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Some Problematic Fossils from the Vendian of the Southeastern White Sea Region

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Abstract—Three new genera and five new species of uncertain taxonomic position, i.e., *Solza margarita* gen. et sp. nov., *Parvancorina sagitta* sp. nov., *Karakhtia nessovi* gen. et sp. nov., *Temnoxa molliuscula* gen. et sp. nov., and *Vaveliksia vana* sp. nov., from the Late Vendian localities of the Onega Peninsula and Zimnii Bereg of the White Sea are described.

Key words: Metazoa, Late Vendian, Arkhangelsk Region, White Sea, Russia.

INTRODUCTION

The present paper continues the description of new taxa of the Late Vendian metazoans collected by the permanent expedition of the Laboratory of Precambrian Organisms of the Paleontological Institute of the Russian Academy of Sciences in the southeastern White Sea Region. The material was collected in the following localities: (1) the Onega Peninsula, the vicinity of Severodvinsk City, left bank of the Solza River, approximately 5 km south of the city diversion dam; (2) the same region, left bank of the Karakhta River, approximately 2 km upstream from the road Severodvinsk–Onega; and (3) Zimnii Bereg (Winter Coast) of the White Sea near the Zimnegorsk lighthouse. The host rock of the first and second localities is assigned to the Ust-Pinega Formation (Grazhdankin and Bronnikov, 1997), the third locality displays the Mezen Formation of the Upper Vendian. The studied collections (nos. 3993, 4852, and 4853) are housed at the Paleontological Institute of the Russian Academy of Science, Moscow (PIN). All specimens were found on the basal surface of thin layers of fine-grained sandstone. The species *Parvancorina sagitta* sp. nov., *Solza margarita* gen. et sp. nov., *Karakhtia nessovi* gen. et sp. nov., and *Temnoxa molliuscula* gen. et sp. nov. are represented by counterparts, while *Vaveliksia vana* sp. nov. is represented by a positive mold.

The reconstruction of the fossils represented by counterparts is based on two assumption, i.e., (1) in addition to the relief of the upper surface of the animal's body, an imprint partly reproduces some internal structures; and (2) convex elements of imprints correspond to body structures relatively less compact at the moment of sediment lithification, while concavities correspond to more compact structures.

Parvancorina sagitta. Judging from the absence of folds and rough deformations of the imprint (Pl. 1, figs. 5–8), the body of *Parvancorina* was rather hard and, possibly, sclerotized. The single species of *Parvancorina, P. minchami* Glaessner, 1958 (Fig. 1), was

