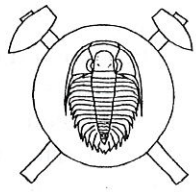
New information on trace fossils of the Early Ordovician of Prague Basin (Barrandian area, Czech Republic)



Nové poznatky o ichnofosiliích spodního ordoviku pražské pánve (Barrandienská oblast) (Czech summary)

(4 plates)

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Coarse–grained sandstones of the Třenice Formation (Tremadocian) at Jivina locality yielded trace fossils *Bergaueria* aff. *langi* and *Skolithos* ichnosp. *Spirophycus* cf. *bicornis* and ?*Urohelminthoida* ichnosp. are described from clay shales of the Šárka Formation at Praha – Jenerálka locality. Oolitic iron ores at the base of this formation (Ejpovice locality) contain frequent *Bergaueria* aff. *hemispherica*, *Phycodes* ichnosp., *Planolites beverleyensis*. From the facies of fine–grained sandstones with intercalations of clay shales (Velíz locality) derive the finds of *Didymaulichnus* ichnosp. and *Helminthopsis* ichnosp. The Dobrotivá Formation (Dobrotivian Stage) yielded trace fossil assemblages from the Ejpovice locality (rhythmical alternation of sandstones and shales; *Diplocraterion, Bergaueria, Isopodichnus, Phycodes, Planolites, Tomaculum*), from Praha, Pelc–Tyrolka locality (siltstones, greywackes, fine–grained sandstones; *Dictyodora, Zoophycos, Rhizocorallium*), from Praha–Žižkov (*Zoophycos*) and from Praha – I.P. Pavlov's square (*Phycodes*).

Introduction

The present paper is a contribution to the knowledge of the trace fossils and ichnofacies of the Early Ordovician in the Prague Basin. It follows the papers on ichnofossils from the siliceous concretiosns of the Šárka and Dobrotivá Formations (Mikuláš 1991) and on ichnofossils from the Klabava Formation (Mikuláš 1993). New collections and the study of older finds enabled to learn the ichnological characteristics of the Třenice Formation (Tremadocian Stage), and of the less extended facies of the Šárka and Dobrotivá Formations (Lanvirnian and Dobrotivian).

Třenice Formation

The Třenice Formation (Tremadocian) represents the basal formation of the Prague basin. It originated during the transgression of sea to the Central European area after a break of deposition in the Late Cambrian. The Prague basin appeared as a narrow depression very shallow all over its width, limited lateraly by elevations. It lacked deep axial depression, known in Arenigian (Havlíček 1982). The petromict conglomerates and coarse– or medium–grained sandstones prevail in the Třenice Formation, reflecting a very shallow–water marine environment. The basal breccia and conglomerates represent a reworked pre–Tremadocian regolith (Chlupáč – Kukal 1988).

The analysis of benthic, namely brachiopod assemblages of the Třenice Formation was presented by Havlíček (1982). The assemblages determined by him correspond to the benthic assemblage 1 to 2 according to Boucot's (1975) classification (tidal to shallow subtidal zone).

Because of the exceptional position on the base of sediments of the Prague basin, and because of a quite explicit interpretation of sedimentological and zoopaleontological data (Havlíček 1982, Chlupáč and Kukal 1988), finds of trace fossils cannot be expected to contribute to fundamental knowledge of the sedimentary environment of the Třenice Formation. Moreover,the traces are very rare, what is caused also by a rock composition unfavourable for preservation (coarse–grained clastic deposits). I have found only one *Skolithos* from the coarse–grained sandstone at Jivina. The same locality yielded specimens collected by C. Klouček. They are now housed in the National Museum, Prague, and comprise one specimen of *Skolithos* ichnosp. and three specimens of *Bergaueria* aff. *langi* (Hallam, 1960).

This poor trace fossil assemblage corresponds to the conclusions of above mentioned works. *Bergaueria*, interpreted as resting traces (cubichnia) of anemones, is (after Miller and Knox (1985) and additional authors) a foreshore, very shallow–water trace fossil. Environmental sense of *Skolithos*, which gave the name to Skolithos ichnofacies, is similar. A modern characteristics of the Skolithos ichnofacies have been given by Frey and Pemberton (1984) and by Frey, Pemberton and Saunders (1990). According to these authors, the Skolithos ichnofacies indicates the environment of a relatively high phys–

ical energy. This ichnofacies is most frequent in the littoral and in the shoreface of beaches, bars and by–bars.

The coarse–grained sandstones of the Třenice Formation at Jivina locality can be undoubtedly placed to the Skolithos ichnofacies. Because of the similar rock composition of the most part of the Třenice Formation, this knowledge can be generalized for other localities, where the trace fossils have not yet been found.

Systematic ichnology

Bergaueria Prantl, 1946
Bergaueria aff. *langi* (Hallam, 1960)

Pl. I, figs. 7–10

Material: Three specimens (two convex hyporeliefs and a single full relief) from Jivina (coll. C. Klouček).

