A new spreite trace fossil from Lower Cretaceous limestone (Western Carpathians, Slovakia)

Jozef Michalík and Vladimír Šimo

Dúbravská cesta 9, P.O. Box 106, 840 05, Bratislava, Slovakia
Email: vladosimo@yahoo.com; geolmich@savba.sk

ABSTRACT: *Zavitokichnus fusiformis* n. igen. et n. isp. occurs in Lower Cretaceous (Valanginian to Hauterivian) limestones of the Fatric Superunit in the Western Carpathians. Typical cross sections of this more or less spiral trace fossil are sometimes U–O–C–S-shaped. In cross-section the trace fossil passes from a simple linear form, and spreads to a wider rolled-up or rolled-out form and then it returns to a linear trace. Spreite-like lamellae are distinguishable on several cross-section examples. The trace fossil was produced by a deposit feeder and it might be classified as a fodinichnion. *Z. fusiformis* co-occurs with trace fossil associations of *Zoophycos*, *Chondrites*, *Planolites*, *Hormosiroidea* and *Palaeophycus* in carbonate sediments of a deep-seated ramp along the margin of the Fatric intrashelf basin.

KEY WORDS: Early Cretaceous, serial sectioning, spreite structure, *Zavitokichnus fusiformis*, 3D reconstruction

The morphological structure of *Zavitokichnus fusiformis* n. igen. et n. isp. was studied in detail using serial cross-sections. In this paper, sections of the trace fossils and their position within the ichnoassemblage are shown. The specific shape of the trace fossil, in combination with a spreite-like lamellar structure, was observed at five different localities in the Western Carpathians. It typically occurs in the Lower Cretaceous Mráznica Formation (Borza *et al.* 1987; Michalík & Vašíček 1987) and has not been observed in similar Lower Jurassic bioturbated pelagic limestones of the Janovky Formation (Gaździcki *et al.* 1979; Wieczorek 1989), which is analogous with the Lower Jurassic 'fleckenmergel-like' Allgäu Limestone of the Northern Alps (Lefeld *et al.* 1985; Wieczorek 1995). *Zavitokichnus* has never been reported from Lower Cretaceous 'spotted' pelitic limestone. *Zavitokichnus* might be of stratigraphical significance in the Western Carpathian area.

The aims of this paper are to provide a detailed morphologic description and three-dimensional reconstruction of the trace fossil, to display a trace fossil ichnofabric tiering model showing superposition of the newly described ichnogenus within the ichno-association, and to discuss the stratigraphic occurrence of *Zavitokichnus*.

1. Geological and geographical setting

The trace fossil occurs in Butkov Quarry (Lat. N49°02′40, Long. E18°32′96) at Ladce (the Manín Unit), also at the Kamenná locality (Lat. N49°00′45, Long. E18°29′85) near Košeca; at Horná Poruba (Lat. N48°94′, Long. E18°30′5) near Ilava; at the Polomec locality (Lat. N49°72′, Long. E18°71′) at Lietavská Lúčka (the Fatricum Superunit; Fig. 1); and at Dubovec Hill near Nová Dubnica (Lat. N48°56′05, Long. E18°07′53). The first locality represents a continuously exposed hemipelagic limestone sequence of Jurassic to early Albian age. The Lower to Middle Cretaceous succession exposed there encompasses the Ladce Formation, the Mráznica Formation, the Kališčo Formation and the Lúčkovská Formation (Borza *et al.* 1987; Michalík & Vašíček 1987; Michalík *et al.* 2005). The trace fossil described here occurs within the Ladce and the Mráznica Formation in Butkov and Polomec quarries (Fig. 2). *Zavitokichnus fusiformis* occurs in Lower Valanginian strata in Butkov Quarry, but in Hauterivian strata in the Krížna Nappe. This trace fossil is indicative of the bioturbated limestone lithofacies of the Lower Cretaceous Ladce and Mráznica formations. This limestone forms the Valanginian–Aptian section of the sequence in the frontal parts of the Krížna Nappe (Michalík & Vašíček 1987), but the Lower to Upper Valanginian interval in the Manín Unit (Borza *et al.* 1987). The Mráznica Formation occurs in the Krížna Nappe of the Strážov Mts, the Malá Fatra Mts, the Vel'ká Fatra Mts up to the northern slopes of the Vysoké Tatry Mts, and in the Nízke Tatry Mts (Michalík & Vašíček 1987). The relatively wide range of occurrence over 200 km does not support a regional endemic character for this trace fossil.

2. Material and methods

Approximately fifty samples containing a new trace fossil were collected. A sample containing two specimens of the trace fossil includes the holotype (numbered Z 24702a) and the samples designated as paratypes are numbered Z 24702b, Z 24703–Z 24705 and Z 35439–Z 35465. Part of the collection includes a type series covering the diverse shapes of the trace fossil (numbered Z 35466–Z 35501). Type material includes a plaster cast model (No. 35505a) and separate images of sections on which the 3-D reconstruction is based (No. Z 35507a, b, c; Z 35505b). Samples Z 35506 and Z 35455 illustrating the original orientation of *Zavitokichnus* are also included in the material.

Four complete series of serial sections (0·1–0·4 mm) have been prepared (Fig 3). This technique was selected for samples containing complete specimens of the trace fossil. Serial sectioning was made by step-by-step grinding and polishing of

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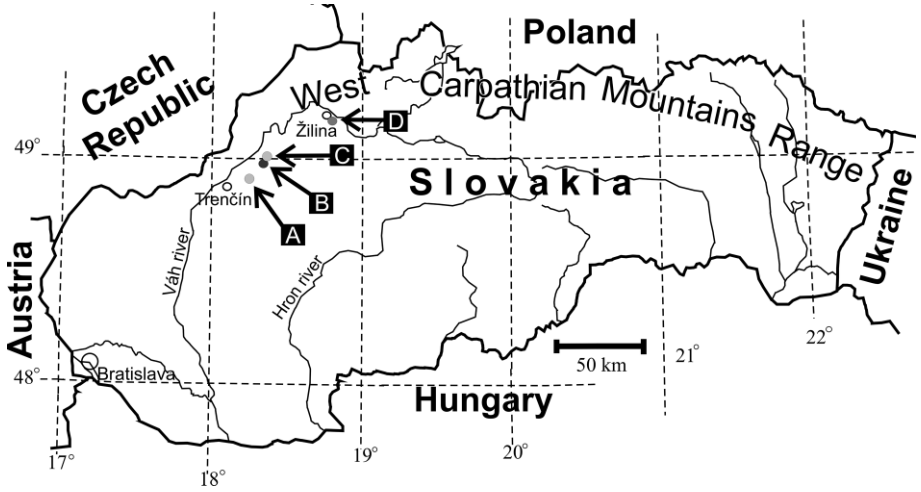

Figure 1 Locality map. A=Horná Poruba near Ilava; B=Kamenná locality near Košeca; C=Butkov Quarry near Ladce; D=Polomec locality near Lietavská Lúčka.