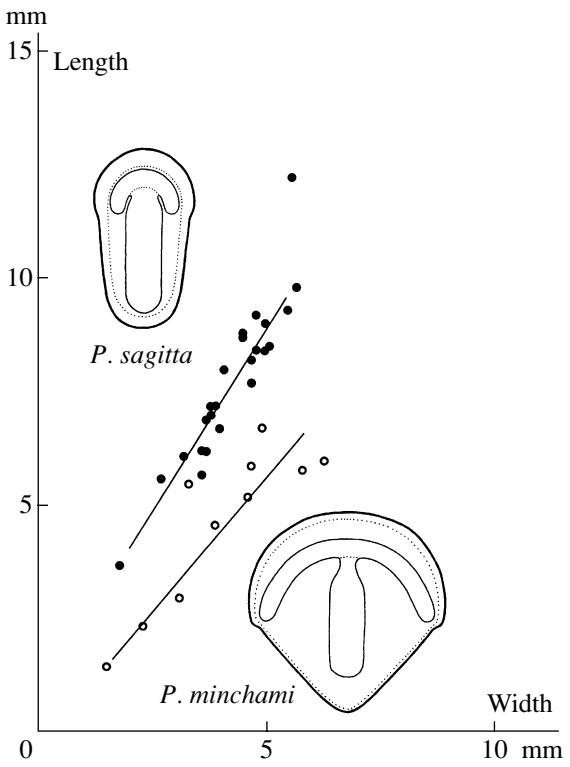
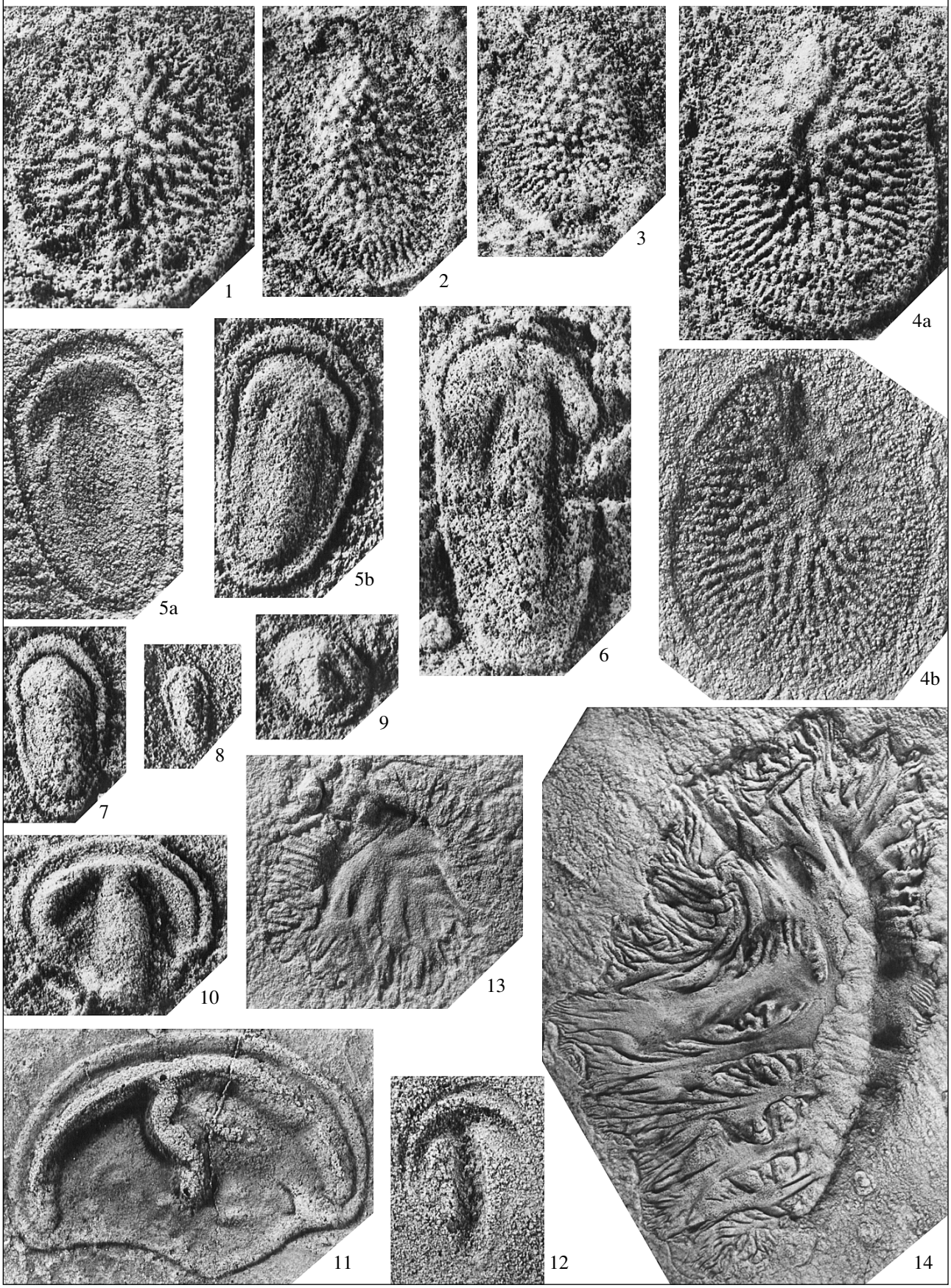


Fig. 1. Plot of length versus width of the imprints of *Parvancorina sagitta* sp. nov. (Onega Peninsula, Solza River; Ust-Pinega Formation) and *P. minchami* Glaessner from Zimnii Bereg (Winter Coast) of the White Sea; Mezen Formation, "*Kimberella* Lenses" locality.

Plate 1



considered to be an arthropod (Glaessner, 1980) due to the presence of oblique hacks on several imprints, which were interpreted as limb remains, and general similarity with carapaces of some Paleozoic arthropods (Glaessner, 1980; Fedonkin, 1985; Jenkins, 1992). Our material does not display any new arguments favoring the arthropod affinity of *Parvancorina*. No signs of limbs were found in specimens of *P. sagitta.* In contrast, the similarity of *Parvancorina* to the new fossil form *Temnoxa molliuscula*, which lacks any arthropodian features at all, casts doubt on the arthropod affinity of *Parvancorina*.

Temnoxa molliuscula. The bilateral symmetry of the body suggests the mobile life style of *Temnoxa*. The substance composing the body was rather compact but flexible. The axial zone of the body could be inflated and displaced laterally (Pl. 2, fig. 2). It was large and high, so that it could enclose a large volume of internal organs. The lateral part of the body, which is flattened in imprints, could be the lateral margin of the foot. The small number of preserved features do not allow us to ascribe this fossil to any known phylum; however, in general, the structure does not exclude a higher organization of this animal, such as the molluskan evolutionary level.

