

brook valley inclined to WSW. Clayey to silty shales with distinctive greywacke to subgreywacke layers in places. These layers show physical sedimentary structures (ripples and flute marks; see Pl. XVI, fig. 3) in hyporeliefs but trace fossils are rare. Fine-grained layers contain numerous carbonatic concretions, usually several centimetres to several decimetres in diameter, with well-preserved trilobite, brachiopod and echinoderm fauna. Trace fossils *Daedalus* isp., *Palaeophycus sulcatus*, *Teichichnus rectus*, and *?Cochlichnus* isp. have been ascertained at the locality.

## 5. Systematic ichnology

*Amanitichnus* CHLUPÁČ and MIKULÁŠ, 1995

*Amanitichnus omittus* CHLUPÁČ and MIKULÁŠ, 1995

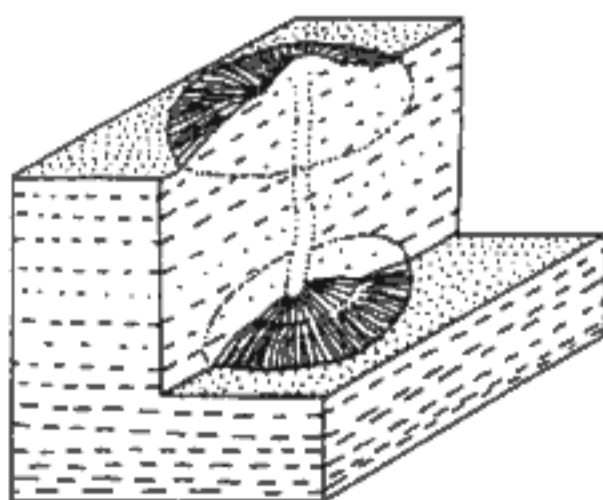
Pl. XV, figs. 1–5; text-fig. 5; ?Pl. XXVI, fig. 5

Material: 22 specimens, commonly several conical structures within the same slab of rock (over 30 conical structures observed) from the locality Buchava.

Description: Intrastratal ichnofossils consisting of one or several low and upwards convex conical structures, commonly recurring in different levels within the same bed either in vertical superposition, or gently shifted laterally. The conical structures are covered with fine radial ridges and grooves, commonly slightly curved and/or anastomosing, particularly close to the outer margin of the cone. The outline of individual cones is subcircular or oval, the diameter equals several centimetres. The vertical or oblique distance between recurring cones ranges from few mm up to several cm. The conical structures are connected by narrow central shaft with homogeneous fill. For more detailed description see CHLUPÁČ and MIKULÁŠ (1995).

Remarks: *Amanitichnus* represents a complex burrow system. Assignment to medusoid-like body fossils is not plausible due to the presence of the vertical shaft connecting the cones. *Amanitichnus* may be classified as fodinichnion. It can be considered as an intrastratal analogy of the ichnogenera *Oldhamia*, *Glockerichnus* a.o. The presumed burrower could be a worm-like animal which was able to move within the narrow central shaft connecting the upwards convex conical parts of the system. The fine radial feeding probes might be originated by special organs (e.g. tentacles) either gradually, or abruptly. For detailed comparisons and remarks see CHLUPÁČ and MIKULÁŠ (1995).

Besides the finds from the Buchava locality, a find showing some resemblance to *Amanitichnus* was found at Bis-



5. *Amanitichnus omittus* CHLUPÁČ and MIKULÁŠ, 1995. Schematic block-diagram showing the position of individual cones within the specimen. Natural size. After CHLUPÁČ and MIKULÁŠ (1995). Bar scale = 10 cm.

koupy (Pl. XXVI, fig. 5). It, however, differs in less regular shape and less prominent radial structure.

*Bergaueria* PRANTL, 1946

*Bergaueria perata* PRANTL, 1946

Pl. XXXI, figs. 1–2

Material: Three specimens from the locality Rejkovice a).

Description: Solitary burrows (full reliefs in silty shales) circular in section, perpendicular to bedding planes. Diameter of them is 24–40 mm, depth of known specimens nearly equal as their diameter. Base of burrows is flat. Surface smooth, showing only sparsely visible transverse rugae. Wall lining is absent. The fill corresponds to the surrounding (and also overlying) rock. It is homogeneous, structureless, probably passive.

Remarks: Modern revision of all “plug-shaped” trace fossils including *B. perata* was given by PEMBERTON, FREY and BROMLEY (1988). *Bergaueria* is considered to be a shallow-water trace fossil, probably the domichnion and/or cubichnion of anemones.

*Chondrites* STERNBERG, 1833

?*Chondrites* isp.

Pl. XIII, fig. 1

Material: One doubtful find from the locality Vystřkov b).

Description: Slab of laminated micaceous siltstone to greywacke showing a group of sections of tunnels: rounded of vertical tunnels, elliptical of oblique tunnels. The sections are of two diameters: smaller ones about 1.5 mm, larger ones about 5 mm. Location and orientation of sections suggest that originally the system of passages had a rhizoidal shape.

Remarks: The presumed shape of the system corresponds to the ichnogenus *Chondrites* as described by numerous authors, most extensively by Fu (1991).

*Cochlichnus* HITCHCOCK, 1858

?*Cochlichnus* cf. *C. anguineus* HITCHCOCK, 1858

Pl. XXXVI, figs. 5–7

Material: Four finds from the localities Buchava, Koníček and Biskoupy.

Description: Smooth, 2–4 mm wide, tunnel- or tape-like traces, slightly, more-or-less regularly sinuously curved. Length of individual “waves” about 10 mm.

Remarks: Because of not full regularity of waving, the assignment to *C. anguineus* is questioned (for description of *C. anguineus* see PICKERILL 1981, KSIĄŻKIEWICZ 1977, McCANN-PICKERILL 1988 a.o.). *Cochlichnus* is regarded to be a feeding trace. It was found in sediments of various settings and age, but density is usually low.

coprolites div. igen. et isp.

Pl. XII, fig. 8; Pl. XXXI, figs. 3–7; Pl. XXXIII, fig. 8

Material: About ten specimens from several (mostly richly fossiliferous) localities [Písky, Koníček, Buchava, Jezírka d)].

Description: Bodies of roughly ovoid or elongated, usually 1–5 cm in size, filled with material rich in bioclasts (Pl. XII, fig. 8) or minute oval pellets.

Remarks: Character of the filling points to a presumption that the coprolites of invertebrates are concerned. Knowledge of this ichnofossil group is so far very low (MIKULÁŠ 1995b).

*Cruziana* D'ORBIGNY, 1842

?*Cruziana* isp.

Pl. XXXII, fig. 7

1992 *Rusophycus* spp.; FATKA et al., Pl. IV, fig. X.

Material: Sole specimen from the locality Vinice a).

Description: Small, straight, subhorizontal bilobate burrow, mostly smooth but along a median ridge there are several very shallow transverse striae.

Remarks: The sole find might be a member of a tapho-series of several ichnotaxa, e.g., finds of smaller specimens of *Psammichnites* from the Vysrkov a) locality are similar. The above-mentioned locality is comparable with the Vinice a) site by its presumed stratigraphical level and the rock composition. The specimens of *Psammichnites* mostly differ from ?*Cruziana* isp. by more conspicuous transverse striation and by the character of backfill (which, however, may not be preserved). Therefore, the specimen is placed preliminarily to *Cruziana*, which represents mostly repichnia of trilobites (e.g., FILLION and PICKERILL 1990).

*Daedalus* ROUAULT, 1850

*Daedalus* isp.

Pl. XI, figs. 1, 2; Pl. XVIII, figs. 1–6; Pl. XIX, figs. 2–6; Pl. XX, figs. 1–4; ?Pl. XXXIV, fig. 5

Material: About 50 collected specimens from various localities, other observed in situ. Common at Konšček, Vinice j), Rejkovice, Buchava, and Biskoupyky.

Description: Bundles of 5–20 cm long, narrow, subhorizontal tunnels, at proximal ends forming low spreiten-structures, at distal ends branching at acute angles. All the structure is usually limited to a plane vertical to bedding. Tunnels are arched; their proximal parts are moderately curved upwards, to a former substrate surface. Tunnel diameter is 3 to 7 mm, length up to 20 cm.

