*Doklady Earth Sciences, Vol. 385A, No. 6, 2002, pp. 618-622. Translated from DokladyAkademii Nauk, Vol. 385, No. 3, 2002, pp. 382-386.*


**GEOLOGY**

# Giant Traces of Vendian Animals

**A. Yu. Ivantsov and Ya. E. Malakhovskaya**

Presented by Academician B.S. Sokolov February 6, 2002

Received February 8, 2002

The Upper Vendian sequences exposed at the eastern coast of the White Sea enclose low-topography impressions of four different patterns that are interpreted as feeding traces of animals belonging to the type Proarticulata Fedonkin that became extinct in the Precambrian [1, 2]. Impressions with a maximum dimension of 4.3 m x ~15 cm (Fig. 1) and 2.5 m x ~35 cm (Fig. 2) were left by very large organisms. These traces occur on a common bedding surface that includes two different areas. The surface of the first area is flattened, whereas that of the second area is hummocky and complicated with different folds. Body impressions and traces of Proarticulata representatives occur only at the surface of the second area. The contact between areas with different surface patterns is *sharp:* the hummocky surface is slightly lower compared to the flattened one, and its margins are downwarped and submerged several centimeters into sediments grading into jointing surfaces. Short linear and star-shaped folds on the hummocky surface can be deep. Like downwarped margins, they can form jointing surfaces crossing the bed. Sometimes, trace impressions also appear to be submerged along these jointing surfaces (Fig. 1), although they preserve the trace patterns on the jointing surface.

It seems that the surface of flattened areas resulted from erosion of the muddy bottom that immediately preceded the accumulation of the sandy substrate. The hummocky surface originated from some flat layer covering the bottom that could break up, downwarp, get folded, and preserve the impressions. Most probably, such a layer was composed of a compact organic (algal-bacterial) film, which subsequently completely decomposed [3].

Trace impressions are characterized by low positive topography, whereas those left by buried bodies are negative and deep. A separate impression (or trace platform) represents a replica of the ventral side of the animal. On a sufficiently large exposed surface, it is seen that trace platforms form chains. The trace platforms are only partly obliterated where they overlap each other (Fig. 3a). As a result, species with slightly curved isomeres leave a wide complex impression with several axes. Impressions of a similar mode are characteristic of *Phyllozoon hanseni* Jenkins et Gehling, 1978 from the Vendian rocks of Australia *[4]*. It is probable that this fossil species also belongs to the type Proarticulata.

Sometimes, a chain of trace platforms terminates with the body of the organism. This allowed us to correlate traces of two types with the known Vendian species *Yorgia waggoneri* Ivantsov, 1999 (Fig. 1) and *Dickinsonia tenuis* Glaessner et Wade, 1966 (Fig. 2). Traces of a third type are referred to *D. costata* Sprigg, 1947 based on the similarity of the trace platform and body impression. However, traces of the most abundant type are not identified. Morphological peculiarities of this form do not permit it to be ascribed to any known Vendian animal. Therefore, in this article, we describe it as *Epibaion axiferus* gen. et sp. n. (Figs. 2, 3). The description of the organism based on its trace impression seems valid in the case considered, because the developed trace platform reflects the organism habitus at least as completely as the customarily used impression left by its dorsal side.

In addition to giant traces of *Epibaion,* the rocks also bear a body impression and trace of *Dickinsonia tenuis* (Fig. 2). This is the largest *Dickinsonia* specimen ever found in Russia: its visible length with the downwarped anterior end is 55 cm. Its large size is probably responsible for its preservation. With respect to the thickness, isomeres of this giant specimen are comparable with isomeres of smaller *Epibaion* specimens. Dimensions of other specimens of the above-mentioned *Dickinsonia* species found in the area are significantly smaller, and their isomeres were probably too thin to leave impressions; i.e., they are too small and indistinct to be detected. Traces *of Dickinsonia costata* in the Erginskii Bed accumulation were found in talus. In terms of preservation, they are similar to those left by other Proarticulata representatives and also consist of platforms united into chains. The wide axial structure, which occurs in body impressions of all *Dickinsonia* species, is not expressed in trace platforms of *D. cos-*

