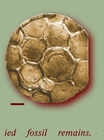
COMPARATIVE TAPHONOMY OF VENDIAN GENERA BELTANELLOIDES AND NEMIANA AS A KEY TO THEIR NATURE

Maxim V. Leonov

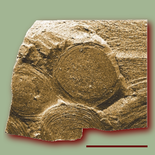
Laboratory of Precambrian Organisms
Paleontological Institute of the Russian Academy of Sciences
Profsoyuznaya, 123, Moscow, 117647, RUSSIA
maxleon@narod.ru

A significant part of described Neoproterozoic remains of soft-bodied animals represented by very simple forms with round or cyclic form. Few morphological features make some problems with reconstruction of their nature and ecology. The taphonomic analyze of oryctocenoses can produce data for solving some of this problems.



PIN, № 3992/501, Beltanelloides sorichevae Sok, 1965. Russia, Archangelsk region, Yarnema borehole, Upper Vendian, Verkhovka Formation (Fedonkin et al., 1983. Pl. IV fig. 2,). Scale 1 cm.

Beltanelloides sorichevae Sokolov, 1965 is the first group of studied fossil remains. This taxon was primarily described on the material from Upper Vendian of Eastern-European Platform (White Sea area). Organisms typically preserved as a negative round impression with thin, non-regular, concentric wrinkles on the peripheral part. The thin organic film was also observed on the surface of this imprints.

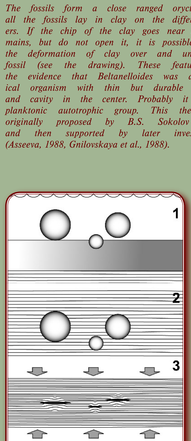


Beltanelloides sorichevae Sok., 1965. Russia, Archangelsk region, Lyamtca locality, Upper Vendian, Lyamtca Formation. Scale 1 cm.

Remains lay in the beds of massive clay. These imprnts have the same structure both on the upper and on the lower surface of the rock chip.

Beltanelloides sorichevae Sok., 1965. Russia, Archangelsk region, Lyamtca locality, Upper Vendian, Lyamtca Formation. Scale 1 cm.

The fossils form a close ranged oryctocenosis, all the fossils lay in clay on the different layers. If the chip of the clay goes near such remains, but do not open it, it is possible to see the deformation of clay over and under the fossil (see the drawing). These features are the evidence that Beltanelloides was a spherical organism with thin but durable envelope and cavity in the center. Probably it was a planktonic autotrophic group. This thesis was originally proposed by B.S. Sokolov (1976) and then supported by later investigations (Asseeva, 1988, Gnilovskaya et al., 1988).



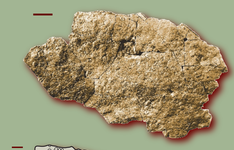
Forming of Beltanelloides imprints may be illustrated by four stages:
1) spherical organisms came down to the surface of muddy bottom;
2) organisms were buried by the mud. At this stage their spherical form did not changed;
3) mud was compacted in the process of diagenesis. Beltanelloides was compacted also to form flat imprints with phytoleima. Upper and lower beds of rock were deformed to fill the space of inner cavity;
4) at present we see the double-sided imprints in the clay stata.

Another evidence of different nature of studied fossils depends on the biometric criteria of their distribution on the rock surface. Specimens with numerous imprints of Nemiana from Yampol beds of Mogilev Formation (Novodnestrovsky quarry, Podolia, Ukraine) and from Yorga Formation (Zimnie Gory locality, White Sea Coast, Russia) were used for this comparison. Specimens that represent Beltanelloides come from Lyamza and Zimnegory Formations (Lyamza and Zimnie Gory localities, White Sea Coast, Russia). Mean diameter of each fossil (D) and the shortest distance between the center of fossil and the center of neighbor one (L) were measured on the specimens. Accuracy of measuring was about 0,3 mm, number of measured imprints – from 20 to 125 (typically 60) on each specimen.