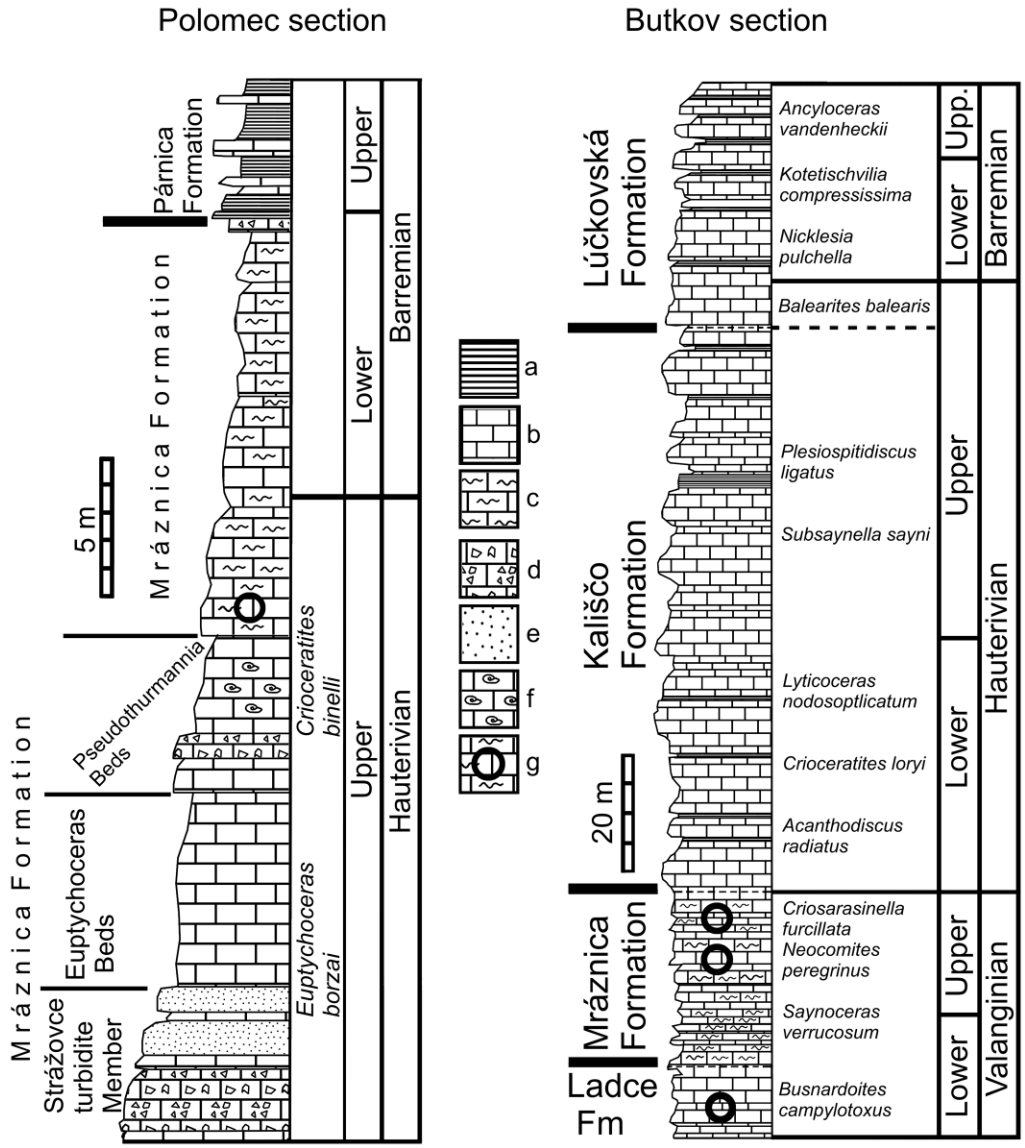

Figure 2 Schematic sections of Polomec and Butkov modified after Vašíček *et al.* 1994 and Michalík 2007. a – marls; b – limestone; c – bioturbated limestone; d – carbonate breccia; e – turbidite sandstone; f – fossiliferous limestone of Psedothurmannia Beds; g – *Zavitokichnus* occurrences.

the rock surface and scanning the sectioned trace fossil structure. The investigated samples were completely destroyed during this process. Images were obtained using a standard office scanner. Distances between sections were measured and included in the subsequent reconstruction. At the beginning of the sectioning process, some data was not obtained for

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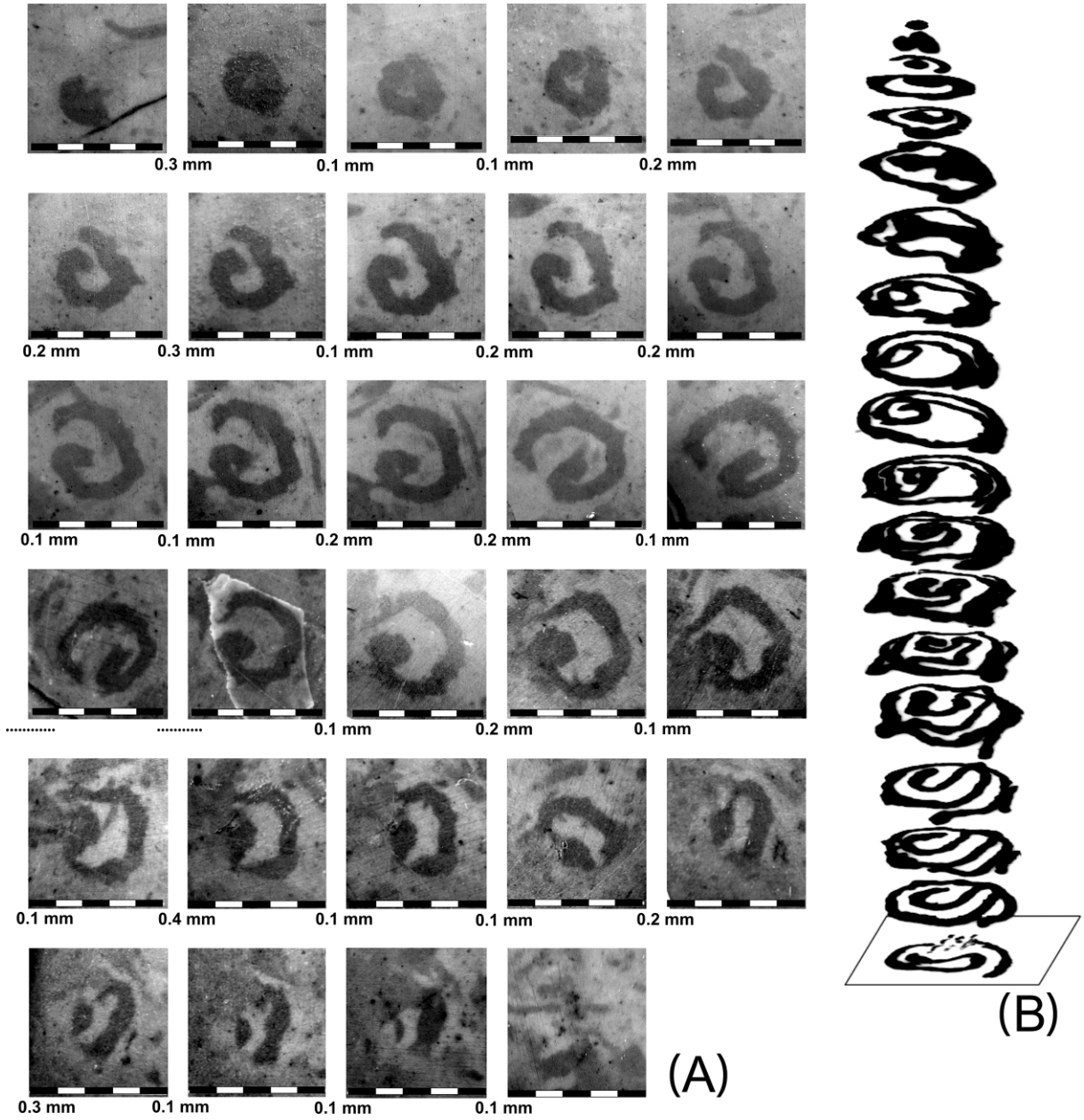