*Paleontological Institute (PIN),*
*Russian Academy of Sciences,*
*Profsoyuznaya ul. 123, Moscow, 117647 Russia*

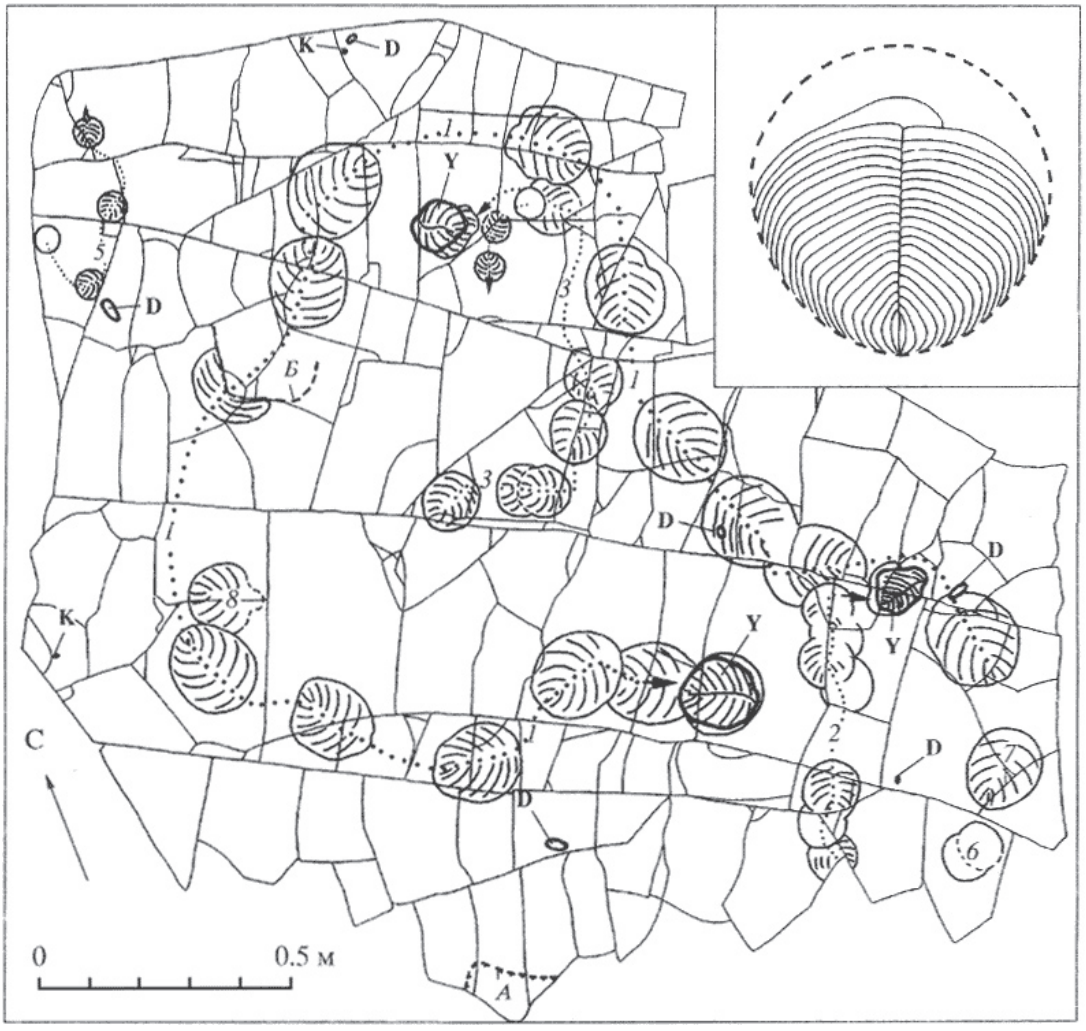


Fig. 1. The surface fragment with *Yorgia waggoneri* traces. The trace platforms at the ends of three chains *(1-3)* are almost completely overlain by the corresponding organisms. The body impression is curved and sometimes smaller than the trace platform. The occurrence of these deformations probably implies that the organism tried to climb out from under the overlying sediment. Sample ARM, no. 44-686 KP. *(1-8)* Trace chains and isolated trace platforms; dashed lines with arrows designate routes and directions of the movement of animals; body remains: (D) *Dickinsonia* sp., (K) *Kimberella quadrata,* (Y) *Yorgia waggoneri', (A)* boundary of the surface; (B) linear fold, along which the surface with a part of the trace platform was submerged into the sediment. The inset demonstrates the reconstructed isolated trace platform of *Yorgia waggoneri;* the number of isomeres is voluntary.

*tata* and *D. tennis.* Traces of *Epibaion* and *Dickinsonia* differ mainly in this feature. The discontinuous pattern of trace chains, their abrupt beginning, and the occurrence of isolated platforms implies that the animal left no traces during its movement. It could probably rise above the bottom, but there are no signs of its leaving and subsequent sinking back onto the bottom. The absence of fecal pellets also confirms the mode of trace platform formation: the organisms were attached to the sediment surface (leaving impressions on the organic film). Owing precisely to this *modus vivendi,* the trace platforms were preserved, whereas lying freely on the bottom pellets and ephemeric movement traces were eliminated with the beginning of the next sedimentation phase. We assume that the trace platform was formed by the organism in the course of its consumption of an organic-rich sediment [1, 2] or a compact algal-bacterial film. The ventral surface of the Proarticulata body was covered by flagellae that caught substrate particles and delivered them to the oral area. Rare fragmentary impressions with indistinct topography and curved contours could mark stages of the regeneration of a biological film subjected to such feeding. Despite the fact that such a manner of feeding (collecting food by ciliated epithelium) is unknown amid recent organisms of similarly large dimensions, it was probably characteristic of representatives of the Late Cambrian genus *Climactichnites [5].* It is probable that it was appropriate only for conditions of the Vendian and Cambrian biosphere.

Type Proarticulata Fedonkin, 1985

Family Dickinsoniidae Harrington et Moore, 1955

*Epibaion axiferus* Ivantsov gen. et. sp. n.