Remarks: *Daedalus* is a typical Early Palaeozoic feeding trace, consisting of vertical to subvertical spreiten walls consisting of J-shaped segments (e.g., HÄNTZSCHEL 1975, PICKERILL et al. 1984). Individual fragments may resemble *Teichichnus* or *Phycodes*, however, I suppose that most of the spreiten-structures found in the Bohemian Middle Cambrian belong to this ichnogenus.

*Didymaulichnus* YOUNG, 1972

*Didymaulichnus lyelli* (ROUAULT, 1850)

Pl. XXXII, figs. 1–6

Material: About thirty specimens from the localities Dubinky a) and Jezírka c); several samples from Vysrkov.

Description: Narrow (2–4 mm), smooth, usually curved trails (convex hyporeliefs) of various length (1–5 cm, mostly limited by a rock sample or by a subsequent bioturbation). They are formed by two parallel lobes bordered longitudinally by a relatively broad groove. Height of hyporeliefs about 0.5 mm. Flanks of the trace are not bordered

from a surrounding bedding plane sharply, lateral ridges are not present. Several specimens are usually preserved on the same bedding plane.

Remarks: The ichnogenic and ichnospecies determination follows the works of YOUNG (1972), and PICKERILL, ROMANO, and MELÉNDEZ (1984). The mollusc traces are probably concerned, known mostly from the Early Palaeozoic.

*Dimorphichnus* SEILACHER, 1955

*Dimorphichnus* isp.

Pl. XXVI, fig. 2; text-fig. 6.

Material: Sole find (convex hyporeliefs and partly cleavage relief only) from the locality Slapnice – camp.

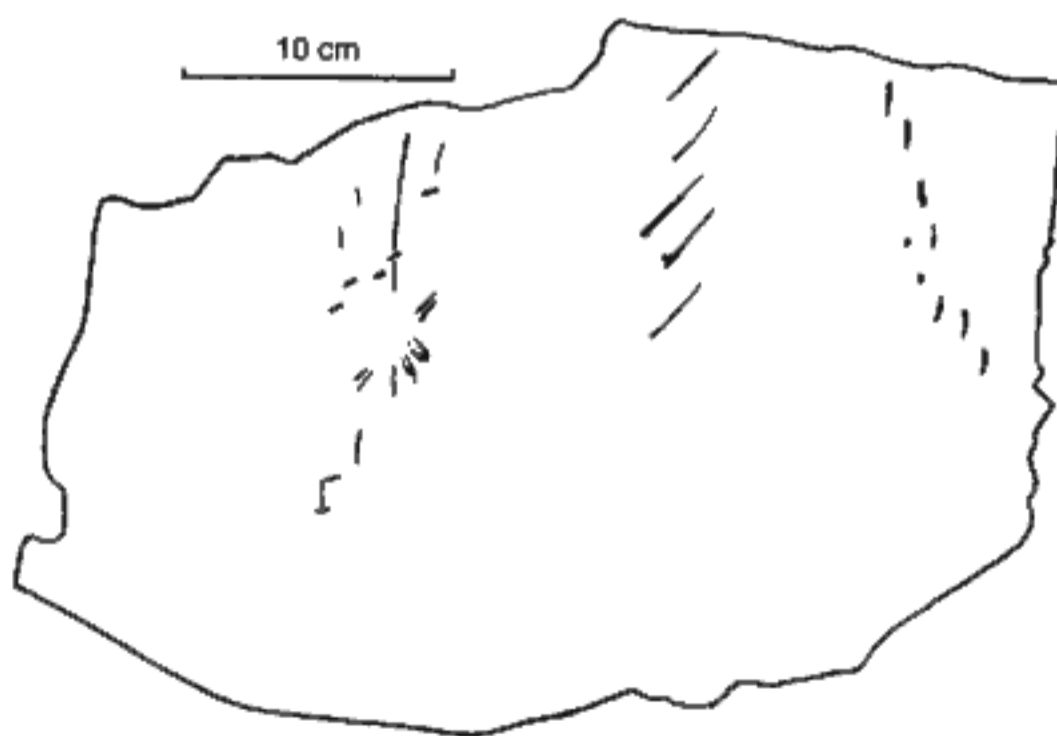
Description: Large slab (ca. 25 x 40 cm) of laminated siltstone to greywacke with several series of ridges. Right side of the sample (when orientated as Text-fig. 6) bears two series of ridges (originally grooves on the bottom). Left of them consists of five parallel, straight or very moderately bent wedge-shaped ridges. They are up to 25 mm long, their width of 2 mm declines gradually to distal ends. The ridges are at angle of 40° to the trace axis. Length of preserved part of the trace is 12 cm. Distances between the ridges (measured in a direction perpendicular to them) are 13–14 mm.

The right row is declined from the left one for 25°. It is moderately bent, formed by seven shorter ridges (ca. 8 mm long). These are conspicuously curved at one side of the preserved section, passing to straight on the opposite side. They are nearly parallel with the trace axis, declining from the direction of all the row at 10–20°.

Distance between the series of ridges varies from 80 mm to 122 mm.

Left part of the slab shows several other ridges which, however, do not allow us to reconstruct the pattern of their distribution. The longest solitary ridge, parallel to direction of the series and, therefore, oblique to the individual ridges, can be interpreted most probably as a flute mark. Other short ridges are parts of small series; therefore, their biogenic origin is plausible.

Remarks: *Dimorphichnus* is typically produced by trilobites (grazing obliquely to direction of movement – see,



6. *Dimorphichnus* isp. Schematic drawing of the possible crawling trace of a paradoxid trilobite, Slapnice – camp locality.

e.g., OSGOOD 1970). In the Paseky Shale of the Bohemian Early Cambrian, origin of *Dimorphichnus*-like traces by specific activity of probably eurypterid arthropods *Kodymirus vagans* CHL. et HAVL. and *Kockurus grandis* CHL. also seems possible (MIKULÁŠ 1995). The specimen described herein comes from a sequence of the Skryje Shale with common occurrence of the trilobite *Hydrocephalus carens* (BARR.) (mostly disarticulated carapaces). Comparison of the trace dimensions and the size of *H. carens* shows that the intervals between the ridges corresponds to the interval between pleurae and the total dimension is corresponding to complete specimens. Because of the joint occurrence, the described trace is considered to a probable grazing trace of a large paradoxid trilobite. This is the first trace fossil attributable with a certain probability to this important element of the Bohemian Middle Cambrian fauna.

*Diplichnites* DAWSON, 1873

*Diplichnites* isp.

Pl. IV, fig. 1; Pl. XXVI, fig. 1

Material: Two rock samples with the trace from the localities Pod trním (coll. V. Kordule and R. Mikuláš) and Dlouhá hora (coll. B. Bouček).

Description: Two parallel rows of minute imprints. Both the specimens are preserved as cleavage reliefs in laminated siltstones to fine-grained greywackes; this way of preservation made worse visibility of details of morphology. The specimen from the locality Pod trním is 23–26 mm wide and the preserved part (limited in both sides by a dimensions of rock sample) is 170 mm long. Individual imprints of one side show a roughly triangular shape; they are about 5 mm long and 2–3 mm wide, at intervals 5–6 mm, oriented at angle 50–60° to axis of the trace. Imprints of the opposite side are not so conspicuous; they are oval and shorter. Their intervals and orientation to the axis are the same as described above. The second find comprises three pairs of rows, e.g. three specimens can be distinguished on the slab. Their morphology is similar to the specimen from the locality Pod trním; both width of the traces, and dimensions of individual imprints are roughly half compared to that specimen.

Remarks: *Diplichnites* occurs most frequently in the Cambrian and Ordovician. It is usually interpreted as repichnion of arthropods including trilobites (e.g. OSGOOD 1970, HÄNTZSCHEL 1975, FILLION and PICKERILL 1990) but BRIGGS et al. (1979) advocated a more restricted usage of the name to exclude trilobite trackways. In the Paseky Shale of the Bohemian Early Cambrian, an exceptional origin of *Diplichnites*-like traces by the activity of *Kodymirus vagans* or *Kockurus grandis* was described (MIKULÁŠ 1995).

*Diplocraterion* TORELL, 1870

*Diplocraterion paralellum* TORELL, 1870

Pl. XXXI, fig. 8

1992 *Diplocraterion* sp.; FATKA et al. (1992), Pl. IV, fig. 10

Material: 1 specimen (full relief) collected by FATKA et al. (1992) at the locality Vinice a).

