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Phytolith Research of Shilka-12 and Zaostrovka-2 Archaeological Settlements on Middle Yenisey

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The article focuses upon the results of phytolith research on multilayer and single-layer archaeological settlements of the Middle Yenisey taiga zone. The features and nature of changes on the site plant coating during the last three millennia are defined, the presence of weeds in the period of settlement inhabitation and the fact of sedge usage for building of the Bronze Age dwellings are revealed.

Keywords: archaeology, ecology, phytoliths, the Bronze Age, taiga, Siberia, the Yenisey.

Introduction

Phytolith method is based on the analysis of microscopic opal plant stones, phytoliths. They are formed in plants by intracellular precipitation of silica, replicate the form of a plant cell and assume a specific morphology. This permits to use phytoliths as diagnostic indicators for the reconstruction of plant coating of ancient times (Golyeva, 1997).

Archaeological sites study with phytolith analysis ensures the possibility to receive additional information about the use of plants by ancient people. In ancient times as well as at present plants were used for food, decoration, clothes and bedding, in rites and other fields of life. It explains a profound interest in phytolith analysis in archaeology (Golyeva et al., 1994). It was first used at the beginning of the last century when excavating Anau kurgan in Kazakhstan (Schellenberg, 1908). The excavation results proved that the inhabitants grew cereals (for example, wheat and barley). Modern aspects of the method application are various. Thus, the researches by G. Baker (1959), P.L. Armitage (1975), L.S. Cummings, A. Magennis (1997), J. Juan Tresserras (1997) on the basis of studying phytoliths from dental calculus and caries cavities show the possibility to identify diet elements (usage of plants for food) taken by people who lived within the period from the Paleolithic to Middle Ages. The works by Arlen Rosen (1992; Rosen, Weiner, 1994) prove the analysis potential to determine

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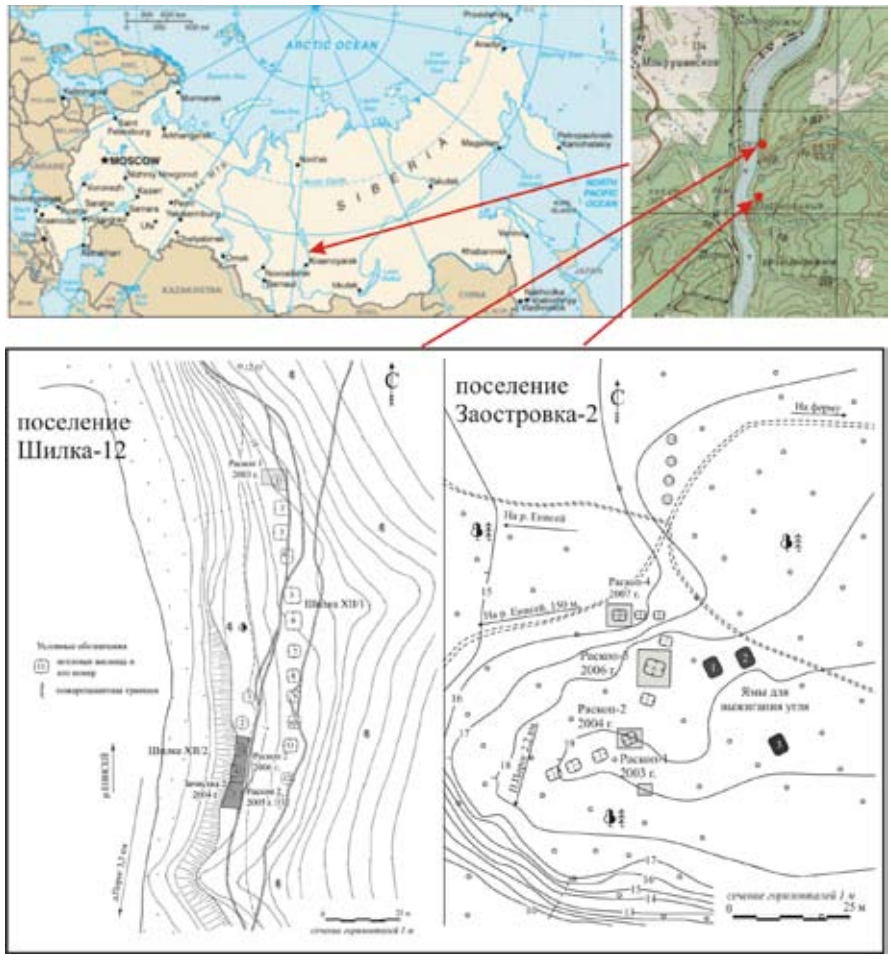