Solza margarita. The imprint of *Solza* remains a certain volume, so that its central part is slightly inflated. Specimens of this form are usually slightly deformed, i.e., incurved in the anterior region (Pl. 1, fig. 4a) or inclined laterally (Pl. 1, fig. 2). Probably, the body was elastic: not firm but not excessively soft. The body is asymmetrical; one end is acuminate, the maximum convexity is displaced toward this end. The dorsal side of the body bears furrows radiating from the center of convexity, branching, and anastomosing (Fig. 3). It is impossible to recognize whether these furrows covered the body during the animal's life or they were formed postmortem above certain cavities inside the body. Judging from the indistinct relief in the majority of imprints, the latter assumption seems more probable. The narrow ends of the cavities reached the body margin and were probably open outside. The pores could also be present in the central area of the body, where the cavities anastomose; however, they are not prominent on the imprint. On the basis of available material, it is

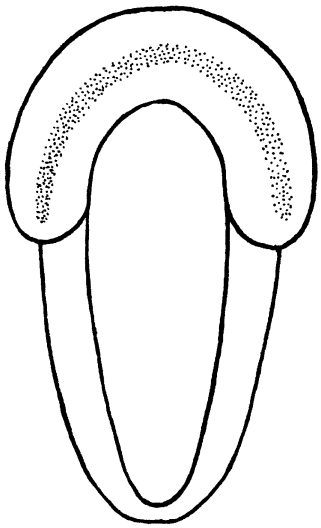


Fig. 2. *Temnoxa molliuscula* sp. nov.; schematic reconstruction, dorsal view.

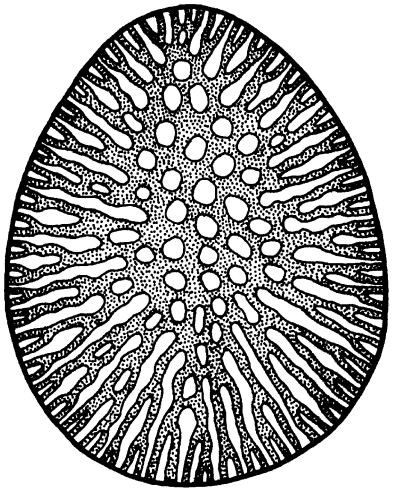


Fig. 3. *Solza margarita* sp. nov., schematic reconstruction, dorsal view (spotted area shows the system of internal canals).

Explanation of Plate 1

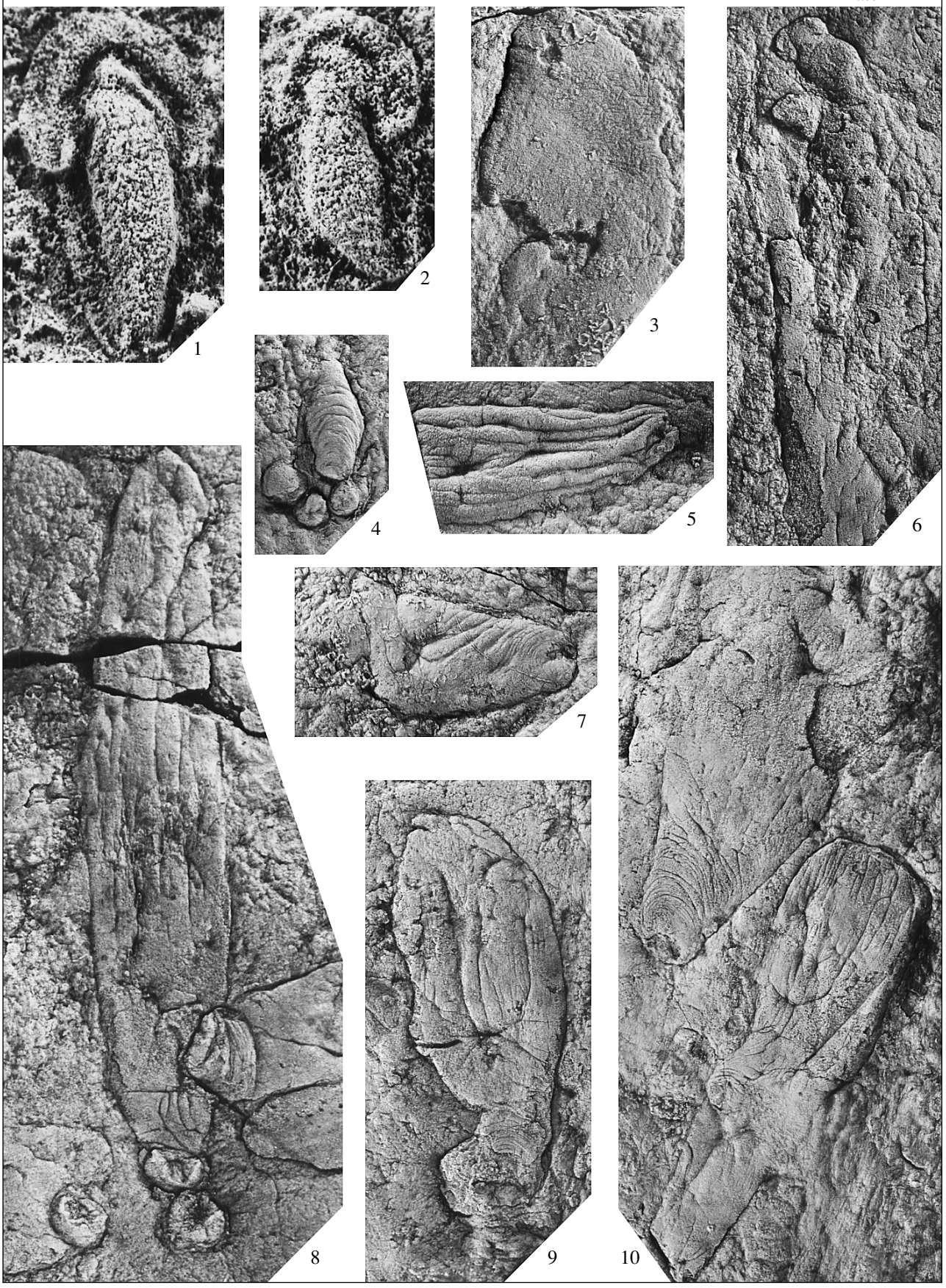
Figs. 1–4. *Solza margarita* sp. nov.: (1–3, 4a) latex replica from the natural specimens, (4b) imprint on the rock surface; ×6; (1) specimen PIN, no. 4853/55; (2) specimen PIN, no. 4853/58; (3) specimen PIN, no. 4853/61; and (4) holotype PIN, no. 4853/60; Arkhangelsk Region, Onega Peninsula, Solza River; Upper Vendian, Ust-Pinega Formation.