Figs. 2, 3

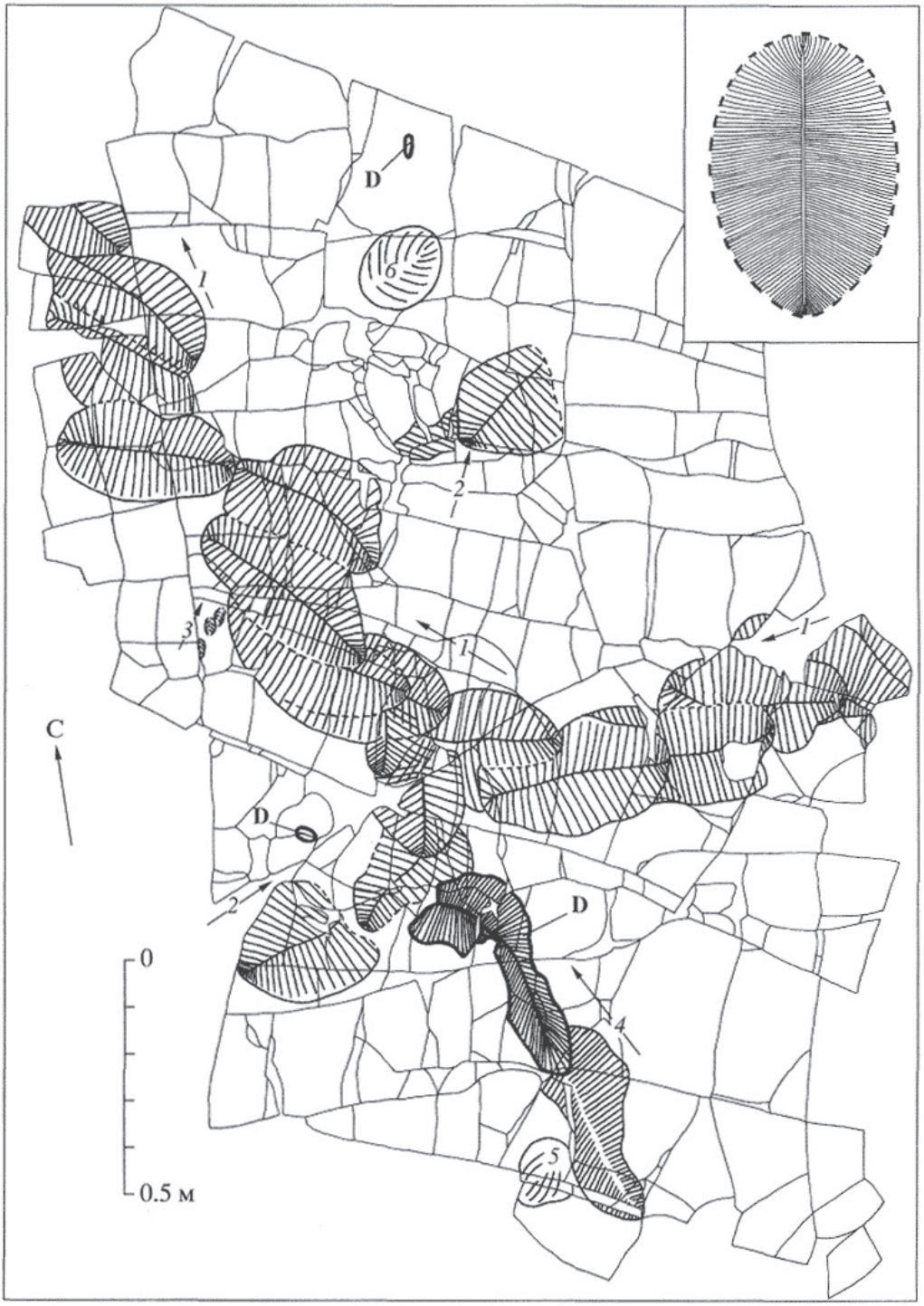


Fig. 2. The surface fragment with trace chains. *Epibaion axiferus* sp. left by the largest specimens—*(1)* holotype PIN, no. 3993/5199, (2) PIN, no. 3993/5211—and (3) smallest of the available specimens (3993/5198); *(4) Dickinsonia tenuis* (specimen PIN, no. 3993/5195); (5, 6) isolated trace platforms of *Yorgia waggoneri.* Sample from the Museum of PIN RAS, no. 11-30. Legend as in Fig. 1. The inset demonstrates the reconstructed isolated trace platform *of Epibaion axiferus;* the number of isomeres is voluntary.

*Etymology.* Genus: from Greek words επιβαινω (to step) and βαιον (palm branch); species: from Latin words *axis* (axis) and fero (to carry).

*Holotype.* PIN, no. 3993/5199, chain consisting of 15 trace platforms that represent impressions of the ventral side of a single specimen; Arkhangelsk district, Zimnii Coast of the Wite Sea; Upper Vendian, Mesen Formation, Erginskii Bed.