Fig. 1. Shilka-12 and Zaostrovka-2 settlements on the map

the appearance and development stages of irrigation in arid conditions. This subject is developed in the articles by A. Powers-Jones (1997). Bishop with co-authors (1982) points at the significance of the phytolith analysis for ceramic study.

In Russian science phytolith research is applied to the study of ancient burials containing plants brought by people for a funeral ceremony. A big number of phytoliths has been found out in beddings in burial mounds and cenotaphs, abdomens of people and sacrificial animals, burial vessels, etc. (Golyeva, 2000; 2001; Bobrov, 2002). It has been noted that high concentration of phytoliths was observed only in floor beddings or in cattle pens (Rosen, 1987; Golyeva, 2001). In the rest cases content of phytoliths on single-layer settlements was not too high or they were not found at all, the latter case being also significant (Phytoliths…, 2001). The example of Bobrovka multilayer settlement on the river Yenisey is the evidence of the possibility to define changes of local ecological situation in inhabited areas (Archaeology …, 2003).

Materials and methods. Shilka-12 and Zaostrovka-2 archaeological sites are situated 1 km from each other on the right bank of the Yenisey in the range of Kazachinsky rapid. They form parts of Ust-Shilka archaeological

Fig. 2. Turf and podzol soil with second humus horizon (Shilka-12 settlement, dwelling N 3)

micro area which had been inhabited since the Mesolithic Age. The territory is in the southern taiga subzone of the Middle Yenisey (Fig. 1).

On the northern, eastern and southern sides the territory of ***Shilka-12 multilayer settlement*** is bordered by slopes of high basic terraces cut by a small ravine. Its western side is washed by the river. 18 dwelling ditches located in two rows along the verge of terraces of various heights can be visually identified on the site.

Samples for phytolith analysis were taken from the section of the first terrace above the flood plain with the row of five dwelling ditches. The total length of the settlement along the terrace verge is 40 m. The southern part of the multilayer site with dwelling ditches N 3, 4, 5 was studied by solid excavation in 2005 – 2006 (Mandryka, Zharnikov, 2008).

Soil profile of Shilka-12 section has the following structure (Fig. 2).

O 0 – 0,5 cm	Forest spreading (consists of birch, pine and grass waste).
AY 0,5 – 3 cm	Dark grey, humid, sandy-loam, friable, lumpy structure, abundantly pierced through with roots of grassy and woody plants, developed pores, clear change, wavy border, it does not boil with HCl.
EL 3 – 19 cm	Light grey, dry, middle density, lumpy and dusty structure, sandy-loam, developed pores, it does not boil with HCl, wavy border, gradual change.
I [A] 19 – 29 cm	Cultural layer N1. Dark grey with fulvous spots, humid, friable, sandy, with bad structure, developed pores, with roots of trees, charcoal and artifacts (ceramics with coating roller), it does not boil with HCl, gradual change, blurred border.
II [B] 29 – 45cm	Cultural layer N2. Light grey, humid, friable, sandy-loam, small lumpy and dusty structure, with single roots of trees, artifacts (ceramics with cut roller), it does not boil with HCl, blurred border, gradual change.
III.1 [A] 45 – 61 cm	Cultural layer N3.1. Dark brown, humid, with middle density, sandy-loam, small lumpy and dumpy structure, with single roots of trees and artifacts (ceramics), it does not boil with HCl, blurred border, gradual change.