Figs. 5–8. *Parvancorina sagitta* sp. nov.: (5a) imprint on the rock surface; (5b, 6–8) latex replica; (5) holotype PIN, no. 4853/89, ×6; (6) specimen PIN, no. 4853/92, ×6; (7) specimen PIN, no. 4853/101, ×6; and (8) specimen PIN, no. 4853/91, ×8; Arkhangelsk Region, Onega Peninsula, Solza River; Upper Vendian, Ust-Pinega Formation.

Figs. 9–12. *Parvancorina minchami* Glaessner: (9–11) latex replica, (12) imprint on the rock surface; (9) specimen PIN, no. 3993/5190, ×8; (10) specimen PIN, no. 3993/5188, ×6; (11) specimen PIN, no. 3993/5115, ×3; (12) specimen PIN, no. 3993/5187, ×6; Arkhangelsk Region, Zimnii Bereg (Winter Coast) of the White Sea; Upper Vendian, Mezen Formation.

Figs. 13 and 14. *Karakhtia nessovi* sp. nov., imprint on the rock surface: (13) holotype PIN, no. 4852/250, ×2; and (14) specimen PIN, no. 4852/249, ×1; Arkhangelsk Region, Karakhta River; Upper Vendian, Ust-Pinega Formation.

Plate 2



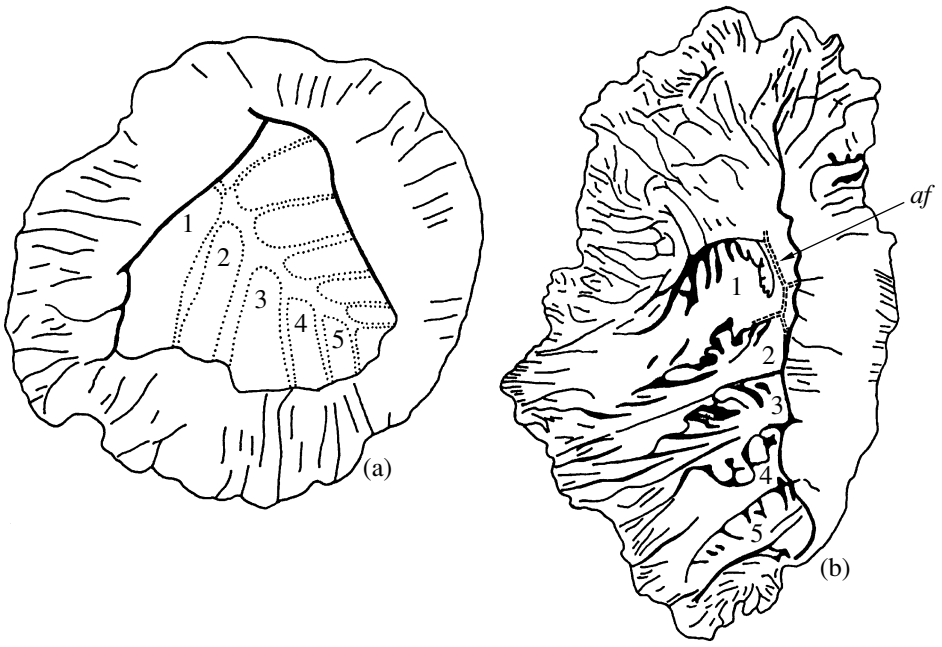


Fig. 4. *Karakhtia nessovi* sp. nov., drawing based on the photographs of (a) holotype PIN, no. 4852/250; and (b) specimen PIN, no. 4852/249. Designations: (*af*) axial furrow isolating two rows of isomeres from each other; the numbers designate the isomeres of the left side (on the imprint).