Description: Vertical U-shaped tube showing a spreiten-structure between the U branches. The tube is ca. 1 mm in diameter, smooth, unlined. Distance of the openings is 5 mm, depth of the structure 20 mm. The spreite is retrusive.

Remarks: For description, relations and figures of the ichnogenus and particular ichnospecies see FÜRSICH (1974), HÄNTZSCHEL (1975), CRIMES et al. (1977), BJERSTEDT (1988), BJERSTEDT and ERICKSSON (1989), FILLION and PICKERILL (1990), a.o. According to these authors, *Diplocraterion* is a dwelling burrow of suspension feeders characteristic of settings with stronger wave and current energy.

?*Diplocraterion* isp.

Pl. XII, fig. 6; Pl. XXXI, figs. 9–11

Material: Several tens of observations or collected finds from various localities [e.g., Vinice a), Ostrý, Dubinky a), Jezírka c), Buchava, Koníček, Potůček].

Description: Pairs of cross-sections of vertical tubes, joint with straight or curved cross-section of spreite lamina. The cross-sections of the tubes are distant usually 4–15 mm, 1–2 mm in diameter.

Remarks: These traces are most common in the beds where the bioturbation rate is generally high. Very probably, they represent horizontal cross-sections of *Diplocraterion*.

?domichnion igen. et isp. indet.

Pl. XXI, fig. 6

Material: Sole specimen (full relief) from the locality Rejkovice b).

Description: Smooth, thinly lined, vertical cylindrical shaft. Its uppermost part, i.e. the presumed opening, is probably not preserved. At the middle part, the trace branches suddenly to a few narrow, oblique arched tunnels. Preserved part of the shaft is 20 mm high, 4–6 mm in diameter.

Remarks: The overall morphology points to a dwelling function of the trace (analogies: *Skolithos*, *Lingulichnus*), or a “utility structure” might be concerned (analogies: *Chondrites*, *Pragichnus*).

fodinichnion igen. et isp. indet.

Pl. XIII, figs. 3, 4; Pl. XXXIV, figs. 6, 7

Material: Eight specimens of large inarticulate brachiopods bearing the described trace; Rejkovice b) and Koníček localities.

Description: Valves of inarticulate brachiopods, usually ill-preserved, damaged, 1–3 cm in diameter, whose walls are deformed to form moderately curved to winding ridges or grooves of various width (0.2 to 1.5 mm). One valve (or imprint of the valve) bears usually both ridges and grooves. The surrounding rock (usually silty to clayey shale) does not bear a visible bioturbate texture.

Remarks: Suggestive “feeding” pattern of the ridges and grooves points to a hypothesis that traces of heal of injuries caused by predators and/or internal parasitic organisms are concerned.

*Gyrolithes* DE SAPORTA, 1884

? *Gyrolithes* isp.

Pl. XXV, figs. 1–5; text-fig. 7

Material: One specimen from the locality Buchava (leg. I. Chlupáč), one specimen from the left bank of Karáskovský Brook, about 50 m N of the locality Pod trním (leg. V. Kordule).

Description: Helicoidal structures (full reliefs). Their axes are perpendicular to bedding. Both the specimens are preserved in clayey shales and are strongly compacted. The specimen from the Buchava locality is exposed by three horizontal rock fractures and its preserved part is 26 mm high. Diameter of the helicoidal body decreases along the vertical axis; because the specimen comes from debris, it is impossible to state with certainty whether the diameter is decreasing downwards or upwards. Diameter of the ichnofossil on the probably lowest fracture is 11 mm; that of the middle fracture is 13 mm, and it is 18 mm at the third (probably the uppermost) fracture. The second find is visible on one horizontal rock fracture. Diameter of that helicoidal body is 14.5 mm.

Surface of the helicoid is smooth, only the presumed uppermost part of the first find shows fine striae. Both the finds show a sinistral helicoid. It is formed of a fattened tunnel without preservable wall lining but the preserved uppermost part of one of the finds has a spreite-like lamina only. Reconstruction of the structure on Fig. 7 shows such a combination of the "tunnel and spreite" morphology. The tunnel may represent dwelling part of the trace and the upper one is a feeding structure.

Remarks: The name *Gyrolithes* is in modern literature used for burrows, forming a dextral or sinistral circular helix approximately upright in the sediment, showing the surface with or without wall structure or scratch marks; radius of whorls and diameter of tunnel rather constant (BROMLEY and FREY 1974, emended by FILLION and PICKERILL 1990). Several individual ichnospecies differ by dimensions, character of surface of tunnels and by regularity of coiling. As the original morphology of the tunnels is not clear fully and it is probably more complex, the described finds are placed to *Gyrolithes* with the reserve. *Gyrolithes saxonicus* (HÄNTZSCHEL 1934) was found in tidal environment of the Lower Ordovician of the Eastern Newfoundland by FILLION and PICKERILL (1990). There are numerous ethological interpretations but the opinion, that the domichnia are concerned, is prevailing (e.g., POWELL 1977).

*Helminthopsis* HEER, 1887

*Helminthopsis* isp. A

Pl. V, figs. 2, 3; Pl. XXX, figs. 4, 5

Material: More than 10 specimens (thin full reliefs) from the locality Buchava and Vinice d) and e).

Description: Smooth, unbranched, irregularly winding, strictly horizontal, tape-like bodies formed of fine-grained material compared with the surrounding rock. Width 3–10 mm, length of preserved parts (limited mostly by a size of the rock sample) more than 10 cm.

Remarks: The traces represent very probably repichnia.



7. ?*Gyrolithes* isp. Reconstruction of the dwelling-feeding system. Buchava locality.

The tape-like bodies from Buchava should originate by a sticking of clay particles to a mucus.

The few material does not enable a reliable ichnospecific determination. For detailed information on the ichnogenus and its representatives see KSIĄZKIEWICZ (1977), FILLION and PICKERILL (1990). The eurybathic fodinichnia are concerned, occurring, however, more often in deep-water flysch sequences (PICKERILL 1981).

*Helminthopsis* isp. B

Pl. V, fig. 1

Material: Sole convex hyporelief from "Skryje" (after indication by B. Bouček).

Description: The specimen from the collection of B. Bouček is a winding to meandering rounded ridge, 1.5 mm wide, totally 7.5 cm long. It is intersected by shorter ridge of the same width and shape.

Remarks: See remarks to *Helminthopsis* isp. A.

*Lockeia* JAMES, 1879

*Lockeia silliquaria* JAMES, 1879

Pl. III, fig. 8

Material: One slab of fine-grained subgreywacke bearing 12 specimens from the locality Vystrkov – Za hřbitovem (collection of B. Bouček).

Description: Smooth, almond-shaped bulges preserved as low convex hyporeliefs. Dimensions of the bulges range from 4 x 1 mm to 10 x 2.5 mm.

Remarks: The morphologically simple trace is considered to be a cubichnia of molluscs. For the description of the ichnogenus, its origin and representatives see PICKERILL (1990), MAPLES and SUTTNER (1990), a.o.

*Megagraption* KSIĄZKIEWICZ, 1968

*Megagraption* isp.

Pl. XXII, figs. 1, 3, 5; Pl. XXIV, fig. 2

Material: Four specimens from the localities Buchava and Dubinky a).

Description: Narrow, flat, smooth, horizontal, more or less curved "tapes" formed by a substance differing in colour and finer grain size from the surrounding rock. The "tapes" are branching at obtuse angles thus forming scarce open networks. Width of tapes is up to 2 mm, distances between branchings usually 2–5 cm. All the specimens are limited in measurable extent by a size of the collectible samples, but their original dimensions were probably considerable, at least several decimetres.

Remarks: The traces are very probably pascichnia. For a detailed description of the morphology of the ichnogenus see KŚIAŹKIEWICZ (1977). Palaeozoic finds of *Megagraption* are described, among others, by BENTON (1982) from the Upper Ordovician of Scotland, and by BJERSTEDT (1988) from the Early Mississippian of the Appalachian Mountains (outer shelf). *Megagraption* is a representative of a deep-water *Nereites* ichnofacies, namely in post-Ordovician sediments (FREY and PEMBERTON 1984).