TABLE OF OBSERVED DATA

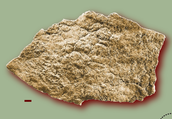
Locality	Series	Specimen №	CV(D)	CV(L)	R
Russia, Arkhangelsk region	Beltanelloides	3/0	0,209	0,287	1,389
		10/1	0,360	0,368	1,044
		10/2	0,307	0,395	1,806
		89-1/MSTC	0,181	0,304	1,758
Ukraine, Podolia	Nemiana	13/9	0,060	0,058	1,013
		7/18, 8/5, 9/1, 9/3	0,097	0,120	1,494

This comparative study may be summarized by three main conclusions:
1) Nemiana and Beltanelloides are two quite different groups of Vendian organisms that had different morphology, ecology and producing quite different oryctocenoses.
a) Beltanelloides is planktonik, possible autotrophic form,
b) Nemiana is benthic organism that tend to form clusters (assemblages) on the sea bottom.
2) There are two types of Beltanelloides preservation:
a) Double-sided imprints with negative relief with phytoleima in clay,
b) Positive in hyporelief imprints on the bottom surface of sandstone layers,
3) Beltanelloides and Nemiana form different types of oryctocenosis. This difference depends on different ecological niches that were occupied by the organisms and may be observed both by taphonomic and biometric methods. There is no evidence about findins of Nemiana and Beltanelloides from the same surfaces or even members. So in the future investigations it is possible to link this fossils with the different types of paleoecological environments in Vendian basins.



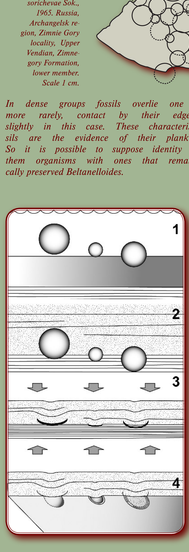
Beltanelloides sorichevae Sok., 1965. Russia, Archangelsk region, Zimnie Gory locality, Upper Vendian, Zimnegory Formation, lower member. Scale 10 cm.

There is another type of preservation for Beltanelloides. Fossils represented as low, positive in hyporelief, imprints on the lower surfaces of sandstone beds. These remains are found on the surfaces both with accumulative and erosive features.

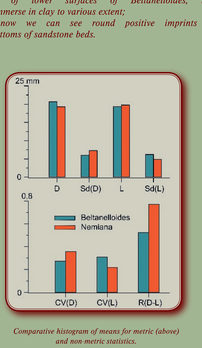


Beltanelloides sorichevae Sok., 1965. Russia, Archangelsk region, Zimnie Gory locality, Upper Vendian, Zimnegory Formation, lower member. Scale 1 cm.

In dense groups fossils overlie one another or, more rarely, contact by their edges, deformed slightly in this case. These characteristics of fossils are the evidence of their planktonic nature. So it is possible to suppose identity of producing them organisms with ones that remains as typically preserved Beltanelloides.



Following sequence illustrates the process of forming for second type of Beltanelloides preservation:
1) organisms came down to the muddy bottom. Some of them may be buried in the mud – partially or entirely;
2) as the result of some hydrodynamical event, for example storm currents, the thin layer of sand lays over the mud. Depending on local conditions it may cause some erosion and excavation of the levels with buried organisms;
3) when the sediment was compacted, on the boundary of clay and sand were formed the imprints of lower surfaces of Beltanelloides, that was immerse in clay to various extent;
4) now we can see round positive imprints on the bottoms of sandstone beds.

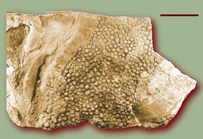


Comparative histogram of means for metric (above) and non-metric statistics.

Specimens vary by non-metric parameters: coefficients of variation for diameter (CV(D)) and distance between fossils (CV(L)). More distinctive data comes from comparison of correlation coefficients of diameter and distance between fossils (R(D-L)) for specimens with Beltanelloides and Nemiana.