III.2 [B] 61 –76 cm	Cultural layer N3.2. Light brown, humid, middle density, sandy-loam, small lumpy structure, with roots of trees and artifacts (thick-walled ceramics), it does not boil with HCl, blurred border, gradual change.
IV [A] 76– 103cm	Cultural layer N4. Dark brown with grey tint, humid, sandy-loam, dense, small lumpy and dusty structure, with single roots of trees and charcoal, it does not boil with HCl, blurred border, gradual change.
BT 103 – 151cm	Brown, humid, sandy-loam, lumpy structure, dense, with single roots of trees, it does not boil with HCl, blurred border, gradual change.
C 151 – 166cm	Dark brown, humid, light loam, small lumpy and dumpy structure, dense, with single roots of trees and charcoal, it does not boil with HCl, blurred border, gradual change.
C 166 – 178cm	Brown, humid, light loam, with bad structure, dense, with single roots of trees and a little charcoal, it does not boil with HCl, blurred border, gradual change.
178 -210 cm Alluvial sediments	Dark brown, humid, loam, with bad structure, dense, with single roots of trees, it does not boil with HCl, blurred border, gradual change.
210-Alluvial sediment	Brown, humid, fine-grain sand, dense, with bad structure, it does not boil with HCl.

Samples for phytolith analysis from Shilka-12 section were taken from the following depth intervals: 1-2 cm, 8-10, 21-23, 26-28, 34-37, 53-55, 62-66, 78-80, 87-90, 98-100, 116-118, 138-142, 159-161, 174-176, 198-200, 238-240 cm.

The excavation revealed four cultural layers connected with different burial soils. The finds of the Early Bronze Age (the 4th layer), transitional period from the Bronze Age to the Iron Age (the 3rd layer), the Early Iron Age (the 2nd layer) and the Middle Ages (the 1st layer) were made there.

The first, second and forth layers were formed by short-term sites of ancient people. The third one was left by a season settlement. Three dwellings, partly destroyed by the terrace side crumbling, were studied from this layer. Their boundaries had a round outline. It allowed to presume an oval form of dwellings with the size about 4,0×5,0 m that makes about 15 square meters. Pits from ceiling supporting poles were not discovered that allowed to assume the form of a roof that rested on ditch walls to be cone-shaped. A cup-shaped floor of the dwellings was deeper in the center where a fireplace was located. The latter had an oval form in the 3rd and 4th dwellings and a rectangular one in the 5th dwelling. The most numerous finds from the layer were ceramic fragments of forty vessels. Besides them a stone disk-shaped hand scraper, hammers, abrasives, knapping flakes and a bronze knife with a straight back, a fragment of an arrowhead (?) and a fragment of a blade were also found. The archaeological material mentioned above enabled to refer the layer to the late stage of Shepilevskaya culture and date it to the transitional period from the Bronze Age to the Iron Age on the basis of radiocarbon date of charcoal from a fireplace of dwelling N5 – 2580±60 (SBAS-5934) (Zharnikov, 2007; Mandryka, Zharnikov, 2008; Mandryka, 2008).

Zaostrovka-2 settlement is situated 150 m from the river bank on a 14-19-metre terrace. Ancient people had settled in this place four times, each settlement consisting of half dug-in dwellings. Archaeological works have been carried out here since 1999.

Samples for phytolith analysis were taken from excavation N 4 in 2007. The dwelling under study was dwelling N 10. The samples were taken from an excavation wall in a solid column, a fireplace and a floor of the dwelling as well as from a ceiling containing the details of a wooden roof frame.

Soil profile of Zaostrovka-2 section has the following structure (Fig. 3):

O 0 – 0,5 cm	Forest spreading formed by birch, conifer and grass waste.
AY 0,5 – 9 cm	Humid, dark grey, sandy-loam, friable, with lumpy structure, abundantly pierced through with roots of grassy and woody plants, developed pores, gradual change, straight border, it does not boil with HCl.
EL 9 – 21 cm	Humid, grey, friable, small lumpy structure, sandy-loam, developed pores, it does not boil with HCl, straight border, clear change.
A[I] 21 – 31cm	Cultural layer N 1. Humid, grey with brown tint, friable, sandy-loam, with lumpy structure, developed pores, with roots of trees, charcoal and artifacts (ceramic and simple stone tools), it does not boil with HCl, sharp change, wavy border. Lens of light loam was noticed.
BEL 31 – 75 cm	Humid, brown, with middle density, sandy-loam, with small lumpy and dumpy structure, with single roots of trees and new formation (red spots), it does not boil with HCl, blurred border, gradual change.
BT 75 – 101 cm	Humid, grey and brown, dense, sandy, with bad structure, with single roots of trees, it does not boil with HCl, blurred border, gradual change.
C 101 –	Humid, grey, dense, foliated, sandy, with bad structure, with lenses and carbonate spots (it boils with HCL well).