Figure 3 (A) Serial images of horizontal sections of *Zavitokichnus*. Spacing of sections ranged from 0·1 mm to 0·4 mm. Spacing data in the middle of the series are missing due to the uneven fractured surface of the sample at the starting point of the sectioning. (B) Oblique view of a series of cross-sections from another sample. Orientation of specimens to the bedding could not be determined. Scale bars on scanned images = 5 mm. Images A (No. Z 35507b) and B (No. Z 35507c) are saved on compact disk and deposited with the type material.

distances between sections (missing data in the middle of series sections on Fig. 3), because the uneven broken sample surfaces were not suitable for accurate measuring. For this reason the first sections examined were thicker. The unrecorded gaps were less than 1 mm. Outlines of the traces were drawn on the scanned images, and these outlines were altered to planar geometrical objects, and these were put together by 3-D software. On the basis of the sections, an enlarged plaster-cast model was constructed. This model was subsequently sectioned (Fig. 4). A 3-D model was constructed using 107 cross-sections of one sample which contains four specimens of *Zavitokichnus* (Fig. 5, type material No. Z 35507). The 3-D image was put together using the software PowerSHAPE-e 7350 (Delcam). Distances between each of the cross sections were 0·1–0·4 mm. The samples containing only one half of the specimens were ground, and polished in two planes both transversely and longitudinally (Fig. 6). In this way sectioning revealed another cross-cut view of the trace fossil spreite structure (Fig. 7). Several suitable samples were also split by pincers to study oriented sections of the internal structure. The holotype presented the most typical spiral-shaped section of *Zavitokichnus*.

3. Ichnotaxonomy

Ichnogenus *Zavitokichnus* n. igen.

Derivation of name. From the Slovak language word 'závitok' meaning a scroll.

Diagnosis. The trace fossil has the shape of a rolled-up 'plate' or 'wall', the axis of which varies from parallel to vertical respect to bedding. The axis connects the tapering ends of the trace fossil. The general shape of the trace fossil is spindle-shaped. The trace fossil sections are spiral or variously corrugated.

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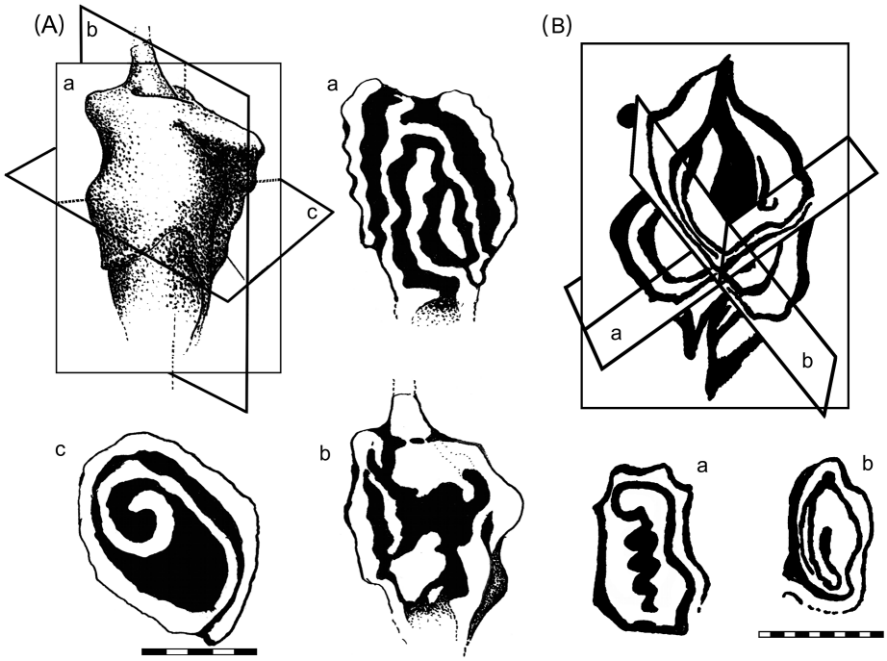

Figure 4 Sections of two plaster cast models of *Zavitokichnus*: (A) a & b show longitudinal sections, c shows a transverse section. Transverse section displays the typical form of the trace fossil. Scale bar = 5 mm. Specimen Z 35505a; (B) a & b show oblique sections. Scale bar = 10 mm. An original orientation of the trace was not determined. B was sketched on the basis of an unlabelled sample which was destroyed during processing. Image of B is saved on compact disk and deposited with the type material Z 35505b.

Zavitokichnus fusiformis n. isp.
Figures 3–10, 12

Derivation of name. Derived from the fusiform shape of the trace fossil.

Material. Holotype No. Z 24702a, and paratypes Z 24702b, Z 24703–Z 24705, Z 35439–Z 35465, type series numbered Z 35466–Z 35501, plus type material of serial sections (Z 35507), and reconstructed plaster cast model (Z 35505). Material is deposited in the Slovak National Museum in Bratislava.

Localities. Type locality Kamenná near Košeca (Lat. N49°00′45, Long. E18°29′85), also Butkov Quarry (Lat. N49°02′40, Long. E18°32′96), Horná Poruba (Lat. N48°94′, Long. E18°30′5) near Ilava, the Polomec locality (Lat. N49°72′, Long. E18°71′) at Lietavská Lúčka and Dubovec Hill near Nová Dubnica (Lat. N48°56′05, Long. E18°07′53).

Stratigraphy. The Ladce Formation and the Mráznica Formation of Valanginian to Hauterivian age.

Description. The trace fossil studied is a small, but characteristic structure. The shape of the trace fossil structure is fusiform. Cross-sections of *Zavitokichnus fusiformis* are apparent on fresh rock surfaces. Cross-sections of this trace fossil are of a characteristic spiral or variously curved shape (Fig. 6). The width of the spiral lines is 0·3–2·5 mm, generally 1 mm, and the trace fossil diameter varies from 5 mm to 15 mm, occasionally 29 mm. Length of the structure in reconstructed 3-D specimens varies from approximately 5 mm (Fig. 3A) to 24 mm (Fig. 5). In many sections of the trace fossil sporadic meniscate elements of the spreite lamellae can be seen. The spreite structure is an active fill exhibiting grain sorting. The spreite structure was defined as a blade-like to sinuous, U-shaped or spiral structure consisting of sets or co-sets of closely juxtaposed, repetitious parallel or concentric feeding or dwelling burrows or grazing traces. Trace fossils comprising a spreite structure develop from a single trunk or stem (as in *Daedalus* Rouault, 1850), or they are strung between peripheral 'support' arms (*Rhizocorallium* Zenker, 1836, according to Frey 1973). Arcuate-shaped sections of lamellae are irregularly spaced on the cross section of *Zavitokichnus*. In some examples, the trace fossil section displays only one or two lamellae. The ellipsoid cross-section of the generating tube of the producer is usually located in the marginal part of the cross-sectional spiral (Figs 7, 8).