rather difficult to suggest the function of these cavities (or furrows). We can only suppose that they were associated with feeding and internal secretion. This system could support a structure filtering suspension, microorganisms, or dissolved molecules in the case that both marginal and central pores developed. The bilateral pattern of the body suggests that *Solza* led a mobile mode of life. To date, it is impossible to ascribed this taxon to any known phylum.

Karakhtia nessovi. The body of *Karakhtia* was flexible and soft. Its imprints are usually strongly crumpled, so that any structural details are hardly discernible. Probably, certain folds were present in living animals. Only two specimens display traces of transverse division in the central part. The pattern of body differentiation suggests that *Karakhtia* is related to proarticulates. Actually, this form displays the main proarticulate characters, i.e., bilateral symmetry of the body composed of equal and alternating elements. The proposed hypothetical reconstruction (Fig. 5) resembles *Yorgia* Ivantsov, *Podolimirus* Fedonkin, *Vendia* Keller, and some other genera from the class Vendiamorpha. However, the structure of the anterior and lateral parts of *Karakhtia* is unknown; therefore, the assignment of *Karakhtia* to vendiamorphs and the phylum Proarticulata is premature.

Vaveliksia vana. *Vaveliksia* is represented by irregularly oval bodies, elongated to different extents, strongly protruding from the host sandstone (Fig. 6). Rather often, the bodies are isolated from the host rock by a separate layer and can easily be extracted. A circular structure having a central depression and a ringlike marginal elevation is located near the body end, either forming its continuation or being slightly apart (Pl. 2, fig. 8). In the majority of imprints, the surface is divided by a system of narrow depressions (Fig. 6). Usually, these depressions look like longitudinal subparallel furrows, more prominent in the middle part of the body and at the end, opposing the circular structure. The concentric wrinkles, sometimes gradually becoming parallel, are visible near the circular structure (Pl. 2, fig. 5). Small starlike depressions are present everywhere on

Explanation of Plate 2

Figs. 1 and 2. *Temnoxa molliuscula* sp. nov., latex replica, ×8: (1) holotype PIN, no. 4852/104 and (2) specimen PIN, no. 4852/106; Arkhangelsk Region, Karakhta River; Upper Vendian, Ust-Pinega Formation.

Figs. 3–10. *Vaveliksia vana* sp. nov.; imprint on the rock surface: (3) specimen PIN, no. 3993/5219-1, ×2; (4) specimen PIN, no. 3993/5244, ×1.5; (5) specimen PIN, no. 3993/5219-2, ×2; (6) specimen PIN, no. 3993/5216, ×1.5; (7) specimen PIN, no. 3993/5224, ×2; (8) holotype PIN, no. 3993/5217-1, ×1.5; (9) specimen PIN, no. 3993/5222, ×1.5; and (10) specimen PIN, no. 3993/5218, ×1.5; Zimnii Bereg (Winter Coast) of the White Sea near the Zimnegorsk lighthouse; Upper Vendian, Mezen Formation, lower part of the *Yorgia* Beds.

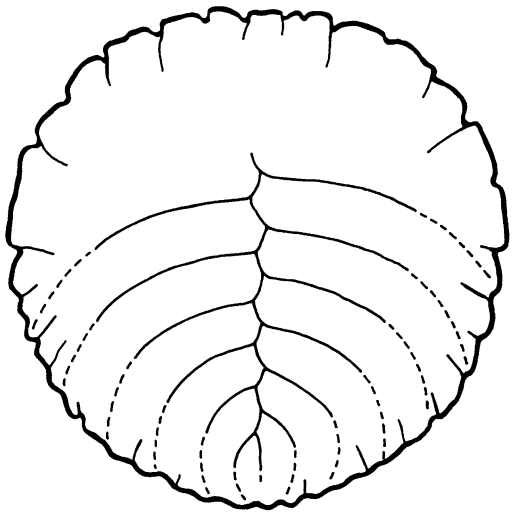


Fig. 5. *Karakhtia nessovi* sp. nov., schematic reconstruction, dorsal view.