Fig. 3. Turf and podzol soil (Zaostrovka-2 section, dwelling N 10)

Soil samples for phytolith analysis were taken from the following depth intervals: 0,5-2 cm; 4-6; 10,5-11; 12-14; 15-17; 18-20; 20-22; 25-27; 27-29; 30-31; 35-36; 42-45; 47-50; 54-55; 58-60; 63-65; 68-70; 79-80; 88-90; 107-110; 117-120; 143-145; 153-155 cm.

In 2007 in excavation N 4 with the area of 42 m one cultural layer was revealed. It contained 173 artifacts from both the dwellings and outside. The majority of finds were ceramic fragments including rims of 12 vessels of Shepilevskaya culture. Stone hammers, scrappers, a core and a fragment of a bronze single-blade knife were also found there. A lot of stones split with high temperature were registered on the whole excavation area. The dwelling under research was half dug-in with a rectangular ditch of 3,8×2,9 m that makes 11 square metres. The floor level was 20 – 25 cm deeper than ancient ground. The ditch bottom slightly went down to the center where an oblong oval fireplace of an open type was located. Pits from ceiling supporting poles were not discovered. As for charred wooden blocks over the dwelling ditch, they could be remains of a wooden frame of a cone-shaped roof that rested on ditch walls (Abdulina, Mandryka, 2007; Abdulina, 2009).

Phytolith separation from the soil, microscopy and interpretation of the obtained material were made by A. V. Grenaderova and E. O. Lisyutina in accordance with A. A. Golyeva's methodical recommendations (Golyeva, 1997; 2001). The photos of phytolith were made with Casio EX-Z750 camera through ZE122 415500-1800-000 microscope monocular under 400× magnification.

Results

Microscopy of samples have registered not only phytoliths but other siliceous biomorphs (spicules of sponges, cuticular moulds) and plant detritus. As a result of the analysis the following correlation between biomorphs in soil horizons of ***Shilka-12 section*** was determined:

There is a high content of detritus and cuticular moulds (Table. 1) in horizon **O.** Their number exceeds the score of phytoliths. It is typical for forest spreading and conditioned by a

Table 1. Comparative bimorph content in Shilka-12 section

SN	Depth, cm	Horizon	Detritus	Cuticular moulds	Phytoliths	Spicules of sponges
1	0 – 0,5	O	+++	+++	+	-
2	0,5 – 3	AY	+++	++	+	-
3	3 – 19	EL	++	++	+	-
4	19 – 29	I [A]	+	+	++	-
5	29 – 45	II [B]	+	single	+++	-
6	45 – 61	III.1 [A]	+	single	++	single
7	61 – 76	III.2 [B]	+	single	+++	-
8	76 – 103	IV [A]	+	+	+++	-
9	103 – 151	BT	+	single	++	-
10	151 – 166	C	single	single	+	single
11	166 – □	C	-	-	+	+

Notation conventions: Comparative biomorph content in a sample: – there are no ones; single – there are single ones; + a little; ++ middling; +++ a lot of.

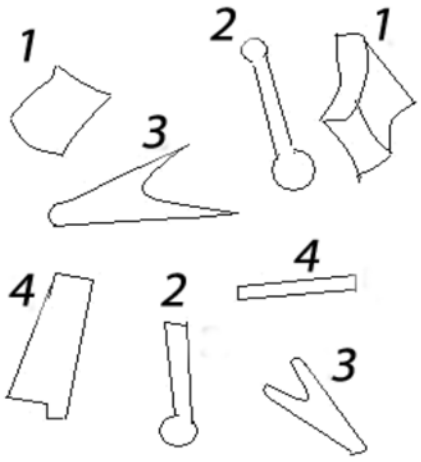

Fig. 4. Forms of phytoliths typical for horizons O and AY of Shilka-12 section: 1 – cubical, 2 – dumbbell-like, 3 – seddle-shaped, 4 – sticks

small degree of plants decomposition. Phitoliths are represented by the forms of pines, meadow cereals and weeds (Lisyutina, 2009).