The imaginary axis (which connects the tapering ends of the trace fossil) of *Z. fusiformis* varies from parallel to vertical to the bedding plane (Fig. 8). Paradoxically, the determination of the orientation of *Zavitokichnus* orientation represented a more complicated problem than the study of the structure, because primary sedimentary structures (such as bedding) were not preserved and the majority of the trace fossil samples were not observed *in situ*. The orientation of *Zavitokichnus* was determined in samples by reference to lobes of *Zoophycos* which are horizontal, and also according to the mutual positions of several trace fossil sections inside one piece of a rock (Z 35455, Z 35506). Spiral-shaped sections of *Zavitokichnus* were observed on vertical, oblique and horizontally oriented sections relative to the bedding.

4. Comparison with other trace fossils

The cross section of *Zavitokichnus fusiformis* is similar to *Dictyodora* Weiss, 1884, *Daedalus* Rouault, 1850, *Paradictyodora* (Scasso *et al*. 1991) and *Heimdallia* Bradshaw, 1981. Dissimilarities between *Paradictyodora*, *Heimdallia*, *Dictyodora* and *Daedalus* were discussed by Olivero *et al*. (2004). The shape of the trace fossil could be comparable with *Daedalus*. However, there are several dissimilarities between *Daedalus* (see Häntzschel 1962; Seilacher 2007) and *Zavitokichnus*. Both forms have a similar rolled-up fusiform spreite lamellae construction. *Zavitokichnus* contains oval spreite lamellae and the 'surface' of the trace fossil is smooth rather then ornamented as in *Daedalus* and *Heimdalia* (Figs 4, 5, 8).

Daedalus is allied to the arthrophycid group of traces (Seilacher 2007). The outline of *Arthrophycus* Hall, 1852

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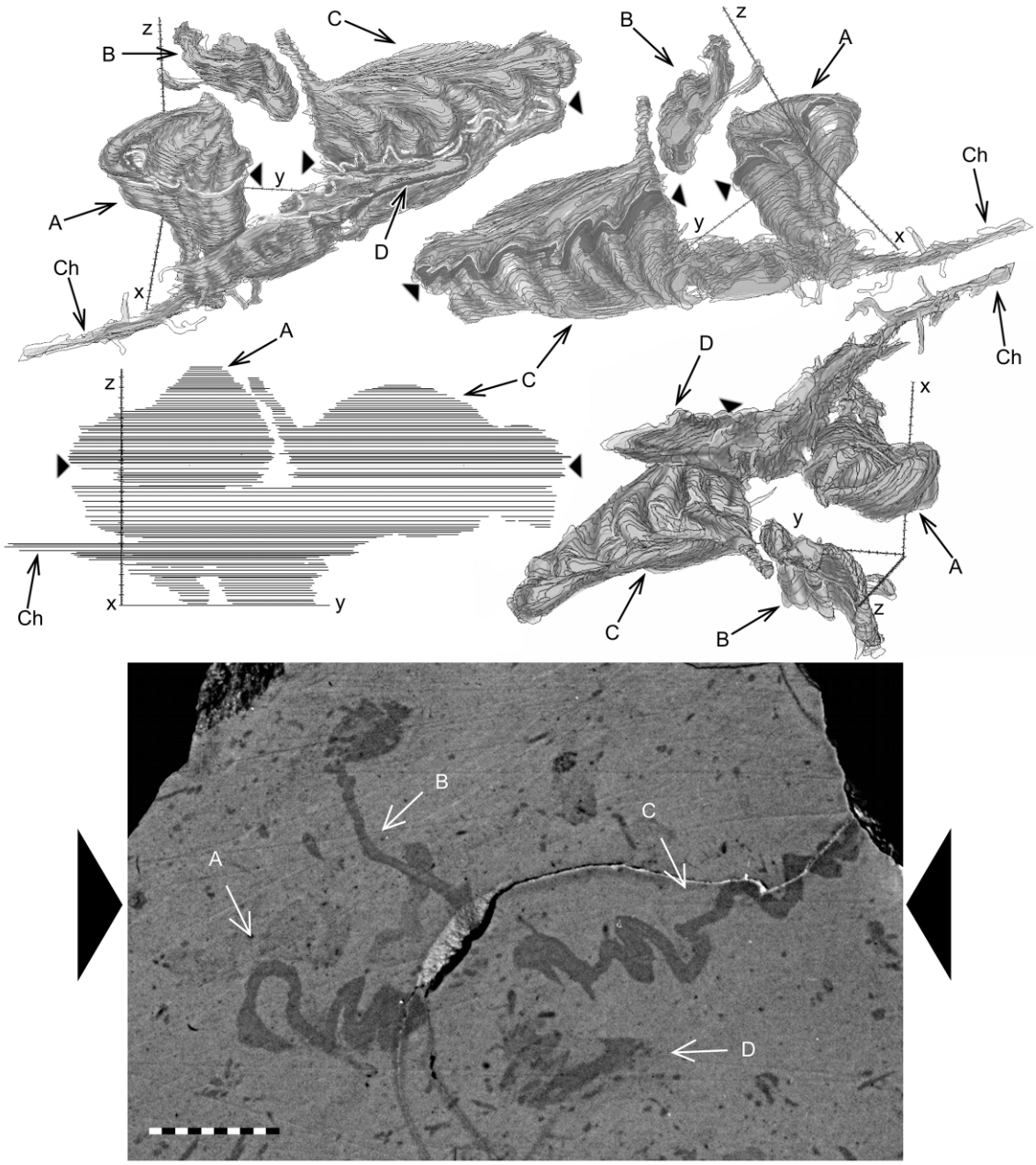

Figure 5 Four views of 3-D reconstruction of composite specimens. The lower image (between two black triangles) has been chosen as a reference for one highlighted section. 107 serial sections are shown in side view. This sample contains four isolated *Zavitokichnus* burrows (A, B, C, D). *Chondrites*-like trace fossil (Ch) cuts *Zavitokichnus* burrow D. Axes of the coordinate system are labelled x, y and z, with mm scales. The axis z is vertical to the bedding plane. All section images of Figure 5 are saved on a compact disk and deposited with the type material No. Z 35507a.

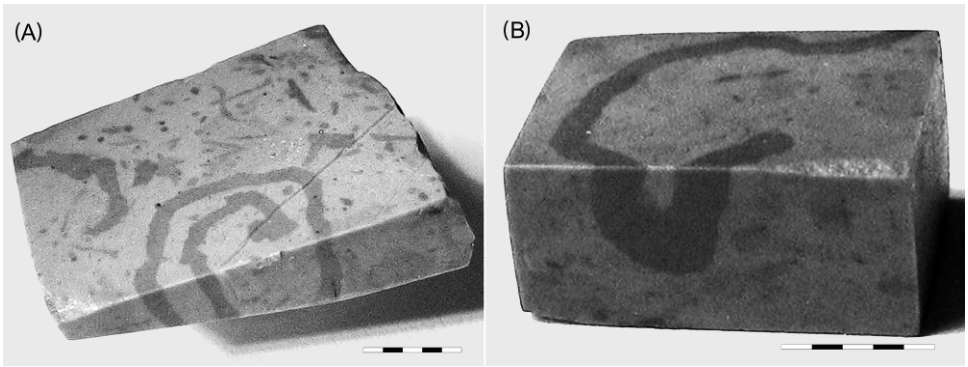

Figure 6 (A) Orthogonal sections of *Zavitokichnus fusiformis*: 'a' is holotype Z 24702a; 'b' is paratype Z 24702b. In the sample, two specimens of the trace fossil occur with *Chondrites*. The holotype section displays the central widest part of *Zavitokichnus*. (B) irregular spiral form of the trace fossil, Z 24703 paratype. Original orientations of samples were not determined, scale bars = 5 mm.