Description: Hemispherical ichnofossils with smooth surface. Circular opening of the hemisphere is parallel to bedding plane. In one case (Pl. I, fig. 7), the hemisphere is marked by two divisional planes. Material between them, being macroscopically of the same composition as surrounding rock (coarse–grained sandstone), represents very probably a wall lining, originally reinforced (for example, by mucus). Diameter of this specimen estimated from a fragment is 30 mm. Diameters of two other specimens are 18 and 22 mm.

Remarks: The representatives of *Bergaueria* were revised by Pemberton, Frey and Bromley (1988). A single ichnospecies with thick walls, placed by these authors to *Bergaueria*, is *B. langi.* As concerns the dimensions and diameter/height ratio (ca. 2.0), finds from the Třenice Formation are conformable to this ichnospecies. *B. langi,* described from the Jurassic (Hallam 1960), shows, however, in most cases the phosphatic walls. Therefore, the assignment of described specimens to *B. langi* remains questionable. Tracemakers of bergauerians are usually considered the anemones; the traces are either dwelling burrows, or (in case of specimens without wall linings) the resting traces (see Pemberton, Frey and Bromley 1988).

Skolithos Haldemann, 1840
Skolithos ichnosp.

Pl. I, fig. 4

Material: Two finds (full reliefs) from Jivina.

Description: Hollow, almost straight, probably vertical tubes, 3.5 and 4.0 mm in diameter. Lengths of preserved parts are 20 and 42 mm. Structures of walls (lining, constrictions) are not present.

Remarks: For the description and interpretation of *Skolithos*, see works of Häntzschel (1975), Benton (1982), Crimes et al. (1977), Chlupáč (1987) a.o. Solitary finds without wall structure are usually described in the open nomenclature. *Skolithos* is known from the Proterozoic to the Recent.

Šárka Formation

The Šárka Formation (Lanvirnian) represents a beginning of a new phase in the geological history of the Prague basin. The quickening of tectonic deformations caused a rapid deepening of the basin. Subsequently the black clay shales with siliceous concretions deposited in the central part. In the marginal parts, chemogenic oolitic iron ores deposited in partly isolated small basins. In the north–western margin of Prague basin, the formation is in places developed as fine–grained sandstones alternating rhythmically with clay shales (Kukal 1963, Havlíček 1982).

The trace fossils from the siliceous concretions of the Šárka Formation have been already described (Mikuláš 1991); this assemblage can be approximately placed in the Zoophycos ichnofacies.

The finds of ichnofossils occuring in the clay shales of the Šárka Formation (not in the concretions) are rare with the exception of the traces of *Chondrites* and *Planolites* type. *Spirophycus* ichnosp. and *?Urohelminthoida* ichnosp. have been found at Praha – Jenerálka locality (former brickyard). Both traces represent typical pascichnia, surface feeding traces, which in the post–Cambrian and largely in the post–Ordovician deposits characterize a deep–water environment. These finds can indicate a relatively deep–water marine environments in the eastern part of the Prague basin, that is presumed by Kukal (1963) and by Havlíček (1982) with some doubts, owing to the lack of the material and to the fact that tracemakers of complex pascichnia colonized the deep sea till in the Ordovician (see Frey and Pemberton 1984).

The facies of oolitic iron ores is exposed at the Ejpovice locality. I have obtained the following trace fossil assemblage at this locality: *Planolites beverleyensis* (very frequent), *Phycodes* ichnosp. (frequent), *Bergaueria* aff. *hemispherica* (very frequent at the base of the Šárka Formation and in the uppermost layers of the Klabava Formation. These finds of bergauerians have been described in the paper dealing with the trace fossils of the Klabava Formation, Mikuláš 1994). The type of sediments shows a strong physical energy of the environment during the deposition of the iron ores (see, for instance, the paper of Skoček 1963). The trace fos–

sils found neither support nor disprove this evidence. *Planolites* and *Phycodes* are the traces after feeding within substrate, showing the maximum occurrence in the Cruziana ichnofacies (a.o. Frey and Pemberton 1984).

Facies of fine-grained sandstones with intercalations of shales (Velíz locality) yielded finds of *Didymaulichnus* ichnosp. and *Helminthopsis* ichnosp. Most of the bedding planes of sandstones at Velíz (old refuse dumps after iron ore mining) contain no ichnofossils. The named trace fossils do not allow a serious ichnofacial characteristics of this marginal facies of the Šárka Formation.

Didymaulichnus Young, 1972
Didymaulichnus lyelli (Rouault, 1850)

Pl. II, fig. 5

Material: Two slabs of fine-grained sandstone with numerous specimens at the lower bedding plane. Collections of the Czech Geological Survey, Prague (inheritance of Prof. B. Bouček).

Description: Smooth, crooked traces (convex hyporeliefs) of various length. Each trace consists of two lobes longitudinally separated by groove. Width of specimens 4.0 to 6.5 mm, length 6 to 70 mm. The central groove sometimes very distinct, occupying about 1/3 of trace width, sometimes indistinct or even lacking. Height of hyporelief small (1 to 2 mm) and usually fluctuate. Flanks sharply separated from surrounding bedding plane. Lateral ridges not developed.