*Monocraterion* TORELL, 1870

?*Monocraterion* cf. *M. tentaculatum* TORELL, 1870

Pl. XXXIV, fig. 2

Material: One specimen from the uppermost (rhythmical) layers at the Kamenná hůrka locality (Mileč sandstone); one specimen from Hrachoviště (*Eccaparadoxides pusillus* Zone, violet greywackes with conglomerate intercalations; leg. M. Szabad).

Description: Vertical shafts with funnel-like openings. The specimen from Kamenná hůrka locality is small (preserved vertical extent 7 mm, shaft diameter 1 mm, diameter of the "funnel" 5 mm; walls of the "funnel" are inclined to 40° from horizontal plane. The trace, originated in a coarse-grained sandstone, was filled with the overlying clay material. The find from the Hrachoviště locality shows a less regular shape and larger dimensions: vertical extent 33 mm, shaft diameter ca. 10 mm; the funnel is unsharply bordered but at least 20 mm of the diameter can be clearly distinguished. The trace was formed in fine-grained greywacke and filled with fine-grained glauconitic conglomerate.

Remarks: *Monocraterion* is common in many Phanerozoic shallow-water sediments (e.g., FILLION and PICKERILL 1990). Its morphology is close to *Skolithos*, and it is considered possible synonym of *Skolithos* by several authors (e.g., FREY and HOWARD 1985). For description of *M. tentaculatum* and its comparison with other ichnospecies see FILLION and PICKERILL (1990). The described specimens are placed to this ichnospecies with the reservation, because their original morphology might be more complex, or even the inorganic structures (e.g., "bubble-sand" textures) might be concerned.

*Monomorphichnus* CRIMES, 1970

?*Monomorphichnus* isp. (div. isp.)

Pl. XXVI, figs. 3, 4; Pl. XXVII, figs. 1–8; Pl. XXVIII, figs. 1–4

Material: Twenty specimens from the localities Vystrkov b)–d), Slapnice – camp, Dubinky, Jezírka b) and Buchava.

Description: Series of parallel to subparallel, thin (up to 1 mm) but up to 7 cm long smooth ridges (convex hypore-

liefs). They are straight or more often moderately curved to sigmoidal; usually their length declines to one of the ends. The series consist of 2–6 ridges, which are in a constant distance one to another, or, rarely, they are in pairs. This structure was often found altogether with flute marks.

Remarks: Basic scheme of morphology of both the specimens agrees with that of *Monomorphichnus* CRIMES, interpreted usually as repichnia of arthropods (see FILLION and PICKERILL 1990, CRIMES et al. 1977, CRIMES 1987 a.o.). Assessment of the described material, however, is complicated by the following circumstances: unevenness of the dimensions, poor preservation of many specimens and their common occurrence altogether with evident mechanic structures.

In the Central Bohemian Middle Cambrian, there is the lack of the sequences suitable for preservation of ichnofossils in hyporelief. Moreover, these are usually occupied by less diversified ichnoassemblage containing *Planolites* and "*Thalassinoides*" [e.g., Jezírka a) and Ostrý localities]. In the fossiliferous localities, where the „inner” trace fossils show mostly higher diversity (e.g., Buchava), there are rare manifestations of episodic sedimentation fossilising the surface traces. Therefore there is no material so far which would enable to distinguish mechanogenic and biogenic "hyporeliefs" with certainty, and most of the described and figured material must be placed to *Monomorphichnus* with the question mark. If the trace fossils are really concerned, they belong to *M. lineatus* CRIMES et al. 1977 (ridges in regular intervals) and *M. bilinearis* ALPERT, 1976 (pairs of ridges).

*Palaeohelminthopsis* igen. nov.

Diagnosis: Horizontal to subhorizontal, narrow, very long, unbranched, winding to moderately tortuous "tapes", trough-like in cross-section, longitudinally strongly striated. Inner space of the "trough" is reworked by the trace-maker; this bioturbation, however, is not sharply bordered by a distinctive wall.

Type ichnospecies: *Palaeohelminthopsis linearis* isp. nov.

*Palaeohelminthopsis linearis* isp. nov.

Pl. II, figs. 1–3; 5, 6; Pl. XXX, figs. 1–3

Holotype: Specimen figured on Pl. XXX, fig. 3 (RM 107).

Type horizon: Middle Cambrian, Skryje Formation.

Type locality: Buchava.

Material: About 20 specimens from the locality Buchava.

Description: See diagnosis of the ichnogenus. The collected specimens are up to 20 cm long but in each case their length is limited by the collected rock sample; therefore, they were much longer originally. Width is 2–5 mm. The moderate winding of the trace is more or less regular, showing "wave length" of 1–2 cm. The parallel longitudinal striae are very regular and continuous; there are 2–4 striae per 2 mm of the trace width.

Remarks: Most of the finds come from clayey or silty shales with only sparse intercalations of carbonatic sandstone. During a routine collecting work at the locality, they

are difficult to distinguish from convex hyporeliefs or concave epireliefs of *Palaeophycus striatus* HALL. However, vertical cross-sections of the rock show that cylindrical tunnels characteristic of *Palaeophycus* are not concerned; instead, the trough-shaped "tape" is the only well-distinct part of the trace. The tape is formed by the material of finer grain size compared to the surrounding rock.

Overall shape of the trace points to its appurtenance to repichnia (locomotion traces). The combination of fine clay material in a very thin matter of the "tape" may result from secreting the mucus; the striae can be traces of organs facilitating support in the substrate during a winding-like course of the movement.

Literary data on *Palaeophycus* come from PEMBERTON and FREY (1982), and FILLION and PICKERILL (1990). Among the traces whose ethological sense is similar to the presumed ethological significance of the new taxon, *Helminthopsis* HEER, 1877 could be mentioned (KSIAZKIEWICZ 1977, FILLION and PICKERILL 1990, WETZEL and BROMLEY 1996, HAN and PICKERILL 1995). *Helminthopsis*, however, is smooth and occurs usually as a convex hyporelief.

*Palaeophycus* HALL, 1847

*Palaeophycus sulcatus* (MILLER and DYER, 1878)

Pl. II, fig. 4; Pl. XXXIII, figs. 5–7

Material: Five specimens from the localities Buchava, Čilá, Dubinky b) and Biskoupky.

Description: Straight to slightly curved, branching or unbranched tunnels with thin wall linings, horizontally flattened (probably secondarily only). Wall surface is covered with short, sharp, anastomosing ridges and grooves. Preserved as full reliefs in siltstones and fine-grained greywackes. Length of preserved sections is up to 70 cm, diameter of tunnels up to 6 mm. A branched specimen from the locality Biskoupky show two branchings at acute angles.

Remarks: The finds are determined as *P. sulcatus* according to criteria given by PEMBERTON and FREY (1982) and respected by most subsequent authors. Tunnels of *Palaeophycus* represent dwelling burrows of predators and suspension feeders.

*Palaeophycus tubularis* HALL, 1847

Pl. XIII, fig. 6; Pl. XXXIII, fig. 1–4

Material: About 15 specimens (collected or observed in situ) from the localities Vinice j), Luh, Dubinky b), Jezírka c) and Buchava.

Description: Straight or slightly curved, smooth tunnels (full reliefs), showing a thin wall lining often of a different (usually darker) colour compared to surrounding rock – mostly fine-grained siltstone or clay shale. Tunnel diameter ranges from 3 to 7 mm, length of preserved parts up to 80 mm.

Remarks: Systematic determination of the finds follows the work of PEMBERTON and FREY (1982). These traces are considered to be domichnia.

*Phycodes* RICHTER, 1850

*Phycodes* isp.

Pl. XIX, fig. 1

Material: Sole specimen from the Vysrkov d) locality.

Description: System of arched branching tunnels. Places of branching are well-defined, and the individual "limbs" are inclined at angles of ca. 70°. Length of the system 50 mm.

Remarks: *Phycodes* is one of the most common feeding traces in the Palaeozoic. From the Barrandian area, *P. circinatum* was described by MIKULÁŠ (1998) from the Letná Formation (Upper Ordovician); CHLUPÁČ (1987) described it from the Ordovician of metamorphic roof-pendant on a Central Bohemian Pluton. For a modern description of the ichnogenus and ichnospecies and their relations see, a.o., FILLION and PICKERILL (1990), and HAN and PICKERILL (1994).

*Psammichnites* TORELL, 1870

*Psammichnites gigas* (TORELL, 1868)

Pl. VIII, fig. 1–6; Pl. IX, fig. 1–5; Pl. X, fig. 1–4

Material: Forty specimens from the locality Vysrkov a) (leg. M. Szabad and R. Mikuláš).