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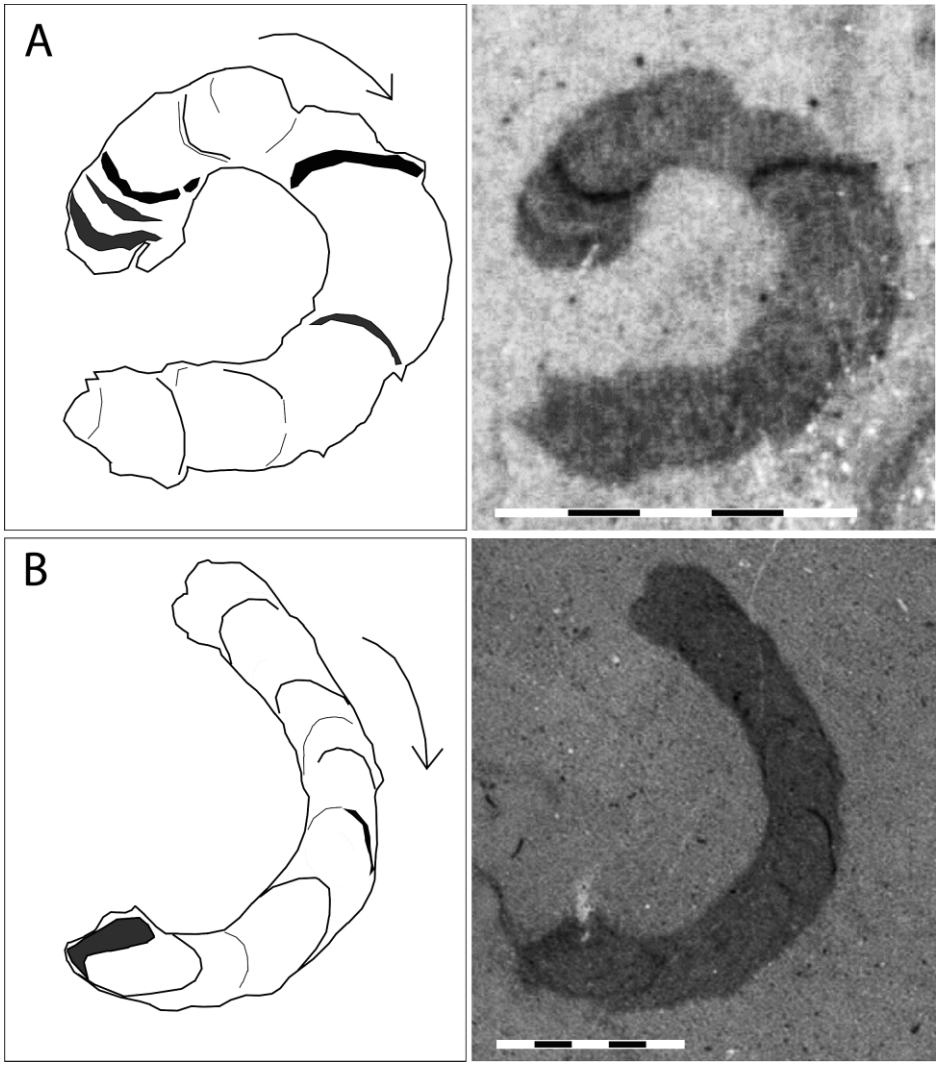

Figure 7 The meniscate spreite lamellae in *Zavitokichnus* indicate the direction in which the generating tube progressed: (A) Z 35498 paratype; (B) Z 35495 paratype. Scale bars = 5 mm.

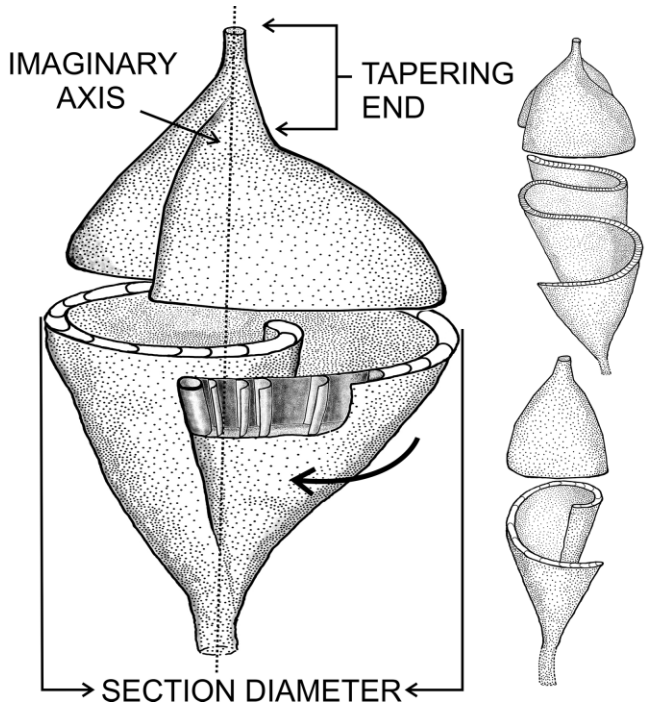

Figure 8 An idealised reconstruction of *Zavitokichnus fusiformis* n. igen. et n. isp. Black arrow shows the progression from the middle to the margin of the trace fossil, as indicated by meniscate spreite lamellae.