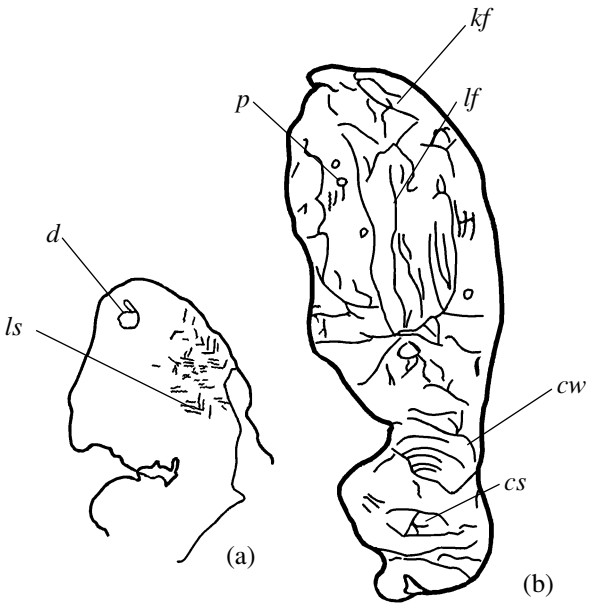


Fig. 6. The types of preservation of *Vaveliksia vana* sp. nov.; drawing based on the photographs of the specimens (a) PIN, no. 3993/5219-1 and (b) specimen PIN, no. 3993/5222. Designations: (*cs*) circular structure; (*cw*) concentric wrinkles; (*d*) depression at the apical end of the body (possibly, aperture); (*kf*) knobby folds; (*lf*) longitudinal furrows; (*ls*) fine linear structures; and (*p*) pit, supposed traces of perforation of the wall.

both the imprints and adjacent rock surface. The three mentioned types of structures are probably caused by postmortal changes, although the furrows and wrinkles possibly reflect some morphological features. Some imprints are crumpled, forming wide sliding isometric folds, especially prominent in the marginal area (Pl. 2, figs. 6, 9). Some imprints are finely pitted in places (Pl. 2, fig. 6). The single specimen (Pl. 2, fig. 3) bears a large depression on the end opposing the circular structure, while the surface of the imprint is divided by more or less regular small linear structures.

Judging from the state of preservation and the position within the host rock, the organism was incapable of self-motion, since no typical signs of muscular activity nor traces of motion and sediment treatment are observed near the imprints. All specimens, at least those composing groups, were preserved *in situ.* One can propose several kinds of habit for this organism. It could be buried in sediment, lie freely on the bottom, or be attached to some substrate and raised above the bottom. We are inclined to accept the last version. The characteristic circular structures can be interpreted as attaching structures. Sometimes, the spatial orientation of imprints can be noted (Pl. 2, fig. 10). The orientation might be caused by the bottom water currents. The feeding strategy of this sessile animal was most likely filtration through the body wall, since its body surface is relatively small and no traces of mouth-like structures are observed. If this is the case, the animal's body most likely contained an internal cavity or a system of cavities increasing the internal surface area.

Thus, the general morphological pattern of *Vaveliksia* can be reconstructed as follows (Fig. 7). The sac-shaped organism was attached by its basal part to the substrate (microbial film?). The walls of the body were soft or composed of sediment particles imbedded into the organic matrix (in the manner of some sponges). It can also be supposed that the walls were supported by spicula-like structures (the small linear structures shown in Fig. 6 can be interpreted as spicules). Superficially similar, but dictionally positioned structures of the Precambrian genus *Palaeophragmodictya* were interpreted by Gehling and Rigby (1996) as spicules. Since the attaching structure and saclike body differ in the preserved relief (the first is significantly more prominent than the second), the sucker was a rather dense and stout structure, while the sac, judging from its extensive postmortal rugosity, had an internal cavity and thin walls. Another fact showing the difference between these elements is disconnection of sac and sucker in the burial (Pl. 2, fig. 8). Possibly, the organism was capable of gemmation, the wide and isometric knobby folds may be interpreted as undetached daughter individuals (Pl. 2, figs. 5, 6). Small circular structures in the marginal areas can be very tentatively interpreted as apertures, while small pits on the surface can be regarded as wall perforations. Probably, sediments got into the body through these openings. The ragged isometric injury (Pl. 2, fig. 3) is noteworthy. It could be a bite trace, although such traces are untypical for the Vendian. Probably, *Vaveliksia* dwelt on the bottom and formed small colonies composed of three or four individuals of different size (Fig. 8). Individuals found in groups lack any communicative structures. From the above observations and assumptions, one may propose

that *Vaveliksia* has the same level of organization as archaeocyaths or sponges.

SYSTEMATIC PALEONTOLOGY

Genus *Parvancorina* Glaessner, 1958

***Parvancorina sagitta* Ivantsov, sp. nov.**

Plate 1, figs. 5–8

Etymology. From the Latin *sagitta* (arrow).

Holotype. PIN, no. 4853/89, imprint on the rock surface, Arkhangelsk Region, Onega Peninsula, Solza River; Upper Vendian, Ust-Pinega Formation.