Description: Horizontal to subhorizontal, essentially transversely sculptured straight to strongly curved, broad "tapes" inside the coarse- to fine-grained micaceous greywacke. The "tapes" may be bordered by flat, smooth marginal segments; they are either unilobate or bilobate. The "tapes" are slightly arched in cross-section, having therefore trough-like shape; all the specimens of each rock samples show uniform orientation of the trough bottom. The traces are transversely striated. Most of the specimens show a very small vertical thickness of the "tape" (thin lamina in the sediment contrasting from the surrounding rock virtually by an orientation of the mica grains (which develops glimmering) as well as somewhat different colour resulting probably from more intensive precipitation of Fe-oxides and hydroxides on the laminar body. However, two specimens show a thin layer of obliquely laminated sediment, suggesting the active backfill.

The traces are 18–60 mm in width, and up to several decimetres long but they are in most cases limited by sizes of collected samples. Usual distance between transverse segmentation is 3–5 mm.

Remarks: Placing the traces to *Psammichnites gigas* follows the description and remarks by PICKERILL and PEEL (1990), FILLION and PICKERILL (1990) and SEILACHER and GAMEZ VINTANED (1995, 1996). The traces point to a presence of large benthic invertebrates without hard skeletons in the earliest Middle Cambrian of the Barrandian area.

*Planolites* NICHOLSON, 1873

*Planolites beverleyensis* (BILLINGS, 1862)

Pl. II, fig. 7; Pl. XIII, fig. 5; Pl. XXXV, figs. 1, 2, 4–7

Material: Several tens of finds (collected or observed in the field) from numerous localities of the Skryje and Jince Shales.

Description: Straight or moderately curved, smooth, exceptionally branching tunnels of circular outline, parallel

to bedding, filled with material differing from the surrounding rock. Preserved as full reliefs, or, when rhythmical sedimentation enables, as convex hyporeliefs (at Dubinky, Jezírka, Ostrý). They occur both solitary, or more often they largely cover some bedding planes (Pl. II, fig. 7). Diameter of tunnels ranges usually from 1 to 3 mm, length of preserved sections up to 30 mm. Tunnels present on one bed or bedding plane show usually a constant diameter.

Tunnels of corresponding morphology but of much larger dimensions were found rarely, e.g., at the locality Potůček (Pl. XIII, fig. 6).

Remarks: Assignment of these traces to *P. beverleyensis* follows the paper by PEMBERTON and FREY (1982).

*Planolites montanus* RICHTER, 1937

Pl. IV, fig. 3; Pl. XIII, fig. 2; Pl. XXXV, fig. 8

Material: Several tens of specimens (collected and observed in situ) from various localities.

Description: Narrow, subhorizontal, smooth, curved to tortuous passages, often branching, without wall lining, occurring often in larger amount at the same layer. Fill is passive and at lithological boundaries it often contrasts by the colour from the surrounding rock. Diameter of the passages 1–3 mm, length of preserved sections usually up to 20 mm.

Remarks: Taxonomical assessment of the described trace follows the work of PEMBERTON and FREY (1982). Where the intensity of the bioturbation is higher, the overall picture of the bioturbate texture is hardly classifiable

ichnotaxonomically and may be confused with the mass occurrence of "*Thalassinoides*" isp.

*Planolites* isp.

Pl. XXIX, figs. 4, 8

Material: Ca. 15 finds from the *Paradoxides gracilis* Zone [upper layers at Vystrkov, Vinice i), Písky and Potůček localities].

Description: Simple, straight to moderately curved tunnels showing a high concentration of larger (several mm) bioclasts (usually echinoderm plates, less often parts of trilobites) in their fill. Length of the tunnels up to 10 cm, width ca. 1 cm. The bioclasts do not show any preferred orientation.

Remarks: The material of the filling is comparable with that of *Rejkovicichnus necrofilus* MIKULÁŠ et al., 1996 (see below); however, in contradiction to *Rejkovicichnus*, there is no preferred orientation of the bioclasts. Tunnel-like forms without specific pattern of filling must be placed to the ichnogenus *Planolites* NICHOLSON in agreement with the paper of PEMBERTON and FREY (1982) and numerous subsequent authors. However, I do not exclude a similar origin of *Planolites* isp. and *Rejkovicichnus necrofilus*, because of the proximity of the stratigraphical level, of probably comparable dimensions of the tracemakers, and because the concentration of the large bioclasts in the *Planolites* fill is quite unusual.

*Rejkovicichnus* MIKULÁŠ, KORDULE and SZABAD, 1996

Diagnosis: Large endichnial structures, showing – if fully developed – the form of straight to moderately curved "walls". Their fill contains large amount of disarticulated parts of body fossils. Other structure or orientation of bioclasts may be none, or the wall may be dissected to horizontal trough-like bodies analogical to the ichnogenus *Teichichnus* SEILACHER. Bioclasts in the fill of these "troughs" may be oriented randomly, or they may form a meniscate structure analogical, e.g., to *Taenidium* HEER (MIKULÁŠ et al. 1996).

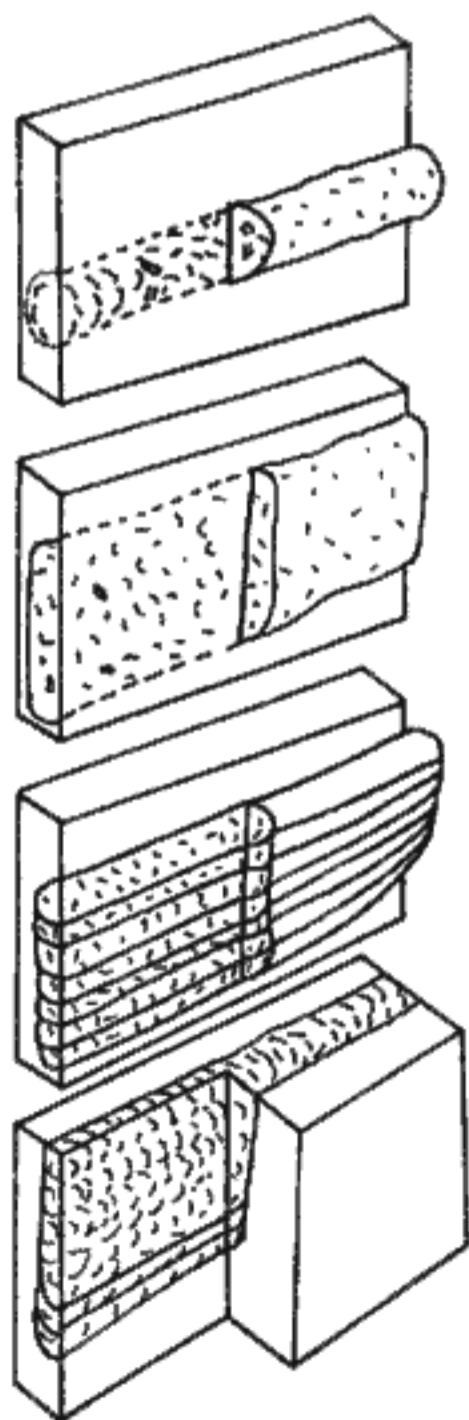
Type ichnospecies: *Rejkovicichnus necrofilus* MIKULÁŠ et al., 1996.