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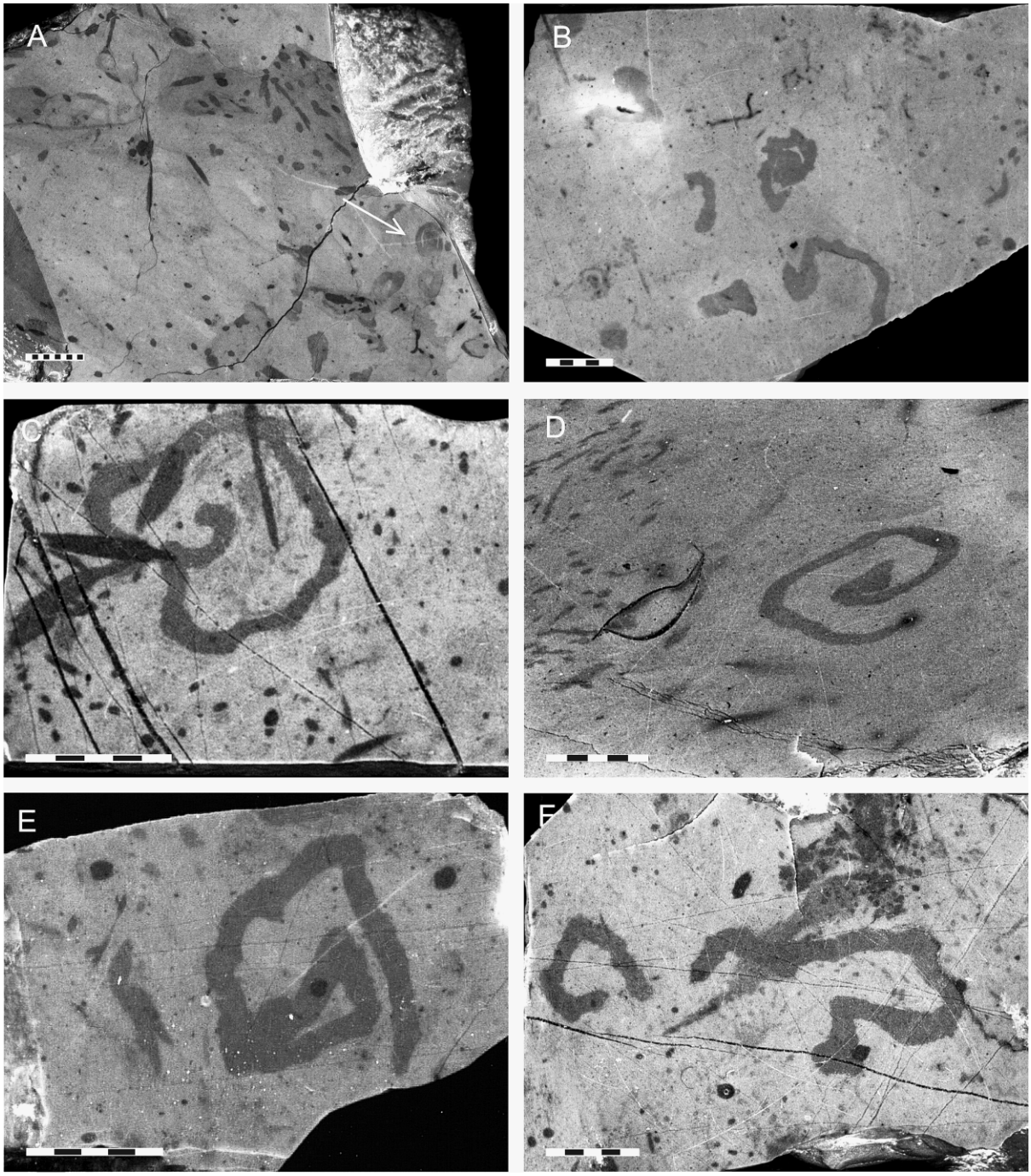

Figure 9 (A) The arrow points to *Zavitokichnus* (sample No. Z 35503); tiny dark dots are referred to *Chondrites*. Scale bar = 10 mm. (B) Z 35466 type series. Scale bar = 5 mm. (C) typical spiral form of the transverse (horizontal) sections (paratype Z 24704). Scale bar = 5 mm. (D) *Zavitokichnus* with trace fossil *Chondrites* and brachiopod shell (Z 35439 paratype). Scale bar = 5 mm. (E) Paratype Z 3544. Scale bar = 5 mm. (F) Paratype Z 35451 Scale bar = 5 mm.

burrows in cross-section is of a squarish, subquadrangular shape (Rindsberg & Martin 2003) and *Daedalus* also contains squarish-shaped spreite lamellae (A. Rindsberg pers. comm. 2006). In contrast, *Zavitokichnus* possesses oval-shaped lamellae. Surfaces of *Daedalus* contain transverse grooves (Seilacher 2007). Sections of involute samples of *Zavitokichnus* and cross-sections of *Daedalus* are also different. *Zavitokichnus* spreite lamellae were formed outward, from the inner central part of transverse section spiral to the outer part of spiral. *Daedalus* spreite lamellae as viewed in a spiral section were formed from the outer part to the inside. *Arthrophycus* and *Daedalus* occur in shallow-marine Silurian sandstones (e.g. Seilacher *et al*. 2002; Ghienne *et al*. 2007; Seilacher 2007). The spreite lamellae of *Dictyodora* were formed by the horizontal motion of a siphon-like tube that was perpendicular to the basal burrow of the trace maker (Benton & Trewin 1980; Benton 1982; Seilacher 2007).

Zavitokichnus is typified by the characteristic cross-section cut perpendicular to the axis. The most noticeable cross-sections have spiral and tortuous forms. However, in some cases, asymmetrically closed circles and loop-shaped cross-sections of *Zavitokichnus* were observed (Figs 9, 10). The circular shape of the two-dimensional cross-section could be misinterpreted as the wall of a cylindrical trace fossil, if the meniscus form of spreite lamellae were not preserved. Problematical 2-D views of closed loop-shape trace fossils in

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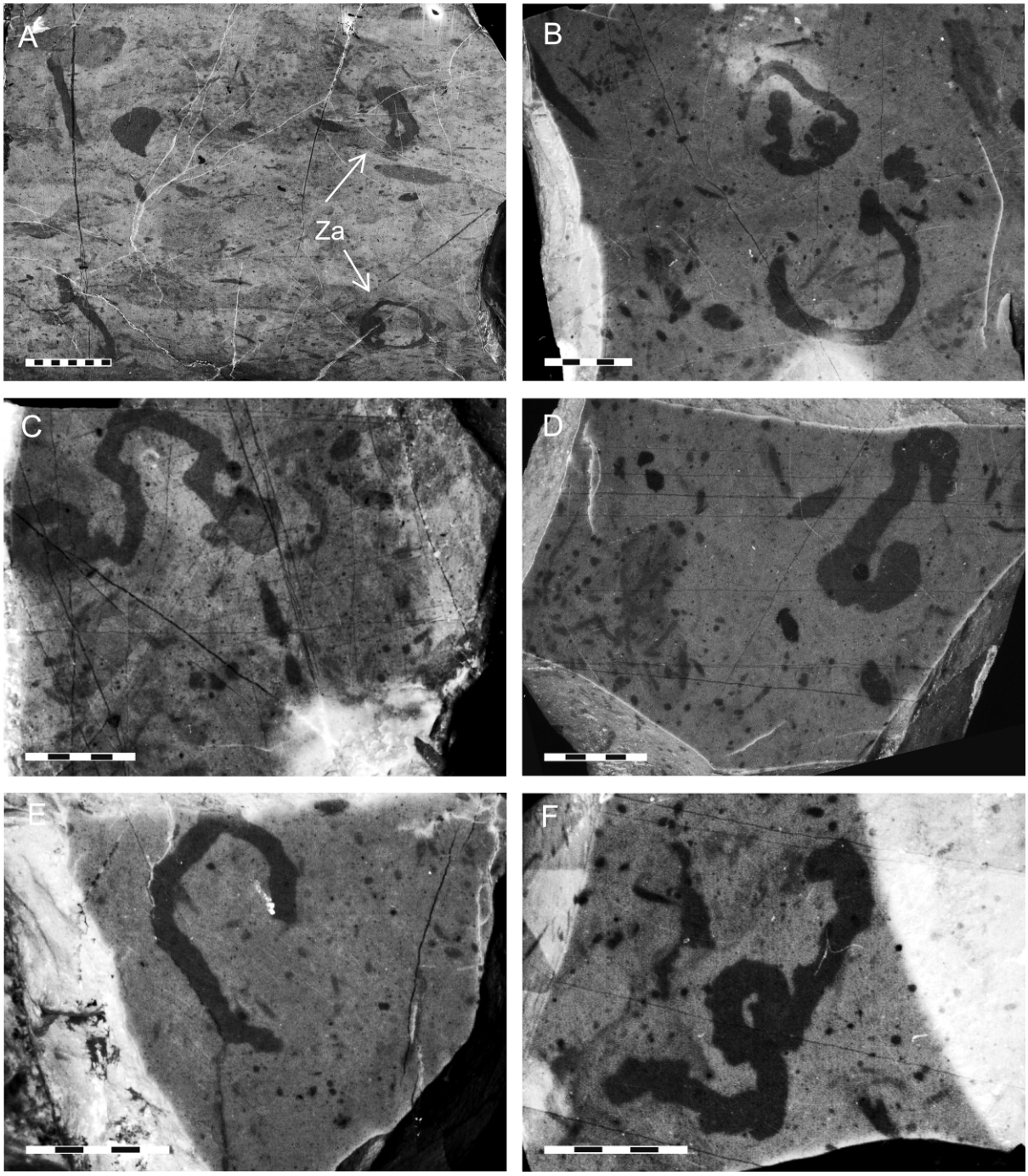