Sod horizon (**AY**) contains cuticular moulds, detritus, phytoliths of Scotch pine, cocksfoot and Siberian meadow-grass.

In **EL** there have been registered less cuticular moulds and detritus than in the upper layer. Phytoliths are few. Their form (Fig. 4) and pink colour indicate the development of taiga phytocenosis.

In **I [A]** the quantity of cuticular moulds and detritus has reduced. It can be explained by their decomposition. Phytoliths have typical features of coniferous forest forms. There are also weed forms.

In **II [B]** phytolith complex is represented by the forms typical for coniferous forests and by meadow cereals.

In **III.1 [A]** phytoliths of pine, birch and weeds are registered (Table. 2). Phytoliths in horizon **III.2 [B]** are more numerous than in horizon **III.1 [A]**. They are represented by pine, birch, dicotyledonous herbs and meadow cereals and reflect the development of taiga phytocenosis. A big number of phytoliths in illuvial horizon is determined by their penetration from superincumbent burial humus and accumulative horizon and more favourable conditions for their safety because of a lesser microbiological and biochemical activity in this horizon.

There are almost all phytolith forms in the forth cultural layer **IV [A]**. Herbaceous forms occupy a dominating position. These as well as the absence of colouring (siliceous biomorphs

Table 2. Quantitative phytolith distribution in Shilka-12 section

Horizon	Total, number/%	Forms of phytoliths of definite plant communities						
		Conifers	Dicotyledons herbs	Forest cereals	Meadow cereals	Steppe cereals	Mosses	Weeds
O	35/100	17/49	7/20	-	5/14	-	-	6/17
AY	19/100	7/37	3/15	2/11	1/5	-	6/32	-
EL	36/100	14/39	5/14	-	4/11	-	9/25	4/11
I [A]	28/100	4/14	17/61	3/11	4/14	-	-	-
II [B]	97/100	29/30	46/47	-	2/2	-	2/2	18/19
III.1 [A]	23/100	6/26	8/35	3/13	6/26	-	-	-
III.2 [B]	125/100	13/10	72/58	11/9	17/14	-	3/2	9/7
IV [A]	56/100	9/16	41/73	2/4	1/2	-	3/5	-
BT	16/100	-	6/38	-	7/44	3/18	-	-
C	4/100	-	-	-	3/75	1/25	-	-

Table 3. Comparative bimorph content in Zaostrovka-2

SN	Depth, cm	Horizon	Detritus	Cuticular moulds	Phytoliths	Spicules of sponges
1	0 – 0,5	O	+++	+++	-	-
2	0,5 – 9	AY	+++	+	+++	-
3	9 – 21	EL	++	+	++	-
4	21- 31	I [A]	+	+	+++	-
5	31- 75	BEL	+	simple	++	-
6	75- 101	BT	simple	simple	+	simple
7	101-	C	-	-	simple	simple

See notation conventions to Table 1.

Table 4. Quantitative phytolith distribution in Zaostrovka-2 section

Horizon	Total number/ %	Forms of phytoliths of definite plant communities						
		Conifers	Dicotyledons herbs	Forest cereals	Meadow cereals	Steppe cereals	Mosses	Weeds
AY	304/100	33/11	58/19	34/11	-	-	4/1	175/58
EL	94/100	60/64	2/2	8/9	-	-	19/20	5/5
I [A]	217/100	154/71	15/7	2/1	-	-	14/6	32/15
BEL	56/100	22/40	12/21	8/14	-	-	11/20	3/5
BT	21/100	6/29	-	3/14	12/57	-	-	-
C	13/100	-	5/38	-	8/62	-	-	-

of that interval were colourless) indicate the development of forest-steppe phytocenosis.

Horizons **BT** and **C** are characterized by an extremely scanty set of phytoliths (Table. 1, 2). Simple forms of steppe and meadow cereals, spicules of sponges are the signs of periodical floods on this area.