*Rejkovicichnus necrofilus* MIKULÁŠ, KORDULE and SZABAD, 1996

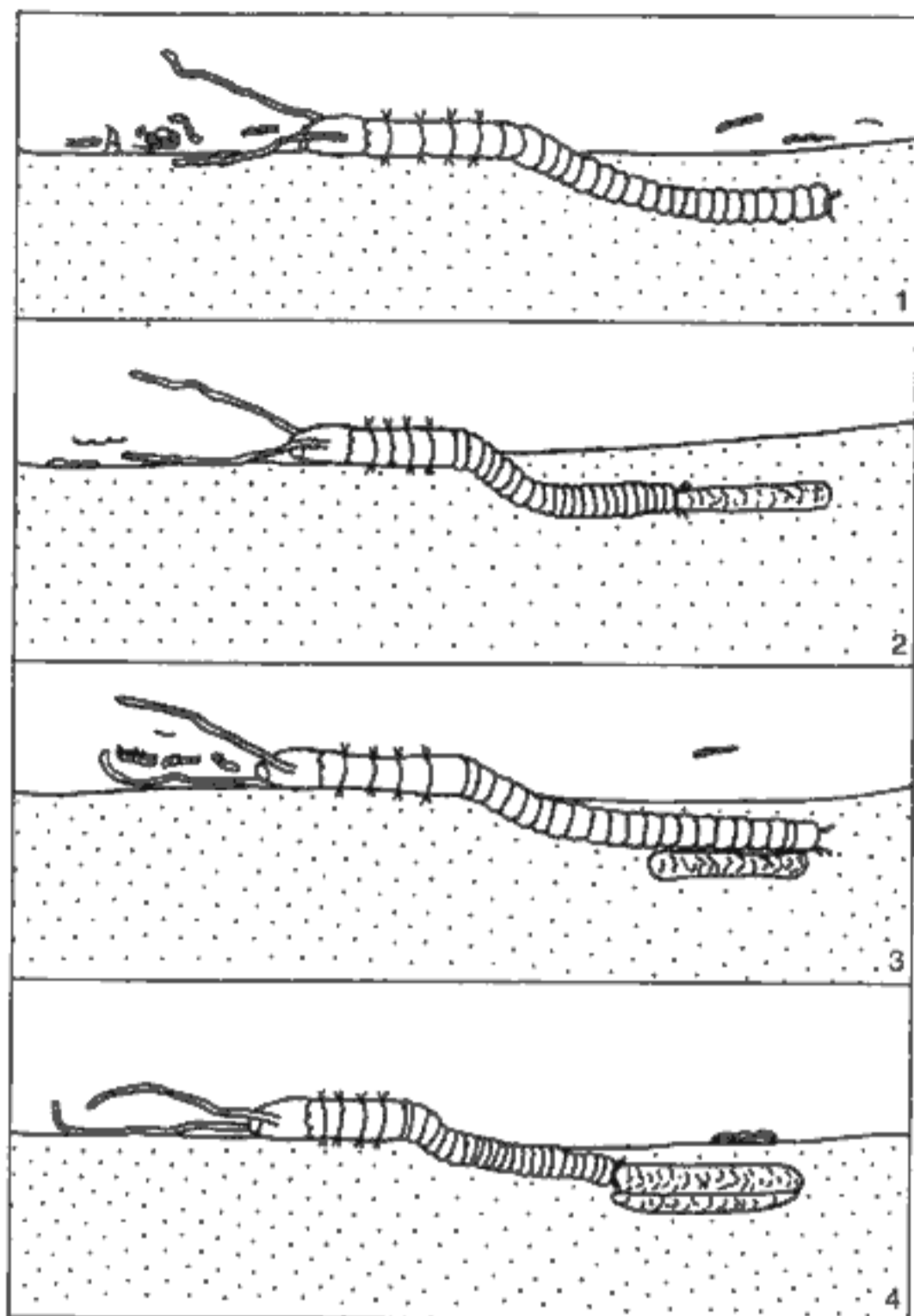
Pl. XIV, figs. 1–8; Pl. XXIX, figs. 1–3; 5–7; text-figs. 8, 9

Material: About 60 specimens from the localities Potůček a), b), and c).

Description: See diagnosis of the ichnogenus. These endichnial traces were found to be preserved as full reliefs, showing virtually a continuous spectrum of forms. Character of fill, dimensions and a horizontal direction of the action of the tracemaker were regarded as unifying elements. The most common form (about 60 % of collected specimens) are long (more than 20 cm), 5–25 mm wide and up to 6 cm high vertical walls contrasting from the surrounding rock by its filling. The fill contains great amount of body fossils of trilobites and echinoderms. The trilobites *Litavkaspis rejkovicensis* (complete specimens, some enrolled, and numerous parts of disarticulated carapaces),



8. *Rejkovicichnus necrofilus* MIKULÁŠ et al., 1996. Schematic drawing of various types of morphology and arrangement of bioclasts in the fill. Approx. natural size. After MIKULÁŠ et al. (1996).



9. *Rejkovicichnus necrofilus* MIKULÁŠ et al., 1996. Speculative reconstruction of the *Rejkovicichnus* producer if we presume its suspension feeding. After MIKULÁŠ et al. (1996). Figures 1–4 represent individual phases of feeding and burrowing.

*Eccaparadoxides pusillus* and *Conocoryphe cirina* (disarticulated), and isolated plates of ctenocystoid and trochocystoid echinoderms are observable in the fill; numerous further body fossils are probably present here but they cannot be distinguished because of their fragmentary character. The colour and the grain size of fillings may be both the same and different from the surrounding rock. In some cases, height of the described walls may only moderately exceed the trace width.

About 60 % of the collected specimens (both the “tunnels” and the “walls”) were found to have a random orientation of minor bioclasts and no visible structure of the matrix. Large, elongate bioclasts (as pleurae of trilobites) are oriented mostly perpendicularly to the trace axis. Ten or even more collected specimens are evidently dissected to horizontal, virtually piled-up “troughs”, well-visible in vertical sections of rock samples (analogy to *Teichichnus*).

These troughs are most frequently several millimetres thick, and they are separated by more or less conspicuous divisional planes in the matrix. Therefore, presence of troughs is not given by an orientation of bioclasts. About one third of the known specimens was found to show a suggestion of meniscate (arcuate) structure in the filling of the tunnel of individual troughs (this structure is therefore visi-

ble on rock fractures or sections corresponding to bedding).

The meniscate structure is demonstrated (on the contrary to trough-like structure) mostly by the orientation of the bioclasts, mostly several millimetres long particles of trilobite carapaces.

Morphology of lateral margins of the trace remained somewhat uncertain because of a fragmentary preservation of most collected samples, but these features of the trace were stated to be probably analogical to *Teichichnus* (i.e., a gradual lowering of both the margins of the “walls”).

Remarks: *Rejkovicichnus* is considered to result from a complex feeding behaviour. MIKULÁŠ et al. (1996) argued for a suspension- or sediment-feeding; later MIKULÁŠ (unpubl. report) re-interpreted the trace as an early example of “gardening”, most probably by small trilobites.

repichnion igen. et isp. indet.

Pl. XXXIV, fig. 3

Material: One specimen (favourably preserved full relief) from the locality Buchava.

Description: Thin, narrow, transversely striated “tape”, crossing the substrate obliquely and then showing an abrupt change into the horizontal direction. Width 6 mm, length of the preserved segment 30 mm; there are 8 to 12 irregular, often moderately coalescing or branching transverse lines.

Remarks: The solitary find cannot be placed with certainty to any of the existing ichnotaxa. Very probably, repichnion or fugichnion of the “worm-like” animal with a flat body is concerned.

*Rhizocorallium* ZENKER, 1836

*Rhizocorallium* isp.

Pl. VI, figs. 1, 2

Material: Two casts from the collection of B. Bouček; localities unknown.

Description: Large horizontal spreiten-structures showing an U-like course of individual feeding probes. Dimensions of more completely preserved specimen (Pl. VI, fig. 2): width 42 mm, length 75 mm. The spreiten-structure is not bordered by a distinctive tunnel.

Remarks: In the collection of the Cambrian trace fossils of B. Bouček, two casts of the described spreiten-structures were also present; photographs of them (probably for a publication prepared by B. Bouček) were also enclosed. No other information, however, was at a disposal. Because I did not find any similar trace fossils in the Bohemian Cambrian so far, I decided to publish at least this information on a probable occurrence of *Rhizocorallium* here.

Appurtenance to *Rhizocorallium* follows the descriptions and figures in KŚIAŹKIEWICZ (1977), HÄNTZSCHEL (1975), FÜRŠICH (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); but occurrences in deep-water sedi-



ments are also known (e.g., PICKERILL, HURST and SURLYK 1982).

*Rusophycus* HALL, 1852

?*Rusophycus* isp.

Pl. XXV, figs. 6, 7; ?Pl. XII, fig. 7

Material: One sample of clay shale with one complete and one fragmentary trace from the locality Vinice i); several other very doubtful specimens corresponding roughly to the morphology of *Rusophycus*.