Remarks: The ichnogeneric and ichnospecific determination of the finds is based on the works of Young (1972) and Pickerill, Romano and Meléndez (1984). Here the relations of *Didymaulichnus* to similar ichnogenera and the relations of other ichnospecies, namely of *D. miettensis* Young, *D. tirasensis* Palij, *D. nankervisi* Bradshaw, *D. rouaulti* Lebesconte, and *D. alternatus* Pickerill et al. are given. The probable tracemakers are mollusks (Häntzschel 1975). *Didymaulichnus* is described mostly from Early Paleozoic; Crimes (1987) referred to finds of *D. miettensis* from several Late Proterozoic localities.

Helminthopsis Heer, 1877
Helminthopsis ichnosp.

Pl. II, fig. 3

Material: Five specimens (convex hyporeliefs) from Velíz.

Description: Smooth, unbranched, moderately winding trails preserved on lower bedding planes of fine-grained sandstone slabs. Width of each specimen constant (3 to 5 mm). Length of preserved parts variable (maximum 15 cm).

Remarks: Description of the ichnogenus and its representatives is given by Ksiazkiewicz (1977), McCann and Pickerill (1988), Pickerill (1981) AO. The described finds cannot be assigned with certainty to some of numerous, morphologically simple ichnospecies similar to each other. *Helminthopsis* is known from rocks of various age and from diverse settings. In Mesozoic it is a representant of deep-water Nereites ichnofacies in association with numerous complex pascichnia (Ksiazkiewicz 1977).

Phycodes Richter, 1850
Phycodes ichnosp.

Pl. III, fig. 7

Material: Eight specimens (free fragments of fillings of burrow systems) from Ejpovice (oolitic iron facies of the Šárka Formation). Trace fossils were collected on refuse dumps of abandoned opencut mine in weathered oolitic rock.

Description: Smooth, straight or slightly curved tunnels, found in bundles of two to four. Each bundle is usually formed of tunnels of various diameter, one tunnel being distinctly wider than others. Tunnels sometimes taper to distal part of bundle. Filling is homogeneous, silty, without ooids, without spreite. Walls are not lined. Tunnel diameter 3 to 10 mm, length up to 60 mm.

Remarks: *Phycodes* is a typical trace of sediment-eaters, very frequent in Palaeozoic (Häntzschel 1975, Crimes 1969, Crimes et al. 1977, Bjerstedt 1988, Baldwin 1977, Chlupáč 1987). Finds from Ejpovice are similar to *P. flabellum* Miller and Dyer, which has no spreite and wall lining, its tunnel systems are shallow and consist of a small number of tunnels (Häntzschel 1975, Bjerstedt and Erickson 1989). The material found at Ejpovice does not enable to determine the original orientation and dimensions of systems.

Planolites Nicholson, 1873
Planolites beverleyensis (Billings, 1862)

Pl. III, figs. 4, 5

Material: More than 50 specimens (mostly studied in situ) from the oolitic iron ore facies. Ejpovice.

Description: Unbranched, unsculptured, straight or slightly curved traces oval or circular in cross-section, parallel to bedding. They are filled by oolitic material or less frequently by material resembling "phosphatic" concretions known from most Ordovician ore horizons of the Prague basin. Diameter of tunnles 5 to 18 mm, length of preserved parts to 20 cm.

Remarks: This morphologically simple trace is conformable to *P. beverleyensis*, as described by Pemberton and Frey (1982) and many other authors.

Spirophycus Häntzschel, 1962
Spirophycus cf. *bicornis* (Heer, 1876)

Pl. II, fig. 1

Material: A single specimen (full relief flattened by compaction of clay shale) from Praha–Jenerálka.

Description: Smooth, spirally arranged trace on bedding plane of clay shale. Filling homogeneous, slightly darker than surrounding rock, glimmering in siutable lateral lighting. Width almost constant in whole length, 4 to 5 mm. Spiral of three roughly elliptical threads, first widely open, 120 mm long in a line of longer axis; second is 48 mm long in the same line. Third, incomplete thread passes into trail, that points out of "spiral", crossing the first and second thread. Several winding trails, 3.5 to 6 mm wide, are present near the spiral trace.

Remarks: Because of the general arrangement of the trace, its assignment into pascichnia is very probable; tracemakers advantageously ate the upper layer of sediment. Similar traces have been described as *Spirophycus* by Häntzschel (1962), Ksiazkiewicz (1977), McCann and Pickerill (1988), mostly from Mesozoic and Tertiary. Type ichnospecies *S. bicornis* Heer, 1876) is considerably variable (see descriptions and figures of Ksiazkiewicz) and the sole specimen from the Šárka Formation can be placed to this ichnospecies with reserve.

Urohelminthoida Sacco, 1888
?*Urohelminthoida* ichnosp.

Pl. II, fig. 2

Material: A single specimen from Praha–Jenerálka.