*Description.* The body is elongated-oval and completely subdivided into isomeres. Their orientation is, in general, radial, but 2/3 of isomeres in the posterior end are turned backward. Isomeres are narrow and

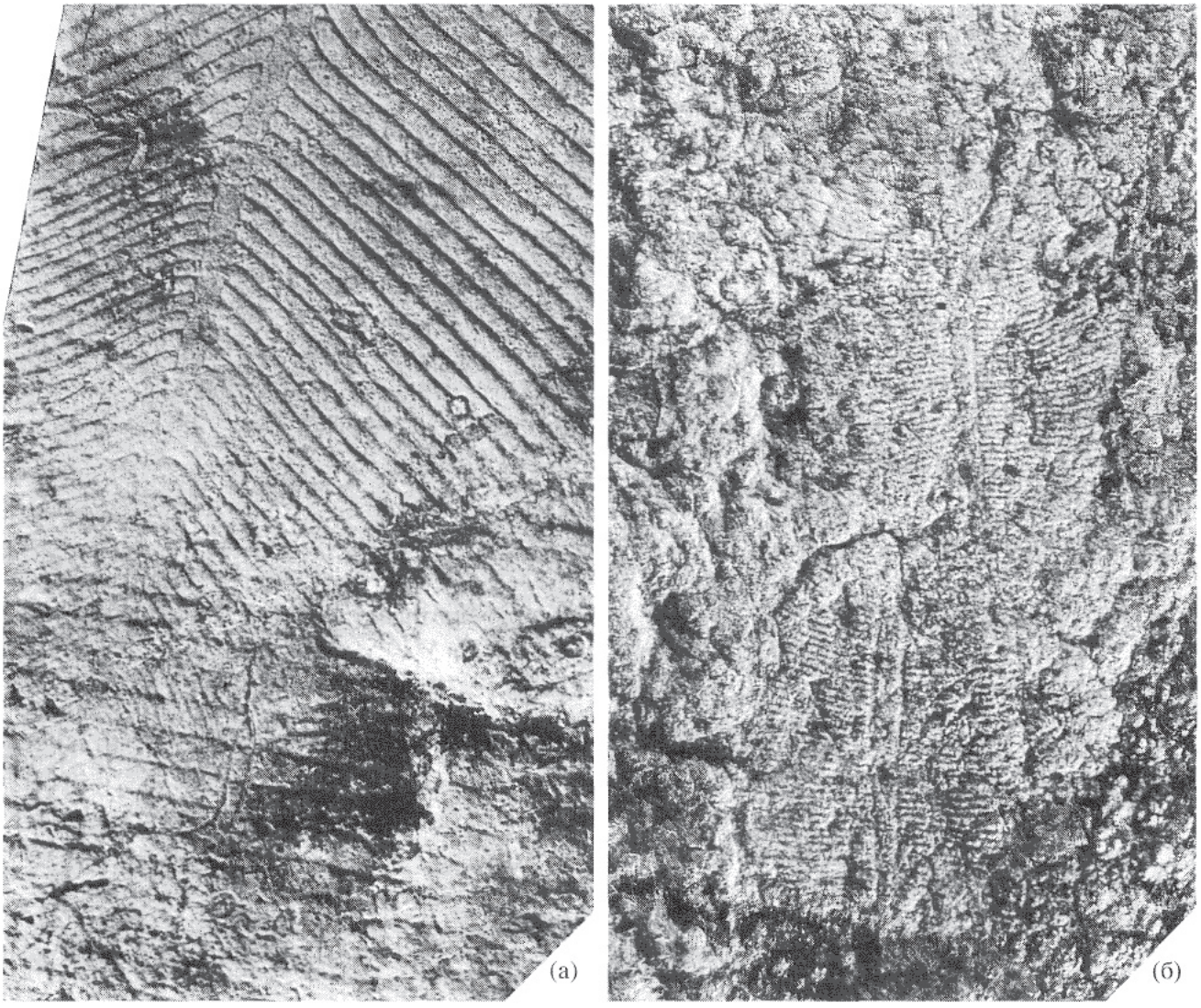


Fig. 3. Traces *of Epibaion axiferus* sp. n. (the largest of all available specimens). (a) Two superimposed trace platforms, the posterior end of the younger platform occupies the upper part of the photograph, and the anterior part of the preceding platform is eliminated (holotype PIN, no. 3993/5199, 2x); (b) two trace platforms, the smallest of available specimens (specimen PIN, no. 3993/5198, 2x).

equally thick. Only in the posterior part of the body and immediately near its anterior end does the thickness of isomeres decrease. Their number exceeds 120 pairs. The isomere surface is smooth. The longitudinal axis of the ventral side is marked by a narrow lobe tapered from both ends and connecting the inner ends of all isomeres. The width of the axial lobe is almost equal in different-size specimens.