Description: The find from the Vinice i) locality (concave epirelief) is a coffee-bean shaped bilobate pit dissected longitudinally by a sharp ridge. Maximum length is 24 mm measured close to one of the ends of the trace; towards the opposite end, the trace narrows. Length is 33 mm. Surface of the lobes is smooth but it is slightly weathered. The second specimen – the pit touching upon the margin of the first one – is incomplete, broken longitudinally, showing the dimensions comparable to the first one. There are other divisional planes (parallel to the visible surface of the trace) observable on the rock fracture; therefore, the structure is a "cleavage-relief". Depth of the pit is 3–4 mm.

Remarks: Overall morphology of the trace corresponds to *Rusophycus*; this ichnogenus is typically preserved as a convex hyporelief, showing striae made by individual tracemaker's limbs during the burrowing. In the Jince and Skryje Shales, the potential for preservation of surface traces is high in places, but these layers are usually poor in finds of trilobite and other shelly fauna. I presume that the described specimen represents a *Rusophycus* preserved exceptionally in more-or-less homogeneous, fine-grained rock, as epirelief continuing into cleavage-relief. Because of the find is solitary and it was found in the debris and therefore there is no direct evidence of its toponomy, I place it to *Rusophycus* with a question mark.

*Rusophycus* is very often found in the Early Palaeozoic Cruziana ichnofacies. Undoubtedly the cubichnia of trilobites are concerned. Individual ichnospecies are detailedly described, e.g., by OSGOOD (1970), BALDWIN (1977), SEILACHER (1970), CRIMES et al. (1977), CRIMES (1975), CRIMES and MARCOS (1976).

*Scolicia* DE QUATREFAGES, 1849

*Scolicia* isp.

Pl. IV, fig. 2

Material: Sole specimen (convex hyporelief) from the collection of B. Bouček; the locality designation "Skryje" may represent various localities in the Skryje area.

Description: Trail, moderately sinuously waving; width of preserved section 3–5 mm, length of preserved section 40 mm. There are two narrow parallel ridges close to the trace axis, 1.5 to 2 mm distant.

Remarks: The trace has been placed to morphologically variable ichnogenus *Scolicia* representing repichnia of various benthic organisms on the basis of description and figures by HÄNTZSCHEL (1975), BJERSTEDT (1988), FILLION and PICKERILL (1990), a.o.

*Skolithos* HALDEMAN, 1840

*Skolithos* isp.

Pl. XXXIV, fig. 1, 4

Material: From the locality Vinice d), several samples of silty shales intercalated with fine-grained siltstone, with numerous specimens of ?*Skolithos* isp. From some other localities [e.g., Dubinky, Vystrkov d), Buchava], numerous finds of cross-sections possibly of this ichnotaxon.

Description: The material from the Vinice d) locality is represented by vertical shafts, filled with contrasting material. Diameter of the shafts 0.6–3.0 mm, depth up to 30 mm, usual distance of neighbouring shafts 1–5 mm. Upper parts of the shafts are often affected by the bioturbation of higher tier. Walls of the tubes are hardly preparable but probably always smooth and unlined. The tubes were formed in an intercalation of the light sandy substrate in the sequence with prevailing siltstones and fine-grained greywackes. The other named localities yielded circular cross-sections (mostly preserved as convex hyporeliefs) of the same diameter as described above, but they do not show corresponding vertical components.

Remarks: The material from the Vinice d) locality is attributable to the ichnogenus *Skolithos* HALDEMAN. It is the ichnofossil giving the name to the *Skolithos* Ichnofacies (e.g., SEILACHER 1967, FREY and PEMBERTON 1984) which characterises shifting substrates under a high level of water waving and currents. For systematic ichnology of *Skolithos* and its ichnospecies see, e.g., OSGOOD (1970), ALPERT (1974, 1975), FILLION and PICKERILL (1990). *Skolithos* is typically a dwelling burrow. However, in the described material, the vertical shafts might represent also escape structures, because the walls are not sharp.

The material from other localities may be attributed to *Skolithos* with certain probability only: the possibility that the circular cross-sections belong to other, more complex ichnotaxon comprising vertical shafts (e.g., *Thalassinoides*) exists.

*Skolithos rotundus* isp. nov.

Pl. III, figs. 1–6; Pl. XXI, figs. 1–5, 7

Holotype: Specimen figured on Pl. III, fig. 1.

Type horizon: Middle Cambrian, Jince Formation, *Hydrocephalus lyelli* Zone.

Type locality: Rejkovice – right bank of Litavka Brook.

Material: More than 20 specimens collected and several others observed in situ; Vinice d), Rejkovice a) and b) localities.

Diagnosis: Relatively shallow, large-diameter *Skolithos* with finger-, pot- or goblet-like base of the shaft.

Description: Vertical and subvertical shafts in siltstones to greywackes, mostly circular in cross-sections, exceptionally moderately elliptical. Walls are more or less smooth, often showing sparse and irregular annulation, rarely finely longitudinally striated (Pl. III, fig. 4). Wall lining is not present (with exception of one vertical shaft having about 1 mm thick lining, but its appurtenance is doubtful). Fill is either homogeneous or it shows fine horizontal lamination similar to surrounding or overlying rock. Bases of the shafts are of variable shape, therefore "pot-like",

"goblet-like" and "finger-like" specimens may be distinguished. One specimen shows a very long narrow "initial shaft" below the main one. It is difficult to find specimens apparently not truncated by erosion. Depth of the shafts is usually about 30 mm, maximum 55 mm, diameter 5–11 mm.

Remarks: The ichnofossil show some resemblance to "plug-shaped" ichnofossils revised by PEMBERTON et al. (1988). Also the ichnogenus *Lingulichnus*, erected for vertical to slightly inclined burrows with elliptical cross-section is similar. However, the prevailing morphological feature of the trace is a vertical cylindrical shaft, therefore the trace belongs to *Skolithos*. None of so far existing ichnospecies of *Skolithos* is characterised by the finger-, pot- or goblet-like base.

#### *Taenidium* HEER, 1877

##### *Taenidium* isp.

Pl. XXXVI, figs. 1–4

Material: Four finds (full reliefs) from the localities Jince – Ovčín, Buchava and Písky.

Description: Cylindrical, straight to slightly curved, non-ramifying, horizontal tunnels, showing a regular, fine meniscate filling. Diameter 4–6 mm, length of preserved parts several centimetres 22 mm. Wall lining is not present.

Remarks: Using conclusions by D'ALESSANDRO and BROMLEY (1987) and subsequent authors, these traces correspond to *Taenidium* HEER. Actively filled traces of sediment feeders are concerned.

#### *Teichichnus* SEILACHER, 1955

##### *Teichichnus rectus* SEILACHER, 1955

Pl. VII, figs. 2, 3; Pl. XI, figs. 4, 5; Pl. XII, figs. 1–4; Pl. XXXII, figs. 8–10

Material: Several tens of specimens (collected or observed in situ) from various localities [Vinice, Vystrkov a), Jezírka, Buchava, a.o.].

Description: Spreiten-structure resembling troughs piled up in a vertical plane, oriented upwards by their concave surfaces. The troughs are straight or slightly curved. The uppermost trough is bordered by a tunnel of oval cross-section. Width of the trace usually 8–15 mm, length up to 100 mm. The trace is composed usually of a small number (2–4) of troughs. In vertical plane, some traces show a shape of a very broad "U" letter. In some cases, the troughs separate one to another in marginal part of the trace, forming therefore a simple bunch-like system.

Remarks: *Teichichnus* is a very frequent inner feeding trace known from the Late Proterozoic up to Cenozoic. Description, figures and discussions are, e.g., in the papers of SEILACHER (1955), PICKERILL and FORBES (1979), CRIMES et al. (1977), BALDWIN (1977), CRIMES (1987), FREY and BROMLEY (1985), FREY and HOWARD (1982), BJERSTEDT (1988), BJERSTEDT and ERICKSON (1989). In the material from the Bohemian Middle Cambrian, numerous fragmentary specimens of *Daedalus* isp., showing the trough-like proximal part of feeding probes only, may be considered to *T. rectus*. Moreover, some specimens represent a mixture of *Daedalus* and *Teichichnus* morphology. Describing the palaeontological content of the locality Buchava, CHLUPÁČ (1993) design-

ated them as "complex burrow systems of *Teichichnus* and/or *Phycodes*".

#### *Teichichnus multiplex* isp. nov.

Pl. XI, fig. 3

Holotype: Specimen figured on Pl. XI, fig. 3 (RM 018).

Type horizon: Middle Cambrian, Jince Formation, *Ellipsocephalus hoffi* Zone.