Description: Three subparallel, smooth, slightly curved trails on a bedding plane of sliver of clay shale found in debris. Filling homogeneous, of same colour as surrounding rock, so that the trace can be distinguished only by a different lustre. Two of the trails converge and fuse in one of the ends. Width of trails 4.6 to 7 mm, distance between them 0 to 10 mm. Length of preserved part is 10 cm.

Remarks: Similarly as *Spirophycus* cf. *bicornis* (Heer), the ichnofossil resulted probably from advantageous eating of the uppermost layer of sediment. The trace can be placed to *Urohelminthoida* (for description, synonymy and relations see Häntzschel 1975, Ksiazkiewicz 1977). However, a possibility that the subparallel arrangement of the trails is incidental only, cannot be excluded.

Dobrotivá Formation

The Dobrotivá Formation (Dobrotivian) differs lithologically from the underlying Šárka Formation namely in the presence of the facies of the Skalka Quartzite. This facies represents almost all the formation in marginal parts of the basin; the qartzites are mostly deposits of tidal flats and offshore bars. Facies of black clay shales dominate in central part of the basin (Kukal 1963, Havlíček 1982). Transitional facies between the Skalka Quartzite and clay shales may be developed as rhythmical alternation of sandstones and shales in thickness of several centimeters or decimeters. Ejpovice and Praha (Pelc-Tyrolka) localities are examples of such development. The transitional facies can be considered also in the micaceous siltstones known to me from Praha (Ohrada), Praha (Pelc-Tyrolka), and Praha (I. P. Pavlov's square) localities.

The finest preservation of the traces is in the siliceous concretions, frequent almost everywhere in the shaly facies. The description of these traces and of the ichnoassemblage has been already published (Mikuláš 1991). Concerning the traces of the Skalka Quartzite, I refer to papers of Bouček (1937) and Chlupáč (1987).

The trace fossil assemblage from rhythmically developed parts of the Dobrotivá Formation from Ejpovice shows a relatively shallow-water character. The elements showing the adaptation to a high physical energy of the environment are *Diplocraterion* and *Bergaueria*. The ichnogenera *Isopodichnus, Phycodes, Planolites, and Tomaculum* have been also found in this formation.

One specimen of *Phycodes* ichnosp. B originated from the grey micaceous siltstone at Praha (I.P. Pavlov's sqare) locality (coll. B. Bouček). Numerous finds of *Zoophycos* ichnosp. come from bioturbated, irregularly laminated pale siltstones affected by linear cleavage, exposed in a temporary outcrop at Praha–Žižkov (Ohrada). *Dictyodora tenuis* (M'Coy, 1851) is very frequent in lower layers at the Pelc–Tyrolka locality (thin slabs of fine-grained sandstone with intercalations of black shales). The first information on *Dictyodora* of this locality is given by Röhlich (1960). A sole specimen of *Didymaulichnus* ichnosp. was also found there. From the upper layers at Pelc–Tyrolka (weathered yellow-brown siltstones, similar to those from Ohrada locality) come the finds of *Rhizocorallium* and *Zoophycos. Dictyodora* and *Zoophycos* are typical of "ecologically limited" conditions. In this case, the limitations can follow unfavourable chemical settings and periodical drastic physical phenomena (slumping, storms) responsible for the rhytmic sedimentation.

Bergaueria Prantl, 1946
Bergaueria ichnosp.

Pl. II, fig. 4

Material: Two finds (convex hyporeliefs) from rhythmic parts of the Dobrotivá Formation (alternating of sandstones and shales) at Ejpovice.

Description: Shallow vertical structure circular in cross–section, originally probably hollow, preserved in hyporelief as a protrusion of bedding plane. Base almost flat, passing by a short arc to vertical walls. Surface of base and walls smooth. Figured specimen 16 mm in diameter. Height of hyporelief, that can be lesser than original depth of shaft, is 6 mm.

Remarks: This morphologically simple trace belongs probably to *Bergaueria*. Features that characterize bergauerians on ichnospecific level (radial ornament, hemispherical outline, central pit, wall lining) are not present.

Dictyodora Weiss, 1884
Dictyodora tenuis (M'Coy, 1851)

Pl. IV, figs. 1, 3–5, 7

Material: More than 20 finds of thinly slab–like sandstone with the trace from Praha (Pelc–Tyrolka) locality (coll. of Prof. B. Bouček and my new finds). Other specimens studied in situ on the locality.

Description: Complex three–dimensional structure, visible on bedding planes as a system of meandering traces often crossing each other. Meanders are of two orders. Large meanders are up to 40 mm wide and their "wave length" is usually 5 to 20 mm. They are either entirely irregular (Pl. IV, fig. 4, 7) or more–or–less regular (Pl. IV, fig. 1). Meandering or waving of the second order is very variable. Meanders are either regular, conspicuous, with amplitude 2 to 4 mm (Pl. IV, fig. 3), or less regular, but distinctly devloped (Pl. IV, fig. 7), or practically missing (Pl. VI, fig. 4). Thickness of traces is 0.7 – 11 mm.