*Comparison.* It is similar to species belonging to the genus *Dickinsonia* Sprigg, 1947 and *Phyllozoon hanseni* Jenkins et Gehlig, 1978 in complete body segmentation and isomeres with blunted lateral ends that are generally arranged in a radial manner. It differs from the above-mentioned species and all other Proarticulata representatives by the presence of the axial lobe.

*Dimensions.* See the Table.

*Remarks.* The number of isomeres was counted only in the holotype, because all other impressions are incomplete. Nevertheless, judging from available fragments, one can assume that the latter was almost the same in 8- to 44-cm-long specimens.

*Material and distribution.* Several isolated trace platforms and fragments of their chains; the holotype and paratypes (nos. 3993/5198 and 5201-5210) originate from a single locality. Two specimens from the Museum of the Paleontological Institute RAS (PIN, no. II-30) and Arkhangelsk Regional Museum (ARM, no. 44-686 KP), as well as a collection of *Yorgia, Epibaion,* and *Dickinsonia* traces stored in the Laboratory of Precambrian organisms of the PIN RAS (part of collection no. 3993), served as material for this paper.

Dimensions of some *Epibalon axiferus* specimens (mm)

| Specimen | Length of body (visible fragment) | Width of body (visible fragment) | Width of axial lobe | Average thickness of isomere |
|---|---|---|---|---|
| 3993/5199 (holotype) | 440 | 340 | 3 | 2.8 |
| 3993/5198 | (40) | (20) | 2 | 0.5 |
| 3993/5201 | (120) | (50) | 2.7 | 1 |
| 3993/5202 | (HO) | (72) | 3 | 1 |
| 3993/5204 | (70) | (44) | 2.5 | 1 |
| 3993/5205 | (190) | (70) | 2.7 | 1 |
| 3993/5206 | 400 | 254 | 3 | 2.2 |
| 3993/5208 | (120) | (80) | 2.5 | 1 |
| 3993/5209 | (140) | (64) | 2.6 | 1 |
| 3993/5210 | (40) | (34) | 2 | 0.7 |

Notes: The width was measured as a doubled distance from the axis of a body to its lateral margin. The thickness of an isomere was measured approximately in the middle of a body at an equal distance from the axis of a body (or visible fragment) to its lateral margin.

## ACKNOWLEDGMENTS

This work was supported by the Russian Foundation for Basic Research (project nos. 00-15-98110 and 01-05-79133) and the National Geographic Society (grant no. 5015-97).

## REFERENCES

1. Ivantsov, A.Yu., *Ekosistemnye perestroiki i evolyutsiya biosfery* (Ecosystem Reorganizations and Evolution of the Biosphere), Moscow, 2001, issue 4, pp. 119-120.
2. Ivantsov, A.Yu. and Fedonkin, M.A., *Materialy II Mejdunarodnogo simpoziuma "Evolyutsiya zhizni na Zemle"* (Materials of II Int. Symp. on Evolution of Life on the Earth), Tomsk, 2001, pp. 133-137.
3. Gehling, J.G., *Palaios,* 1999, vol. 14, pp. 40-57.
4. Jenkins, R.I.F. and Gehling, J.G., *Rec. South Aust. Mm.,* 1978, no. 17, pp. 347-359.
5. Yochelson, E.L. and Fedonkin, M.A., *Paleobiology and Climactichnites an Enigmatic Late Cambrian Fossils* Washington (DC): Smithsonian Inst., 1993, no. 74.