, Jince-Vinice, RM 156, × 1.2.

→ Plate II
1–2. *Planolites* isp.; 1 – Middle Cambrian, basal beds of the Jince Formation, Jince-Vinice (carbonate nodule), RM 157; 2 – Middle Cambrian, Skryje Shale, Týřovice-pit (greyish-green shale), RM 158. 3 – *Palaeophycus striatus* Hall, 1852; Middle Cambrian, basal beds of the Jince Formation, Jince-Vinice, RM 159. 4 – *Nereites missouriensis* (Weller, 1899); Middle Cambrian, Jince Formation, *Eccaparadoxides pusillus* Biozone, Vystrkov – asphalt-precoating works, RM 160. Scale in millimetres.

RM = collection of R. Mikuláš in the Czech Geological Survey, Prague. Photos by R. Mikuláš and J. Brožek.

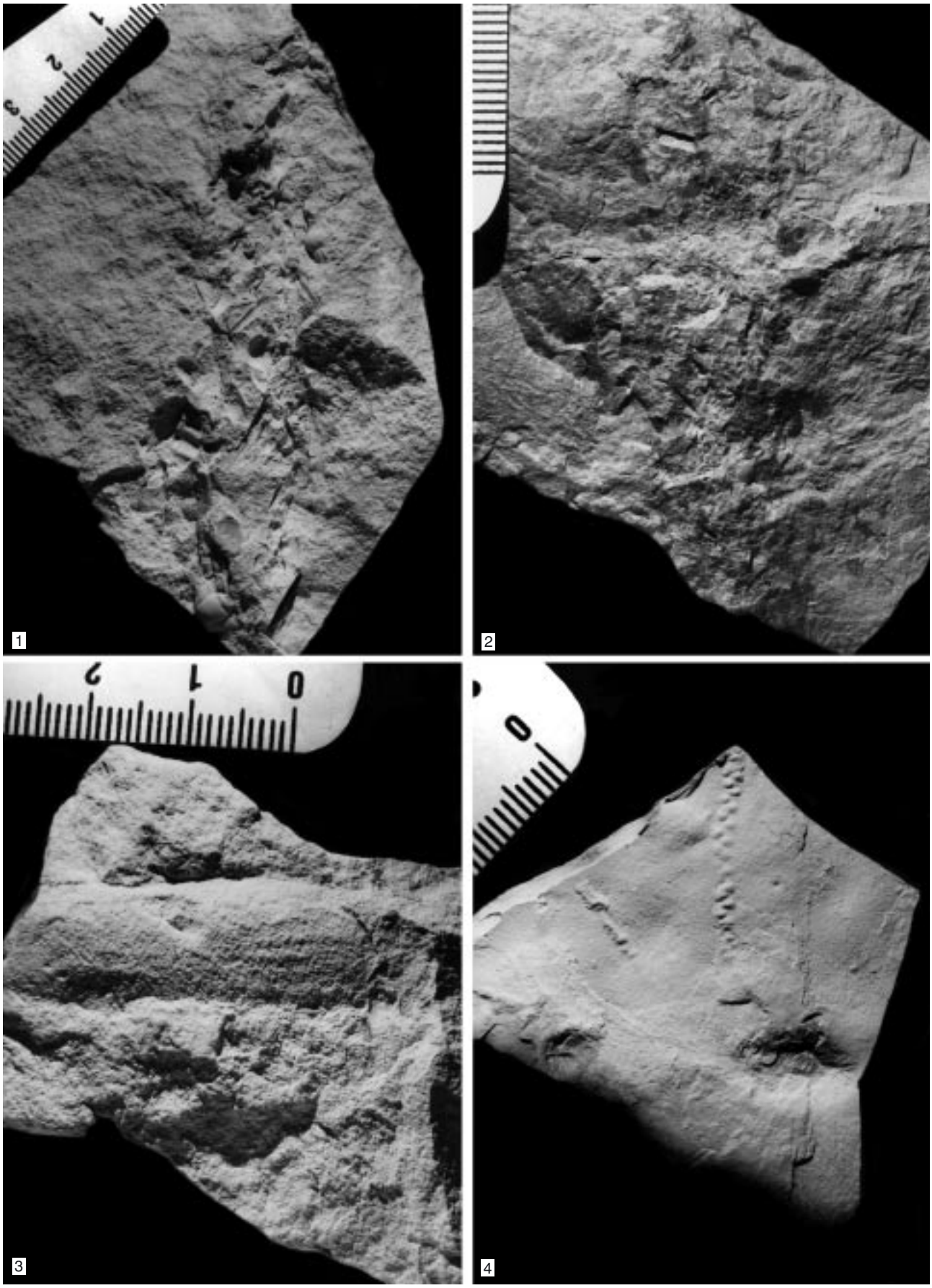

Plate II