Soil profile of ***Zaostrovka-2 settlement*** is characterized by the following set of biomorphs:

O contains a big number of cuticular moulds (ones of couch grass, birch, etc.) and detritus of varied degree of decomposition (Table. 3, 4).

There are cuticular moulds, phytoliths of cereals and dicotyledonous herbs in **AY**. Sample microscopy has revealed 'forest trichomas' with massive base and small awns; rectangular slightly oblong forms with hollows on their surface; clear sticks with straight and slightly wavy sides and round edges (Fig. 5.1). On the whole, the complex characterized conforms to the present developed pine forest with cereal and motley grass, birch and asp undergrowth.

In horizon **EL** cuticular moulds are fewer in number than in **AY**. There are a lot of conifer phytoliths (Fig. 5.2), mosses and fern sticks (Fig. 5.3) (phytoliths have a pinkish colour that is peculiar to the complex of a coniferous forest).

I [A] is characterized by a high content of siliceous biomorphs. There are a lot of conifer forms (64 % of total content), some ericaceae, mosses (Fig. 5.4), forest cereals (Fig. 5.5), a lot of phytoliths of such weeds connected with human habitation as couch grass and nettle (Fig. 5.6). Phytoliths are large that can identify a

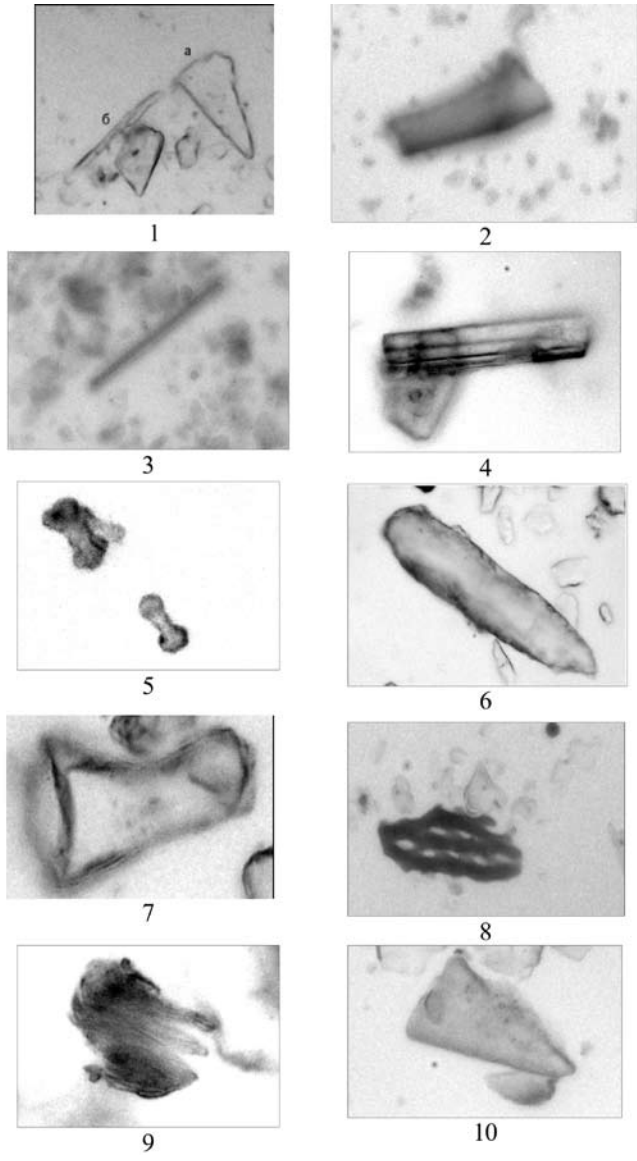

Fig. 5. Biomorphs from soil profile of Zaostrovka-2 settlement: 1 – phytoliths of horizon AY (a – trichoma, b – stick); 2– phytoliths of conifers; 3 – fern "sticks"; 4 – sphagnous moss "sticks"; 5 – Melica nutans phytoliths; 6 –couch grass phytolith; 7 – birch phytolith; 8, 9 – cuticular moulds of sedge; 10 – sedge phytolith

plant community which deposited this phytolith complex as a pioneer one.