Vertical dimensions of structures are hard to determine. In a single find, part of subvertical wall is visible (Pl. IV, fig. 5). Free preparation was enabled by preservation in clay shale, forming intercalations od slab–like sandstone at Pelc–Tyrolka. The wall shows very regular, smooth furrows and ridges. Their shape and intervals do not correspond to the meanders of the second order on the horizontal sections; thus they probably represent impressions of inner structure (spreite) of the trace.

Remarks: Finds of *Dictyodora* from Pelc–Tyrolka have been published already by Röhlich (1960). The described finds have been determined as *D. tenuis* following a work of Benton (1982), who recognized four ichnospecies of *Dictyodora* as valid: *D. liebeana* (Geinitz), showing primarily spiral character; *D. scotica* (M'Coy), forming regular meanders of a single order; *D. zimmermanni* Hundt, showing irregular meanders without waving of 2nd order; and *D. tenuis* (M'Coy), having meanders of the first order usually irregular, secondary waving being present. *Dictyodora* is a feeding trace. Finds of *Dictyodora* from the Ordovician have been published, e.g., by Benton (1982) from Scotland, by Pickerill, Fyffe and Forbes (1987) from Canada (Matapedia Group). Pek, Zapletal and Lang (1978) described *Dictyodora* from the Lower Carboniferous of Moravia.

Didymaulichnus Young, 1972
Didymaulichnus ichnosp.

Pl. I, fig. 5

Material: A sole find from Praha (Pelc–Tyrolka) – rhythmically developed parts of the Dobrotivá Formation.

Description: Slightly curved bilobate trail (convex hyporelief) on the flag of fine–grained sandstone. Width 10–12 mm, length of preserved part 135 mm. Height of hyporelief 0–3 mm. Both central furrow and flanks of the trail are irregular, slight, sometimes inconspicuous. Surface of the trail irregularly rugged, similarly as surrounding bedding plane, that bears also meandering traces of *Dictyodora*.

Remarks: Before the fossilization, the trace was probably damaged by physical processes and by subsequent bioturbation. The basic morphology is conformable to *Didymaulichnus* Young. However, features necessary for ichnospecific determination (lateral ridges a.o.) are not preserved.

Diplocraterion Torell, 1870
Diplocraterion ichnosp.

Pl. III, fig. 3

Material: Two finds from Ejpovice (rhythmical parts of the Dobrotivá Formation).

Description: A pair od conspicuous protuberances on lower bedding plane of slab of fine–grained sandstone. In one case, the pair is connected by a low ridge. Protuberances of roughly hemispherical shape. Diameters of one pair are 9.0 and 10.5 mm, of the second pair 5.0 and 5.5 mm. Distances between centres of protuberances are 15.5 and 10.0 mm.

Remarks: The negatives (hyporeliefs) of openings of U–shaped burrows are probably concerned. The indicated joining of protuberances by the ridge shows that a spreite between the tubes was present, characteristic of *Diplocraterion* (for description, figures and relations to other ichnogenera see Fürsich 1974, Häntzschel

1975, Crimes et al. 1977, Bjerstedt 1988, Bjerstedt and Erickson 1989 a.o.). After these authors, *Diplocraterion* is a dwelling structure of suspension feeders.

Isopodichnus Bornemann, 1889
Isopodichnus ichnosp.

Pl. III, fig. 1

Material: A sole find of micaceous shale with traces from Ejpovice (rhythmicaly developed part of the Dobrotivá Formation).

Description: Smooth, moderately curved, bilobed trail, 45 mm wide; length of preserved part 52 mm. In front of the trail, a series of three bilobate, coffee bean–like protuberances is placed. Their dimensions are 3,5 x 4 mm, 5.0 x 5.5 mm, and 6.0 x 6.0 mm. Height of relief less than 1 mm.

Remarks: Bilobed tape–like furrows joined with small coffee bean–shaped traces are characteristic of *Isopodichnus* (Häntzschel 1975, Pickerill and Forbes 1979, Hakes 1977, Trewin 1975). The ichnogenus occurs both in marine and in nonmarine settings and has various tracemakers. It represents a combination of crawling and resting traces.

Phycodes Richter, 1850
Phycodes ichnosp. A

Pl. III, fig. 6

Material: Seven finds from rhythmic facies of the Dobrotivá Formation at Ejpovice.

Description: Smooth, straight tunnels, suboval in cross–section, arranged in bundles of three, preserved as convex hyporeliefs on the sandstone slabs. Proximal part of trace is a tunnel 5 – 10 mm long, from which three distal branches scatter; outer branches deflect at an angle 40–60 degrees. Branches of the same specimen are not equally wide and long; both the central and some of outer branches may be conspicuously wider or longer. Width of tunnels 1.5 – 6.0 mm, length of complete specimens 16–25 mm.

Remarks: General arrangement of described traces corresponds to *Phycodes*.

Phycodes ichnosp. B

Pl. III, fig. 7

Material: A sole find from grey micaceous sily shale, Praha (I. P. Pavlov's sqare) locality (coll. B. Bouček).