Type locality: Koníček.

Material: Holotype (imprint of full relief in a slab of fine-grained subgreywacke) only.

Description: Retrusive spreiten-structure developed on a plane vertical to bedding. Individual lamellae of spreite as well as the tunnel bordering the upper margin of the trace (i.e. the individual feeding probes) show a characteristic "wavy" course. Therefore, the structure can be easily described as a linear series of specimens of *T. rectus* SEILACHER. Troughs and the upper tunnel, however, pass gradually from one segment to another.

The structure is preserved in 10 cm thick layer of fine-grained subgreywacke. It is oriented slightly obliquely (at the angle of 25°) to the bedding. The preserved segment, limited in both ends by a rock fracture, is 16 cm long, and vertical extent of the spreite is ca 26 mm. The individual feeding probes are not always well-visible; 14 probes were recognized as a maximum. The specimen shows clearly three individual segments ("waves").

Remarks: As mentioned in the description, *T. multiplex* may be understood as a series of specimens of *T. rectus*. The described feature has not yet been described for *Teichichnus* and therefore it is considered a sufficient ichnotaxobase for the new ichnospecies. Other ichnospecies of *Teichichnus*, namely *T. stellatus* a *T. zigzag*, are morphologically easily discernible.

#### *Thalassinoides* EHRENBERG, 1944

##### *Thalassinoides* cf. *foedus* MIKULÁŠ, 1990

Pl. XXII, figs. 2, 4; Pl. XXIII, figs. 1, 3; Pl. XXIV, fig. 1

Material: Five specimens from the localities Buchava, Dubinky a) and Vinice.

Description: Horizontal tunnels, in most cases slightly to moderately striated to sulcated, forming networks with both closed and open "nets". Diameter of the tunnels is either constant, or the width increases in the vicinity of the branchings (but bulbous structures near the branchings are not developed). The branching tunnels show the "Y"-pattern (the angle is close to 120°). Width of the tunnels is 2.5–7 mm, diameter of the meshes 4–7 cm. Fill of the tunnels is probably passive, structureless, either of a different colour and grain size compared to surrounding rock, or identical. None of the five collected specimens show an original horizontal extent of the network. No vertical structures attributable to this trace are known so far.

Remarks: The ichnogenus *Thalassinoides* has been recently recorded as a frequent ichnofossil in the Early Palaeozoic, especially the Cambrian and Ordovician (DROSER and BOTTJER 1988a, 1988b, 1989, BOTTJER et al. 1984a, 1984b, FILLION et al. 1990, SHEEHAN et al. 1984, MIKULÁŠ

1990). As proposed by BOTTJER et al. (1984a), the Early Palaeozoic tracemakers of *Thalassinoides* might be reduced sharply by the Late Ordovician extinction: phyllopodids are one of the groups that might be involved in this process. Therefore, the occurrence of *Thalassinoides* in the Barrandian Middle Cambrian is not surprising and it corresponds well with the presumed assessment of the relevant ichnoassemblages to the *Cruziana* Ichnofacies (although *Cruziana* has not been found there). *T. foedus* was described by MIKULÁŠ (1990) from siltstones and fine-grained sandstones of the Zahořany Formation (Upper Ordovician of the Barrandian area). It consists of horizontal network systems of tunnels; size of polygons is up to 15 cm and width of tunnels ca. 15 mm. Their surface is smooth or sulcate. The specimens found in the Bohemian Middle Cambrian differ from *T. foedus* only in minor (about half) dimensions and in the widening of the tunnels close to the branchings in some specimens. For relations of *T. foedus* to other representatives of the ichnogenus see MIKULÁŠ (1990).

*Thalassinoides* cf. *suevicus* (REITH, 1932)

Pl. XXIII, fig. 2

Material: Sole, favourably preserved specimen (full relief) from the locality Luh (coll. P. Šlehofer).

Description: Horizontal network of tunnels forming closed pentagonal and hexagonal meshes. The tunnels are of constant diameter (2.5–3 mm), their surface is smooth; sections between branchings are straight or curved. Inner diameter of the meshes varies from 8 to 18 mm. Fill of the tunnels contrasts in its yellow colour from the surrounding greyish-green shale: it is formed by greywacke, originally probably carbonatic and cemented secondarily by limonite. Preserved part of the trace occupies area of 7 x 10 cm. There are no or sparse widenings of the tunnels close to the branchings.

Remarks: *Thalassinoides suevicus* has been described by numerous authors (e.g., FREY and BROMLEY 1985, FREY and HOWARD 1985; 1990) mostly from the Cretaceous. The above-mentioned authors place to *T. suevicus* more or less regular tunnel systems, mostly horizontal, Y-branching, showing tunnel diameter usually more than 1 cm. The find from Luh falls to this diagnosis except of the minor size. Regardless a mere one-parameter difference in size is considered generally as a poor ichnotaxobase, the specimen is placed to *T. suevicus* with the reservation.

*Thalassinoides* isp.

Pl. XXIII, fig. 4; Pl. XXIV, figs. 3, 4

Material: Several tens of rock samples with the described trace from various localities [e.g., Koníček, Ostrý, Medový Újezd, Dubinky a), Jezírka c)].

Description: Irregular subsurface tunnel systems showing roughly comparable amount of vertical, oblique, and horizontal components. The vertical ones are short and their mouths are distant at the horizontal fractures or polished sections at 2–5 mm. The horizontal and oblique components are straight or (more often) curved tunnels, in places Y-branching. Diameter of the shafts and tunnels

varies from 2 to 5 mm. Fill is passive, often contrasting from the surrounding rock by its composition and colour.

Remarks: The trace occurs typically in rhythmical sequences (greywackes alternating with shales), covering considerable areas of beds and bedding planes. It often passes to undeterminable bioturbate texture.

## 6. Character of the ichnoassemblages

The ichnofacies characteristics of the locality Buchava, published by CHLUPÁČ (1993), i.e. "the rather shallow-water *Cruziana* Ichnofacies: frequent epi- and intrastratal, planar or oblique burrows mostly ranged with *Fodichnia* (feeding structures) and *Pascichnia* (grazing traces) made by deposit feeders" is generally acceptable for most of the localities of the Skryje and Jince Shale. The ichnofacies evaluation using the concepts published, e.g., by FREY and PEMBERTON (1984), FREY, PEMBERTON and SAUNDERS (1990) and BROMLEY and ASGAARD (1991) has been involved to preliminary reports on the ichnological study of the Cambrian of the Barrandian area (MIKULÁŠ 1993, 1994). These preliminarily published conclusions have been supplemented during the last phase of the fieldwork and laboratory study.

The first phase of the marine transgression in the Brdy area is documented by finds of *Diplocraterion parallelum* in the lowermost layers of the Jince Formation (siltstones alternating with greywackes and subgreywacke layers of various thickness). *Diplocraterion* is a representative of the Skolithos Ichnofacies (e.g., FREY and PEMBERTON 1984) typical for shifting substrates in settings of high physical energy. The Skolithos Ichnofacies shows usually low diversity (but in places high density) of the original benthic assemblage. The localities of the middle part of the Jince Formation, and the Skryje Shale, yielded most often the following ichnofossils: *Planolites* isp., *Teichichnus rectus* SEILACHER, 1955, *Daedalus* isp., *Thalassinoides* div. isp., *Palaeophycus* isp., coprolites, and in places a taxonomically unrecognizable bioturbate texture is also important. Locally, very specific forms as *Amanitichnus omittus* CHLUPÁČ et MIKULÁŠ, 1995 (the Buchava locality) or *Rejko-vicichnus necrofilus* MIKULÁŠ et al., 1996 (the Potůček locality) are also common. The ichnoassemblages may be placed to the *Cruziana* Ichnofacies (e.g., PEMBERTON and FREY 1984), representing most often a shallow sublittoral, below a daily wave base and above a storm wave base. This was the space for the development of the most diversified benthic assemblages in siliciclastic substrates in the Early Palaeozoic, comprising may K-selected forms (e.g., Pemberton /ed./ 1992).

From the upper part of the Jince Formation, finds of *Skolithos rotundus* isp. nov., *Daedalus* isp., "*Thalassinoides*" isp. and *Skolithos* isp. are common. This assemblage is comparable with the Skolithos Ichnofacies by a low diversity, high density and numerous vertical components of the burrows.