Figure 10 (A) Closed-circle shape view of *Zavitokichnus* spreite (Z 35501paratype). Scale bar = 10 mm (B) Z 35452 paratype. Scale bar = 5 mm. (C) Z 35447 paratype. Scale bar = 5 mm. (D) Z 35453 paratype. Scale bar = 5 mm. (E) Z 35471 paratype. Scale bar = 5 mm. (F) Z 35449 paratype. Scale bar = 5 mm.

cross-section should be investigated by serial-sectioning of oriented samples. Closed circles could be formed from cross-cutting with the margin of the previous whorl made by the spiral motion of a J-shaped generating tunnel (Seilacher 2007).

Paradictyodora antarctica (Scasso *et al.* 1991) is similar to *Zavitokichnus fusiformis*. Meniscoid structures of *Paradictyodora* and *Zavitokichnus* in cross-section are ordered in the same way. Both of them are bending outward and these ichnospecies lack the regular transverse ridges that characterise the arthrophycid group traces. *Paradictyodora* sections can be prismatic to conical. The structure of *Zavitokichnus* was produced by the motion of a burrow similar to *Paradictyodora*. *Zavitokichnus* differs from *Paradictyodora* in three morphological features: (a) the prismatic shape of spreite lamellae was not observed on *Zavitokichnus*; (b) *Paradictyodora* is conical and *Zavitokichnus* is spindle-shaped; and (c) *Zavitokichnus* ranges from parallel to vertical to the bedding and *Paradictyodora* is oriented perpendicular to bedding.

The arrangement of *Zavitokichnus* can be compared with an un-named trace fossil, that was found at the same locality as *Zavitokichnus*, the Butkov locality, Lower Valanginian, Ladce Formation (Fig. 11). Only one specimen of this trace fossil was found (Z 35502). The upper end of this *Zavitokichnus*-like trace fossil is tapered, the lower part is widened and the lowest part was not found. An oblique section of this trace fossil section displays a spiral spreite chain like *Zavitokichnus*, that ends with an ellipsoidal section of the generating tube (Fig. 11). A horizontal section of the structure does not display a spiral but a closed circle (Fig. 11A), that is very similar to daedaloid spiral spreite burrows from the Upper Jurassic

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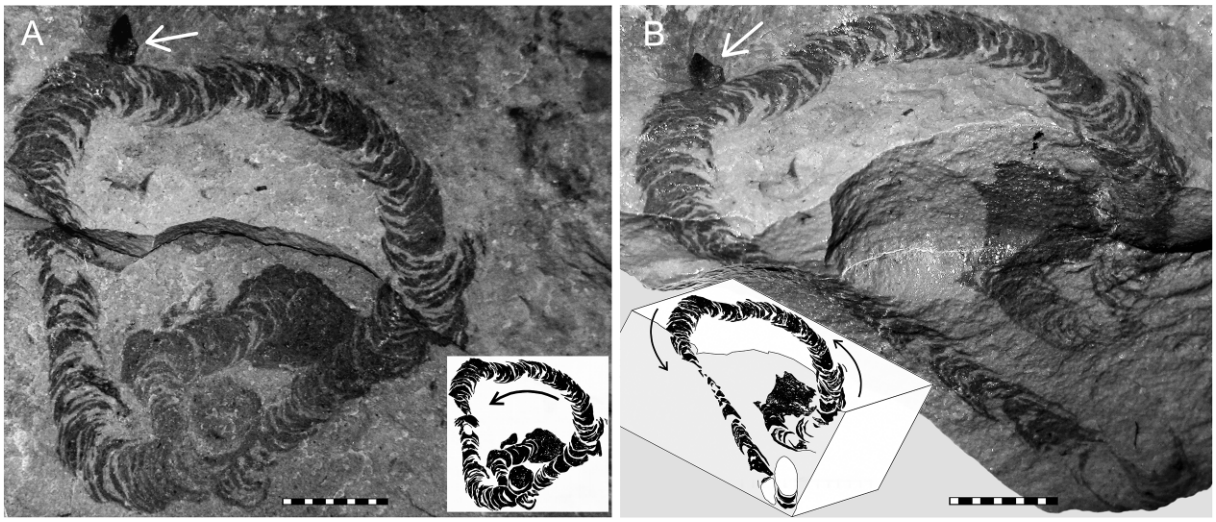

Figure 11 Different oblique views of a specimen of a *Zavitokichnus*-like trace fossil from Butkov: (A) A horizontal trace fossil section shows closed-circle shape of the trace fossil; (B) lower left side of the specimen is removed and the specimen photographed from a different angle. A dashed line provides a reference to relate the images, and sample positions are schematised by sketches. Ellipsoid section of the generating tube and meniscate structure indicate lateral migration from the centre to the margin. Black arrows show direction of movement. White arrows show fragment of an ammonite aptychus on the bedding plane. Specimen Z 35502. Scale bars = 10 mm.

pelagic limestone of southern France (Seilacher 2007, Plate 39). Closed circles followed from intersection with the margin of the previous whorl. Lateral dislocation of this trace fossil was from the inside outwards. Transverse, almost spiral, sections of *Zavitokichnus* axes (Fig. 4) show that the shape of *Zavitokichnus* is fusiform with a single coil. A transverse section of the *Zavitokichnus*-like trace fossil reveals that the form and the size is more comparable to the high-spired trace fossil described by Seilacher (2007, pl. 39) from the pelagic limestone of southern France. Uchman (1997) reported an undetermined form A of a trace fossil from the Kościeliska Formation (Beriasian, Valanginian and probably up to Lower Aptian) from the High Tatras. This undetermined form A was characterised on the basis of a spiral cross-section view as a presumably helicoidal trace fossil composed by spreite lamellae. It might be the trace fossil identical to *Zavitokichnus*.

5. Structural interpretation

The general shape of *Zavitokichnus* is a fusiform, rolled-up plate, tapering at the ends to a simple, narrow, cylindrical trace (see Figs 4, 5, 8). Several samples of cross-sections show that the spreite structure is constructed of meniscate elements, and one elliptical section of the generating tube is located within the end of the cross-section spiral (Fig. 7). It is assumed that this distinct oval elliptical structure represents the final structure, as the trace maker was moving from the inner part to the outer end of the spiral. Spreite structures could imply that the trace fossil was produced during mobile substrate-feeding processes. Spreite lamellae were produced by motion of the body of the *Zavitokichnus* producer. The ellipsoidal backfill lamellae reflect systematic substrate processing by a sediment feeder. An ellipsoidal section of a tube is usually located in the marginal part of the section spiral (Fig. 7). The convoluted shapes of cross-sections of *Zavitokichnus* show that the structure was always produced by bending outward. Spreite structure is not always visible and commonly vague on the cross-sections. Internal spreite matrix of the trace fossil might have been reworked by microorganisms which fed on organic remains in the burrow. The structure of the spreite lamellae is frequently homogenised and blurred, probably by physical, chemical and biological processes. The general shape of *Z. fusiformis* and the preservation of spreite lamellae within the sediment have also been influenced by compaction or later bioturbation. Flattened *Zavitokichnus* spiral sections are often influenced by compaction (Fig. 9D). *Z. fusiformis* is classified as a fodinichnion.