Description. The body is elongated oval with a wider, tentatively anterior end. A narrow band slightly widened anteriorly and posteriorly extends along the margin of the body. The central part of the body is evenly convex in small specimens, while in the larger specimens, the central area is occupied by an anchor-like ridge. The transverse beam of this structure is arched, the distance between its ends is about half of the whole length of the structure. The longitudinal beam is straight and relatively wide.

Measurements. See Fig. 1.

Ontogenetic changes. The central structure is almost indistinct in the smallest specimens (Pl. 1, fig. 8). During the body growth, it becomes more prominent, and, at the same time, the relative width of the longitudinal beam decreases, while the relative width of the transverse beam increases.

Comparison. The new species differs from *P. minchami* in the elongated body, wider marginal band, and wider longitudinal beam and narrower transverse beam of the axial structure. These features are well-pronounced even in distorted and laterally compressed specimens (Pl. 1, fig. 12).

Material. Holotype and paratypes PIN, nos. 4853/36, 4853/37, 4853/39, 4853/40, 4853/47, 4853/90–93, 4853/95–101, and 4853/104–124 from the type locality.

Genus *Temnoxa* Ivantsov, gen. nov.

Etymology. From the Temnoksa River.

Type species. *T. molliuscula* sp. nov.

Diagnosis. Body elongated oval, clearly divided into two parts: wide crescent cephalic part and narrow oval undivided body part. Deep depression extending across cephalic part in parallel to anterior margin. Body part with almost flat lateral margins and strongly convex central area composing more than half of body part.

Composition. Type species.

Comparison. The new genus is somewhat similar to *Parvancorina* in its elongated oval body with wide anterior end and in the presence of a wide and long convex central structure composing more than half of the body part. The two genera could also be similar in the structure of the anterior end, as the convex structure of the anterior part of *Temnoxa* is compared to the transverse beam of the anchorlike structure of *Parvancorina*. The difference between the genera is the division of the *Temnoxa* body into two parts so that the convexities of the anterior and posterior parts are isolated from each other and the absence of the entire peripheral band bordering the body.

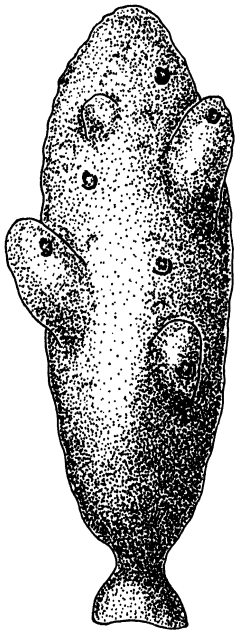


Fig. 7. Reconstructed appearance of *Vaveliksia vana* sp. nov.

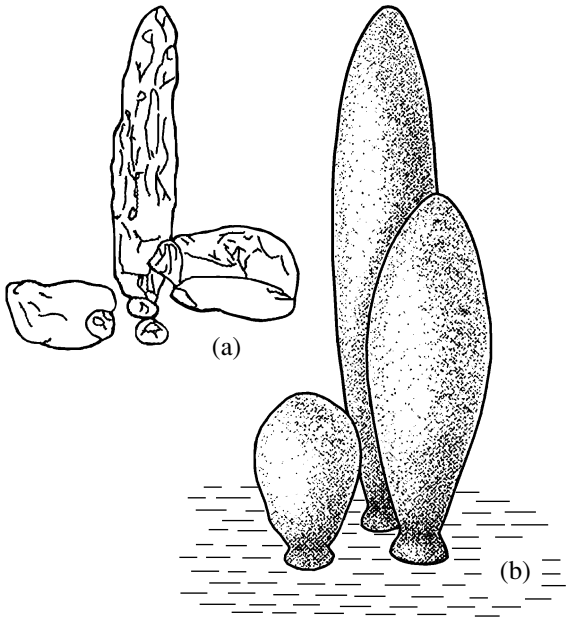


Fig. 8. A colony of *Vaveliksia vana* sp. nov.: (a) drawing based on the photograph of specimen PIN, no. 3993/5217; (b) schematic reconstruction.

***Temnoxa molliuscula* Ivantsov, sp. nov.**

Plate 2, figs. 1 and 2

Etymology. From the Latin *molliusculus* (rather soft).

Holotype. PIN, no. 4852/104, imprint on the rock surface; Arkhangelsk Region, Onega Peninsula, Karakhta River; Upper Vendian, Ust-Pinega Formation.

Description. The same as the generic diagnosis (Fig. 2).

Measurements, in mm. Holotype length, 8.5; holotype width at the cephalic part, 4.6; paratype length, 6.4; paratype width at the cephalic part, 3.7.

Material. Holotype and paratype PIN, no. 4852/106 from the type locality.

Genus *Solza* Ivantsov, gen. nov.