Description: A bundle of four tunnels of circular cross–section, subhorizontal, subparallel. Proximal parts of tunnels directed to one point lying outside rock sample, distal parts parallel. Tunnel diameter is 5–7 mm, length of bundle 30 mm. Thin, moderately undulated walls of tunnels are less dark than surrounding rock.

Remarks: Described specimen shows a close relation to *P. flabellum* Miller and Dyer (for further remarks see p. 173).

Planolites Nicholson, 1879
Planolites beverleyensis (Billings, 1862)

Pl. III, fig. 2

Material: Several slabs of fine–grained sandstone with numerous convex hyporeliefs of the trace. Ejpovice.

Description and remarks: See the same ichnospecies from the Šárka Formation (p. 173). The difference is only in a mode of preservation (full reliefs from the oolitic iron ores of the Šárka Formation; convex hyporeliefs from the Dobrotivá Formation).

Rhizocorallium Zenker, 1836
Rhizocorallium ichnosp.

Pl. IV, figs. 2, 6

Material: Two finds from pale grey micaceous siltstone; Praha (Pelc–Tyrolka) – one find from the collection of B. Bouček, one own find.

Description: Horizontal, large, assymetrical lobes formed by spreite. In one case (Pl. IV, fig. 6) the lobe is bordered by a smooth tunnel 1.5 mm in diameter. The second find does not show such a tunnel. Dimensions of the lobes: Pl. IV, fig. 2; width maximum 58 mm, incomplete length 105 mm, maximum thickness of spreite 1 mm. Pl. IV, fig. 6; width 59 mm, incomplete length 82 mm.

Remarks: Assignment of these finds to *Rhizocorallium* follows the descriptions and figures by Ksiazkiewicz (1977), Häntzschel (1975), Fürsich (1974), Pickerill and Forbes (1979 a.o. *Rhizocorallium* is usually a shallow–water trace fossil with maximum occurrence in the Cruziana ichnofacies (Frey and Pemberton 1984); finds from the deep–water sediments are also known (Pickerill, Hurst and Surlyk 1982). Specimens with lined walls represent domichnia, those without wall lining fall into feeding traces.

Taenidium Heer, 1877
? *Taenidium* ichnosp.

Pl. I, fig. 1

Material: A sole find (cast of full relief) from Svárov – Údersko; dark grey clay shale forming intercalation in the Skalka Qartzite (coll. P. Šlehofer).

Description: A cast of cylindrical, straight, non–ramifying trace parallel to stratification, showing conspicuous transverse constrictions of the surface. Diameter 4.0 to 4.5 mm, length of preserved part 22 mm. This part shows 16 transverse constrictions.

Remarks: Using conclusions by D'Alessandro and Bromley (1987), this unfavourably

preserved trace can be placed to *Taenidium* Heer.

Zoophycos Massalongo, 1855
Zoophycos ichnosp.

Pl. I, fig. 2; pl. IV, fig. 8

Material: One find (sample of siltstone with three-dimensional spreiten-structure; Praha (Pelc-Tyrolka). Nine specimens, preserved as sections of spreiten-structures in pale grey, laminated siltstones affected by cleavage; Praha (Ohrada) locality.

Description: A find from Pelc-Tyrolka is a spreiten-structure bordered by a S-shaped passage 3 mm in diameter. In proximity of this passage, spreite is oblique to bedding at an angle about 30 degrees. This angle decreases with distance of the passage, thus the spreite plane is bent. The finds from Ohrada represent only sections of laminae. Their original orientation was subhorizontal or oblique. Traces are conspicuously darker than surrounding rock. Width of sections is 2–5 mm, length 12–90 mm. 1 cm of section of lamina contains 5 – 8 meniscate lamellae sections.

Remarks: *Zoophycos* belongs to the most frequent and most important ichnofossils for numerous possibilities to indicate various parameters of environment. The occurrences of *Zoophycos* in the Prague basin have been described by Chlupáč (1990) and Mikuláš (1991, 1994). Further literary sources are quoted here.

Translated by the author

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Nové poznatky o ichnofosiliích spodního ordoviku pražské pánve (barrandienská oblast)

V hrubozrnných pískovcích třenického souvrství (tremadok) na lokalitě Jivina byly zjištěny ichnofosilie *Bergaueria* aff. *langi* a *Skolithos* ichnosp. Obě ichnofosilie dokumentují velmi mělkovodní prostředí skolitové ichnofacie.

Z břidličné facie šáreckého souvrství (Praha – Jenerálka) pocházejí nálezy *Spirophycus* cf. *bicornis* a *?Urohelminthoida* ichnosp., které mohou dokumentovat hlubokovodnější prostředí ve v. části pánve během llanvirnu. Z oolitických železných rud na bázi šáreckého souvrství (Ejpovice) jsou známy *Bergaueria* aff. *hemispherica*, *Phycodes* ichnosp., *Planolites beverleyensis*, potvrzující vyšší energii vlnění a proudění.