6. Sedimentary environment and ichnoassociation

The Mráznica Formation was deposited on a hemipelagic carbonate ramp situated near the marginal zone of the Zliechov Basin (Michalík *et al*. 2005; Michalík 2007). The formation contains only rare shelly benthic faunal remains. On the other hand, the trace fossil assemblage is relatively diverse, indicating an oxygenated environment. The colonisation by shelled epifauna was hampered by the unconsolidated substrate, which was colonised by a soft-body infauna. Benthic communities are influenced by internal, ecological evolution of a maturing community, or by changing external environmental conditions (Bromley 1996). The sediment containing *Zavitokichnus* and the other traces are not associated with distinguishable depositional events. The trace fossil association probably belongs to a single community that moved upwards with deposit accumulation. In general, all described traces persisted at the same time, but each trace fossil or group of trace fossils occupied different depths within the sediment.

Visual representation of a uniform community of ichnofabric succession according to cross-cutting relationships is constructed in Figure 12, following the system of Taylor & Goldring (1993). Burrow diameters are shown on the vertical axis of the constituent ichnofabric diagram (Fig. 12).

Tiny dispersed spots indicate that the sediment was bioturbated in the earliest stage of deposition. The first distinct traces are represented by wide burrows attributed to *Thalassinoides* Ehrenberg, 1944. These burrows are cut by *Planolites* Nicholson, 1873, *Palaeophycos* Hall, 1847 and *Hormosiroidea* Schaffer, 1928. Trace fossils with the smallest diameter include *Zavitokichnus*, *Zoophycos* Massalongo, 1855 and *Chondrites* Sternberg, 1833 and were produced in the order described (Fig. 12).

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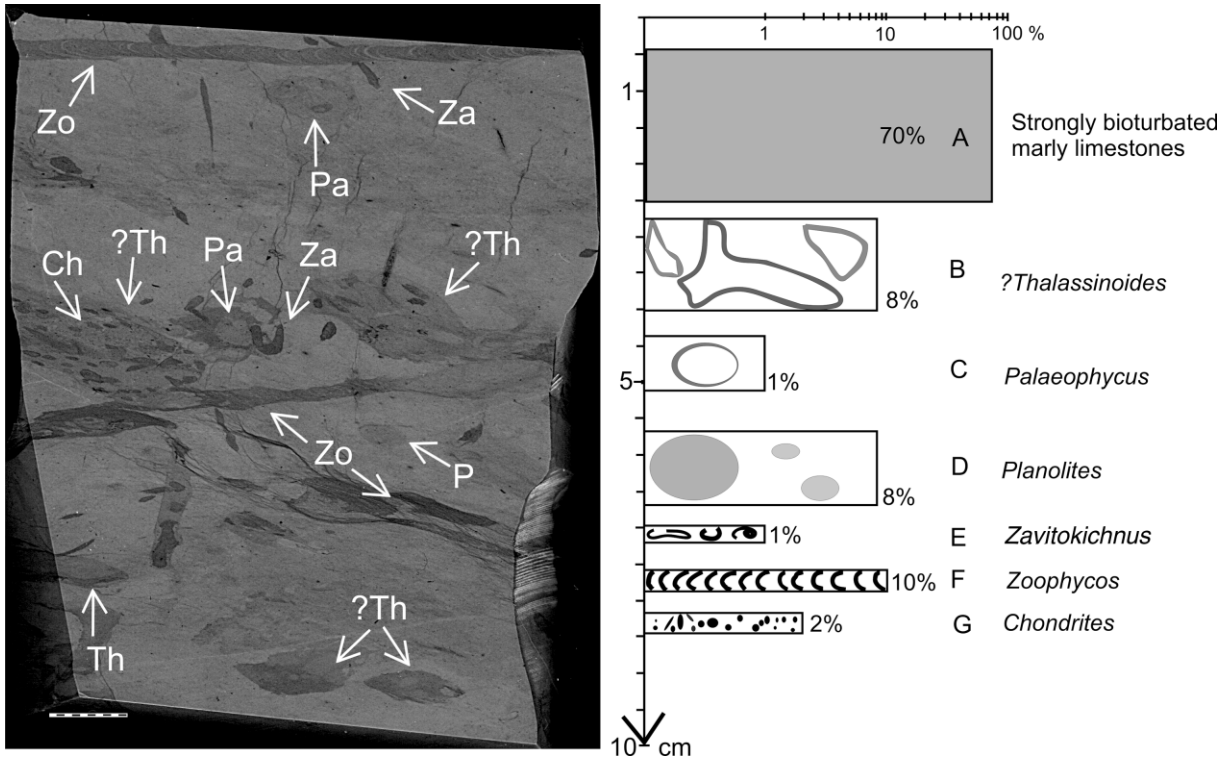

Figure 12 Tiering ichnofabric model show six tiers in vertical section. Grey field shows the oldest bioturbation background (A). The first tier is ?*Thalassinoides* (B), next *Palaeophycus* (C) and *Planolites* (D). *Zavitokichnus* occupies the fourth tiering (E), *Zoophycos* (F) represents the fifth and *Chondrites* (G) the sixth. Scale bar on the left-hand image = 10 mm. Sample No. Z 35504.

Zavitokichnus fusiformis occurs in trace fossil associations containing *Chondrites*, *Hormosiroidea*, *Palaeophycus*, *Planolites* and *Zoophycos*. Specimens of *Zavitokichnus* often blend with general ichnofabric. *Zavitokichnus* is frequently cut by a *Chondrites*-like trace fossil (Fig. 5). The *Chondrites*-like structure does not appear to randomly intersect *Zavitokichnus*. The *Chondrites*-like trace fossil is influenced by the presence of the *Zavitokichnus* structure. These mixed forms of trace fossil structures could be considered as composite specimens or composite structures. Composite specimens are forms that comprise several different trace fossils together (Pickerill 1994). Composite trace fossils are usually made by different producers, usually at different times (Bertling *et al*. 2006). The 3-D reconstruction of *Zavitokichnus* (Fig. 5) revealed that this trace fossil could occur alone or in clusters of several specimens (individuals A, C, D are blended together in the basal part, but individual B is isolated from the others). According to the superposition of these trace fossils, it is evident that the *Chondrites*-type trace fossil belongs to a lower tiering within the ichnofabric than *Zavitokichnus*.

7. Conclusions

- *Zavitokichnus fusiformis* n. igen. et n. isp. is a characteristic tiny trace fossil with a rolled-up plate shape structure composed of spreite-like lamellae.
- Spreite lamellae were made successively from the central to the marginal parts of the trace fossil.
- Active fill of the spreite structure suggests that the trace fossil was produced by a deposit feeder.
- In the trace fossil ichnofabric tiering model, *Zavitokichnus* is assigned to a level shallower than that of *Chondrites* and *Zoophycos*.
- The stratigraphical range of *Zavitokichnus* is tentatively estimated as being of Valanginian to Aptian age, and it could represent an important stratigraphical element in the lithostratigraphic correlation of the Western Carpathians.

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