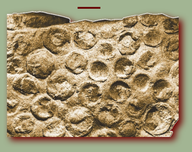
Nemiana simplex Palij, 1976 (Holotype). Ukraine, Podolia, Ozarincy village, Upper Vendian, Mogilev Formation, Yampol beds. (Palij, 1976, Pl. XXII, fig. 1). Scale 1 cm.

Nemiana simplex Palij, 1976 is another genus of round fossils with simple morphology and irregular concentric wrinkles. Primarily it was described from the Upper Vendian of Podolia region (Ukraine). Some autors consider Nemiana as the junior synonim of genus Beltanelloides (Gureev, 1988).



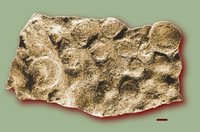
PIN, № 3993/5610, Nemiana simplex Palij, 1976. Russia, Archangelsk region, Zimnie Gory locality, Upper Vendian, Yorga Formation, third member of the first mesocycle. Scale 10 cm.

Nemiana tends to occur in relatively dense assemblages on the sandstone strata with accumulative type of bottom boundary. Specimens distributed in this oryctocenosis only on the same level. Fossils never overlay the neighbour imprints, that occure in the same sandstone layer. The remains of Nemiana may be deformed in the places of contact with another ones, which may cause illusion of "honeycombs" structure.



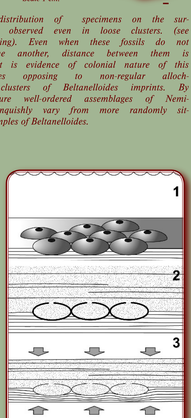
PIN, № 3993/5611, Nemiana simplex Palij, 1976. Russia, Archangelsk region, Zimnie Gory locality, Upper Vendian, Yorga Formation, third member of the first mesocycle. Scale 1 cm.

It is possible to see the negative imprints of upper surface of the organism, the sandstone that fill the space between it and positive imprint of lower surface. So it is possible to think that Nemiana preserved as inner cast of some body.

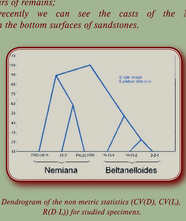


Nemiana simplex Palij, 1976. Ukraine, Podolia, Novodnestrovsky quarry, Upper Vendian, Mogilev Formation, Yampol beds. Scale 1 cm.

Regular distribution of specimens on the surface was observed even in loose clusters. (see the drawing). Even when these fossils do not touch one another, distance between them is regular. It is evidence of colonial nature of this assemblages opposing to non-regular allochthonous clusters of Beltanelloides imprints. By this feature well-ordered assemblages of Nemiana distinguishly vary from more randomly situated examples of Beltanelloides.



Sheme of Nemiana taphonomy:
1) Nemiana is a benthic sach-like, round at the sight from above organism with the hole on the upper part that grows on the mud ground and partially submerged in it. It tends to form groups, (monotaxon assemblages);
2) these assemblages were buried in situ by the sand sediment, and the sand immediately fills the inner cavities of Nemiana;
3) in the process of diagenesis casts of the cavities became solid very early. Fossils were compressed very slightly so overlaying layers were not deformed or were pushed up over the contours of remains;
4) recently we can see the casts of the Nemiana on the bottom surfaces of sandstones.



Dendrogram of the non-metric statistics (CV(D), CV(L), R(D-L)) for studied specimens.

The data show significant difference between clusters of Beltanelloides and Nemiana imprints. So three biometric criteria, mentioned above, may serve for clear discriminating of studied fossils.
It characterizes well-ordered assemblages of Nemiana and more randomly situated examples of Beltanelloides. This regular arrangement of Nemiana imprints on the rock surface can be observed both in cases of loose and dense distribution of fossils over the area of rock surface. Even when these fossils do not touch one another, distance between them is regular. It is evidence of colonial nature of this assemblages opposing to non-regular allochthonous clusters of Beltanelloides imprints.

This study was supported by a Russian Fund for Basic Research grant (RFBR 02-05-64658) and a Grant of the President (NSH – 1790.2003.5).