V rytmicky vyvinutých partiích dobrotivského souvrství (dobrotiv) na lokalitě Ejpovice byly nalezeny *Diplocraterion* ichnosp., *?Bergaueria* ichnosp., *Isopodichnus* ichnosp., *Phycodes* div. ichnosp., *Planolites* ichnosp. a *Tomaculum* ichnosp., tedy ichnospolečenstvo podobné jako v kruzianové ichnofacii. Podobnou litologickou náplň má naleziště ichnodruhu *Dictyodora tenuis* (Praha, Pelc – Tyrolka). V nadloží rytmicky vyvinutých poloh jsou zde přítomny prachovce s význačným ichnorodem *Zoophycos*, který často indikuje prostředí velmi nepříznivé pro rozvoj benthických společenstev. *Zoophycos* je velmi hojný i v prachovcích dobrotivského souvrství na lokalitě Praha–Žižkov (Ohrada).

Explanation of plates

Photos by the author. Material is deposited in the palaeontological collections of the National Museum, Prague (L), in the Czech Geological Survey, Prague (BB) and in the Horák's Museum, Rokycany (I).

Plate I

1: *?Taenidium* ichnosp.; x 2.8, I 15. Dobrotivá Fm., Svárov–Údersko. 2: *Zoophycos* ichnosp.; x 1.1, I 16. Dobrotivá Fm., Praha 3 – Žižkov (Ohrada). 3: *?Planolites* cf. *P. beverleyensis* (Billings, 1862); x 1.5, L 30543. Klabava Fm., oolitical iron ore facies, Krušná Hora near Beroun. 4: *Skolithos* ichnosp.; x 1.5, L 30542. Třenice Fm., Jivina. 5: *?Didymaulichnus* ichnosp.; x 0.85, I 17. Dobrotivá Fm., Praha 8 (Pelc–Tyrolka). 7–10: *Bergaueria* aff. *langi* (Hallam, 1960); 7 – x 1.5, L 30539; 8, 9 – x 1.8, L 30540; 10 – x 1.7, L 30541. Třenice Fm., Jivina.

Plate II

1: *Spirophycus* cf. *bicornis* (Heer, 1876); x 1.0, I 1. Šárka Fm., Praha–Jenerálka. 2: *?Urohelminthoida* ichnosp.; x 1.2, I 2. Šárka Fm., Praha–Jenerálka. 3: *Helminthopsis* ichnosp.; x 0.75, I 3. Šárka Fm., Velíz. 4: *Bergaueria* ichnosp.; x 1.4, I 4. Dobrotivá Fm., Ejpovice. 5: *Didymaulichnus lyelli* (Rouault, 1850); x 0.7. Šárka Fm., Velíz. 6: Bedding plane of shaly oolitical iron ore with *P. beverleyensis*. Šárka Fm., Ejpovice.

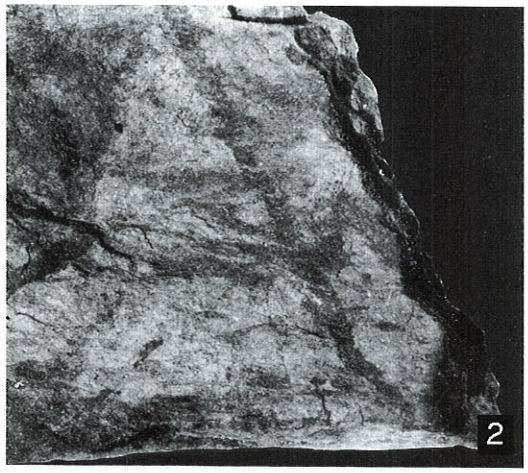
Plate III

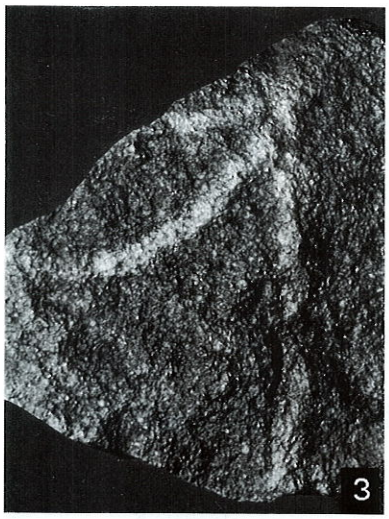
1: *Isopodichnus* ichnosp.; x 1.4, I 5. 2: *Planolites beverleyensis* (Billings, 1862); x 0.9, I 6. 3: *?Diplocraterion* ichnosp.; x 3.0, I 7. 4, 5: *Planolites beverleyensis* (Billings, 1862); x 1.3, I 8 and I 9. 6: *Phycodes* ichnosp.; x 1.2, I 10. 7: *Phycodes* ichnosp.; x 3.2, I 11. 1–3, 6: Dobrotivá Fm., Ejpovice. 4, 5, 7: Šárka Fm., Ejpovice.