Horizon **BEL** contains a lot of birch phytoliths (Fig. 5.7). Pine stones are few. On the whole, the forms are small in size and elements with wavy sides predominate. This complex can indicate the development of depressed birch, pine and motley grass vegetation in relatively cold and dry conditions.

Horizons **BT** and **C** contain spicules of sponges and phytoliths of meadow herbs. Arboreal forms are rare that can indicate periodical floods in this place in the past.

During the analysis of the samples taken from the ceiling of dwelling N 10 it was established that the roof and its structure were made of Scotch pine. There are a lot of phytoliths and cuticular moulds of sedges (Fig. 5.8 – 5.10)

on a floor level of the dwelling. They probably served the base of the beddings. Their stalks might also have covered the dwelling roof. Pine and birch phytoliths predominate in the samples from a fireplace.

Conclusion

Thus, as a result of the research of the soils of Shilka-12 and Zaostrovka-2 archaeological sites on the basis of phytoloth analysis it has become possible to reconstruct the features and character of changes in plant coating, to reveal the presence of weeds connected with human habitation, to characterize the features of soil damping.

So, on Shilka-12 multilayer site the formation of horizons BT and C went on in the time of periodical floods on the terrace. The development of the forth cultural layer took place under the conditions peculiar to forest-steppes. During accumulation of the third cultural layer mixed forest with a lot of various forest herbs and bushes developed. The first and second cultural layers were formed under the conditions peculiar to coniferous forests with mosses and motley grass. Horizons AY and O are characterized by a set of phytoliths corresponding to a birch, pine, cereals and motley grass forest with birch and asp undergrowth developed at present.

The formation of lower horizons (BT and C) on Zaostrovka-2 settlement went on under periodical floods. The development of superincumbent layer BEL went on in drier and colder climate. Cultural layer I [A] was formed under warmer and damper conditions. Horizon EL is represented by phytolith forms peculiar to a pine forest with mosses and motley grass which grew in drier climate than now. A set of phytoliths of horizon AY conforms to a present-day pine forest with cereals, motley grass, birch and asp undergrowth.

The roof and frame structure of dwelling N 10 of Zaostrovka-2 settlement were made of Scotch pine. Numerous forms of sedges on a floor level indicate availability of bedding or roofing material for a half dug-in dwelling. Pine and birch phytoliths predominate in the samples from a fireplace. Brunches of these trees could have been used as firewood.

References

J.A. Abdulina (2009), "Ceramic of Zaostrovka-2 settlement according to materials of excavation in 2007". In *Archaeology and ethnography of Asian part of Russia (new materials, hypotheses, problems and methods*),. Materials of XLIX regional archaeological and ethnographic students' conference. Kemerovo, March 31 – April 3, 2009, P. 91-92. In Russian.

J.A. Abdulina, and P.V. Mandryka (2007), "New settlement of Late Bronze Age in southern taiga of Middle Yenisey". In *Proceedings of the laboratory of ancient technologies*. Irkutsk State University Publishing House, V. 5. P. 168-174. In Russian.

P.V. Mandryka, A.A. Yamskikh, L.A. Orlova, G. J. Yamskikh, A.A. Golyeva (2003), *Archaeology and paleoecology of Bobrovka multilayer settlement on Middle Yenisey*, Krasnoyarsk State University. 138 p. In Russian.

P.L. Armitage (1975), "The extraction and identification of opal phytoliths from the teeth of ungulates", *Journal of Archaeological Science*. 2. P. 187-197.

G. Baker, L.W.P. Jones, I.D. Wardrop (1959), "Cause of wear in sheep's teeth" *Nature* 184. P. 1583-1584.

R.L. Bishop, R.L.Randa, G.R.Holley (1982),. "Ceranic composition analysis in archaeological perspective". In *Advances in Archaeological Methods Theory* (ed. M.B. Schiffer),, New York, Academic Press, V.5 . P. 275-330.

A.A. Bobrov (2002), "Phytolith analysis of modern and burial soils of barrow cemeteries of Kalmykia". In *Ostrovnoy Cemetery: Results of complex investigation of archaeological sites of north-western Pricaspiy*, M.: Elista,. P. 137-167. In Russian.