Etymology. From the Solza River.

Type species. *Solza margarita* sp. nov.

Diagnosis. Body low conical with flattened margin, egg-shaped in plan. Top of cone displaced toward tapering end. Body containing system of canals, which becoming narrower toward periphery, anastomosing in central part, and repeatedly dichotomizing in marginal area. Probably, canals open along body margin.

Composition. Type species.

Comparison. The features listed in the diagnosis are unique to the new genus.

***Solza margarita* Ivantsov, sp. nov.**

Plate 1, figs. 1–4

Etymology. From the latinized Greek (μαργαριτης) *margarita* (pearl).

Holotype. PIN, no. 4853/60, imprint on the rock surface, Arkhangelsk Region, Onega Peninsula, Solza River; Upper Vendian, Ust-Pinega Formation.

Description. The same as the generic diagnosis (Fig. 3).

Measurements, in mm:

Specimen PIN, no.	Length	Width
4853/61	7.2	5.3
4853/56	7.6	5.8
4853/58	8.6	5.9
4853/55	9	7.5
4853/60 (holotype)	10.4	8
4853/7	10.5	8

Material. Holotype and paratypes PIN, nos. 4853/7, 4853/55, 4853/56, 4853/58, and 4853/61 from the type locality.

Genus *Karakhtia* Ivantsov, gen. nov.

Etymology. From the Karakhta River.

Type species. *Karakhtia nessovi* sp. nov.

Diagnosis. Medium and large-sized, body rounded and isometric in plan divided into two rows of transverse elements positioned in alternating order with reference to longitudinal axis of body. Transverse elements gradually decreasing in size from one end to other, their lateral ends inclined in the same direction. Margin of body covered by coarse radial folds, which probably present in living organism.

Composition. Type species.

Comparison. *Karakhtia* is similar in morphological pattern to proarticulates from the class Vendiamorpha (Ivantsov, 2001), but it strikingly differs in the constantly present coarse radial folds.

***Karakhtia nessovi* Ivantsov, sp. nov.**

Plate 1, figs. 13 and 14

Etymology. In honor of the Leningrad paleontologist L.A. Nessov.

Holotype. PIN, no. 4852/250, imprint on the rock surface, Arkhangelsk Region, Onega Peninsula, Karakhta River; Upper Vendian, Ust-Pinega Formation.

Description. The same as the generic diagnosis (Figs. 4a, 4b).

Measurements, in mm:

Specimen PIN, no.	Length
4852/253	8
4852/252	16
4852/250 (holotype)	22
4852/254	40
4852/249	108

Material. Holotype and paratypes PIN, nos. 4852/249, 4852/251–254 from the type locality.

Genus *Vaveliksia* Fedonkin, 1983

Vaveliksia: Fedonkin, 1983, pp. 136, 137; 1985, pp. 103, 104.

Type species. *Vaveliksia velikanovi* Fedonkin, 1983; Podolian Dniester Region, right bank of the Dniester River, Dniester hydroelectric power station; Vendian, Mogilev–Podolsk Group, Mogilev Formation, Lomozov Beds.

Diagnosis. Small saclike organisms with monaxonix heteropolar symmetry of uncertainly large order (terminology after Beklemishev, 1964). Organism composed of two different parts, i.e., rather convex and massive attaching disk weakly connected to capsular body.

Composition. The type species and *V. vana* sp. nov.

Comparison. The features from the diagnosis are unique to the genus.

Remarks. In the original description of *Vaveliksia*, Fedonkin (1983) noted that "at the end opposite to the disk, the ellipsoidal part lacks the smooth closure,

but has short linear elements oriented along the long axis that form a pectinate margin." These structures were interpreted as remains of tentacles. A study of extensive material has shown that these structures are folded walls of the body rather than tentacles.

***Vaveliksia vana* Serezhnikova, sp. nov.**

Plate 2, figs. 3–10

Etymology. From the Latin *vana* (incorporeal).

Holotype. PIN, no. 3993/5217-1, natural mold; Zimnii Bereg (Winter Coast) of the White Sea near the Zimnegorsk lighthouse; Upper Vendian, Mezen Formation, lower part of the *Yorgia* Beds.

Description. The capsular sac is elongated to different extents along the central axis (see measurements). The attaching disk is 7 to 15 mm in diameter. The walls of the body are relatively thin and probably perforated.

Measurements, in mm:

Specimen PIN, no.	Length	Width
3993/5217	86	17
3993/5218	55	16
3993/5219	41	15
3993/5221	35	08
3993/5222 (holotype)	51	19

Comparison. The new species differs from *V. velikanovi* Fedonkin, 1983 in different proportions of the saclike body and a smaller diameter and more convex surface of the attaching disk.

Material. Holotype and paratypes PIN, nos. 3993/5216–5224, 3993/5244–5246 from the type locality.

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