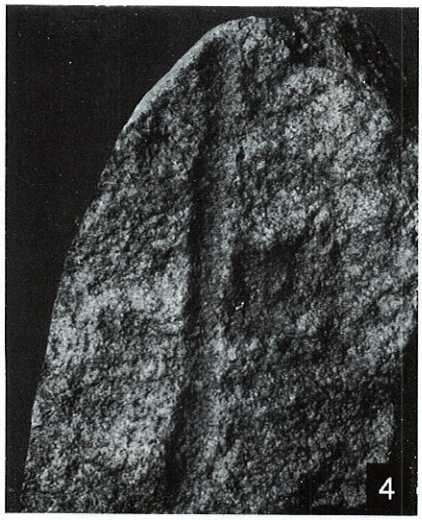
Plate IV

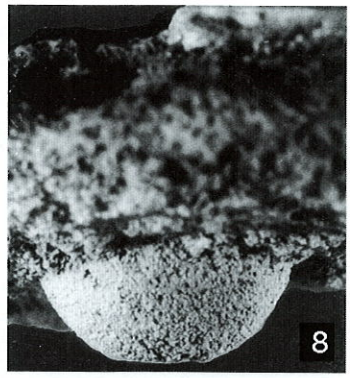
1, 3, 4, 5, 7: *Dictyodora tenuis* (M'Coy, 1851); 1 – x 1.0, collections of the Charles University, Faculty of Natural Sciences, Prague; 3 – x 0.95, I 12; 4, 7– x 0.7, BB; 5 – x 1.1 (wall of the trace oblique to bedding), BB; 2, 6: *Rhizocorallium* ichnosp.; x 0.9, I 13 and BB, 8: *Zoophycos* ichnosp.; x 1.1, I 14. Dobrotivá Fm., Praha 8 (Pelc–Tyrolka).

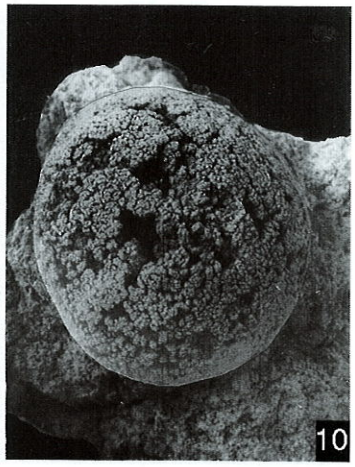
R. Mikuláš: New information on trace fossils of the Early Ordovician of Prague Basin... (Pl. I)



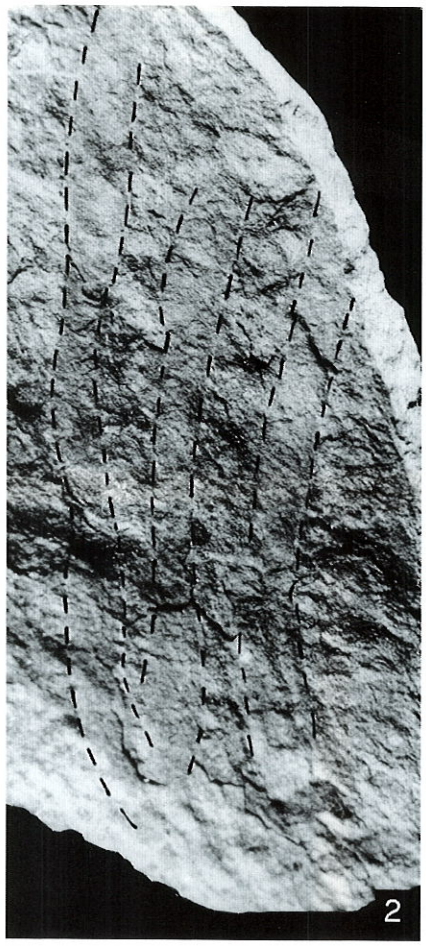




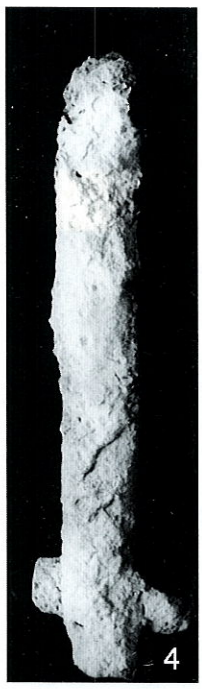


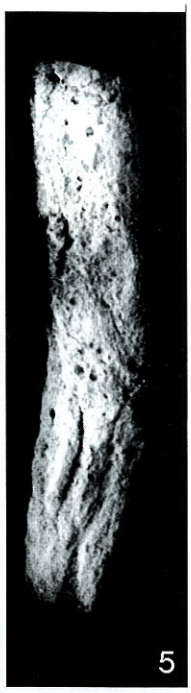


R. Mikuláš: New information on trace fossils of the Early Ordovician of Prague Basin... (Pl. II)



R. Mikuláš: New information on trace fossils of the Early Ordovician of Prague Basin... (Pl. III)





R. Mikuláš: New information on trace fossils of the Early Ordovician of Prague Basin... (Pl. IV)