L.S. Cummings, A. Magennis (1997), "A phytolith and starch record of food and grit in Mayan human tooth tartar". In *First European Meeting on phytolyth research*., Madrid, 23 – 26 September 1996, CSIC, Monografia 4, Madrid. P. 211 – 213.

A.A. Golyeva (2000), "Coeval of Egyptian pyramids", *Science in Russia* (2),. N 4. P. 52-60. In Russian.

A.A Golyeva (1997), "Biomorph analysis as constituent part of genetic and morphological soil study", *Soil Science*. N 9. P. 1045-1055. In Russian.

A. A.Golyeva (2001), *Phytoliths and their information role in nature and archaeological objects study*, M.: Syktyvkar-Elista. 240 p. In Russian.

A. A. Golyeva, A. A. Alexandrovsky, L. K. Tselishyeva (1994), "Phytolith analysis of Holocene paleosoils", *Soil Science*. . N 3. P. 34-40. In Russian.

Z. J. Zharnikov (2007), "Ceramic typology of Shilka-12 settlement on the Yenisey". In *Archaeology, ethnology, paleoecology of Northern Eurasia and contiguous territories*: Materials of XLVII Regional (III All-Russia with international participation), archaeological and ethnographic conference of students and young scientists of Siberia and Far East (Novosibirsk, April 3-4, 2007),, Novosibirsk State Pedagogical University. P. 106-108. In Russian.

E. O. Lisyutina (2009), "Studying Shilka-12 archaeological site with phytolith analysis". In Materials of XLVII International scientific students' conference "Student and scientific and technological progress": *Archaeology of Eurasia*. –Novosibirsk State University. P. 26. In Russian.

P. V. Mandryka (2008), "Problem of distinguishing a new culture of the Bronze Age in taiga of Priyenisey Siberia". In *Time and culture in archaeological and ethnographic research of ancient and modern communities of Western Siberia and contiguous territories: problems of interpretation and reconstruction*: Materials of West- Siberian archaeological and ethnographic conference, Tomsk: Agraf-Press. P. 140 – 145. In Russian.

P. V. Mandryka, Z. J. Zharnikov (2008), "New settlement in the Yenisey taiga". In *Proceedings of the laboratory of ancient technologies, Irkutsk State University Publishing House*, Vol. 6. P. 92-100. In Russian.

Phytoliths and their information role in nature and archaeological objects study., M.: Institute of geography, 2001. 200 p. In Russian.

A. Powers-Jones, P. Echlin, M. Jones (1997), "Investigating ancient plant-water relations by means of the analytical microscopy of phytoliths". In *First European Meeting on phytolyth research*., Madrid, 23 – 26 September 1996, CSIC, Monografia 4, Madrid. P. 245 – 253.

A.M. Rosen (1992), "Preliminary identification of silica skeletons from near eastern archaeological sites: an anatomical approach", *Phytolith Systematics*. Edited by G.Rapp, Jr. and S.C.Mulholland, Plenum Press, New York. P. 129-147.

A.M. Rosen, S.Weiner (1994), "Identifying ancient irrigation: a new method using opaline phytoliths from emmer wheat", *J. of archaeological Science*, n. 21. P. 125-132.

N.S. Shellenberg (1908), "Wheat and barley from the north kurgan, Anau", *Prehistric Civilizations of Anau*. Vol. 1, edited by R. Pumpelly.

J.J. Trisserras, C. Lalueza, R.M. Albert, M. Calvo (1997), "Identification of phytoliths from prehistoric human dental remains from the Iberian Peninsula and the Balearic Islands ". In *First European Meeting on phytolith research*., Madrid, 23-26 September, 1996, CSIC, Monografia 4, Madrid. P. 197-203.

Фитолитные исследования археологических поселений Шилка-12 и Заостровка-2 на Среднем Енисее

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В статье приводятся результаты фитолитных исследований на многослойном и однослойном археологических поселениях таежной зоны Среднего Енисея. Определяются особенности и характер смен растительного покрова в районе расположения памятников на протяжении последних трех тысяч лет, выявляются наличие сорных растений в период обитания поселений и использование осоковых растений в сооружении жилищ бронзового века.

Ключевые слова: археология, экология, фитолиты, бронзовый век, тайга, Сибирь, Енисей.