Eco- cenotic characteristics of phytoliths spectra for steppe phytocenosises soils and phytoliths composition grasses of the North and South Kulunda

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Abstract: The article reflects the phytoliths research of soils and grasses in Kulunda steppe. Various eco-cenotic characteristics of phytoliths spectra of North and South Kulunda have been identified. It is worth stressing the differences between phytoliths spectra in selected plant communities and phytoliths spectra of North and South Kulunda. As a result the main features of the steppe phytoliths spectra have been formulated with consideration of anthropogenic impact.

1. Introduction
Phytoliths analysis is widely used in archeology, paleoecology, and also in the systematics of some groups of plants. The comparison between the modern species of grasses’ phytoliths and the phytoliths of the soil under phytocenosis, in which they grow, has allowed to find out phytoliths spectra of steppe phytocenosis of different degrees of aridization and anthropogenic transformation. The aim of the research is to identify the eco-cenotic peculiarities of phytoliths spectra of the steppe soil communities in the North and South Kulunda.

2. Methods and materials
Field research was conducted in the surrounding territories of Novoilinka (Khabarsky district, Altai Region) and Poluymki (Mikhailovsky District, Altai Region). Phytoliths of the modern grasses, growing in the sites of the study, were researched; later they have been used for the description of the phytoliths spectra of phytocenosis from ground litter.

Three phytoliths spectra under the steppe and meadow vegetation on shallow south chernozem soil have been researched in the surrounding territories of Novoilinka alongside with three phytoliths spectra under the steppe, which grow on the chestnut soil in the surrounding territories of Poluymki.

The extraction of the phytoliths from soil samples and vegetation materials was conducted by A.A. Golieva’s method [1].

3. Results and interpretation
The main morphotype of dominate species of grasses Artemisia-Festuca-Leymus steppe (Elymus exelsus, Festuca pseudovina, Stipa korshinskyi, Stipa pennata, Leymus angustus) is trapeziform short cells and roundish rondel. It is reflected on the phytoliths spectra (Fig. 1, A). Despite the dominance of trapeziform polylobate of several species (Agrostis vinealis, Agrostis gigantea, Calamagrostis epigeios), their number is twice smaller than trapeziform short cells. It can be considered as the feature
of steppe phytocenosis. Other forms reflect the presence of other species in the community (Koeleria cristata, wavy plates). The absence of picle type of rondels in the spectra correlates with extremely rare occurrence of this morphotype in the grasses. Presumably, the dominance of long cells in spectra is determined by the presence in the phytocenosis the species of the Asteraceae family, which form the phytoliths of this form [2].

The phytoliths spectra of Carex-Festuca-Stipa steppe (Fig. 1, B) (dominate: Stipa pennata, Festuca pseudovina; come across: Koeleria cristata, Agrostis vinealis) is characterized by the decrease in the number of long cells and the dominance of trapeziform short cells. It is connected with less degeneracy of this steppe phytocenosis. The part of rondels correlates with the increase of genus Stipa abundance. The part of trapeziform polylobate is significantly lower than in the latter spectra, because only one species, which produces this type, is reflected in the researched vegetation community. There has been an insignificant increase in the number of lanceolate cells. This morphotype appears in the grasses together with the latter one. It can be explained by the Stipa pennata dominance, which among the other species of the genus Stipa produces the greatest number of lanceolate cells [3]. Pricle type of rondels appears in the phytoliths spectra. The species, which produces this morphotype in the great amount, has not been identified in this phytocenosis. These phytoliths spectra can be called as the classical variant of the spectra with the dominance of genus Stipa and sheep fescue phytoliths.

Phytoliths spectra of steppificated herb-grasses meadow (Fig. 1, C) (among the grasses dominate: Agrostis vinealis, Agrostis gigantea, Stipa pennata), which grow on the research site, have more arid than phytoliths composition of the grasses. It was proposed that trapeziform polylobate had to play the equal role with steppe forms (rondel and roundish rondel, trapeziform short cells). But only decrease of the part of trapeziform short cells in comparison with the first and the second spectra alongside with the increase of long cells are being observed. The number of trapeziform polylobate is higher than in the spectra of Carex-Festuca-Stipa steppe; but it is accompanied by the decrease of the part of lanceolate cells. It is possible that prolonged stage of the more steppificated phytocenosis with the
extremely minor number of the rootstock grasses has proceeded to the modern stage of the described community. The close number of parts of trapeziform short cells and rondels corresponds to the leading role of genus Stipa in the vegetation community. The dominance of long cells in contrast to the first phytoliths spectra corresponds to the significant role of the forbs in phytocenosis.

Phytoliths spectra of the soils of phytocenosis in Poluymki (South Kulunda). The dominant form of phytoliths of Artemisia-Festuca-Stipa steppe (Fig. 1, D) (dominate: Stipa capillata, Festuca valesiaca; come across: Koeleria cristata, Poa angustifolia) is long cells. This may possible be connected with the significant role of sagebrush and steppe forbs in community. The great number of nonspecific silica cells can be explained by the same factors. The part of rondels is lower than trapeziform, despite the dominance of Stipa capillata. Possibly, Poa angustifolia also forms trapeziform short cells in the phytoliths spectra along with fescue (Festuca valesiaca) and Stipa genus. The presence of wavy cells corresponds to the presence of Koeleria cristata in the phytocenosis [4].

The high number of lanceolate cells is the feature of these soil phytoliths spectra. Meanwhile, these forms appear in the extremely low amount only in 2 species (Stipa capillata and Koeleria cristata) among the plants of the researched group. It might be possible that the presence of this morphotype in the high layer of the soil proves the previous more mesophytic phytocenosis. It is proved by the earlier research. The absence of trapeziform polylobate, which are also absent among the species of modern phytocenosis, is another important feature of the phytoliths spectra.

Phytolith spectra of Medicago-Artemisia-Festuca steppe (Fig. 1, E) (Festuca valesiaca is dominating among steppe grasses, Elytrigia repens can be come across) is characterized by trapeziform short cells domination and slight increase proportion of roundish rondel. It results in Festuca valesiaca domination. Amount of long cells decreases in comparison with phytolith spectra of Artemisia-Festuca-Stipa steppe, because steppe forbs quantity becomes less in plant formation. But quantity of this phytolith type is still high, because modern phytocenosis is characterized by abundance of sagebrush. The number of lanceolate cells is lower than it in previous spectra, as this phytocenosis is more mesophytic. Wavy plates quantity increases compared to Artemisia-FestucaStipa steppe phytolith spectra, despite the lack in modern plant formation grasses, which form this morphotype. It also proves a significant role of phytoliths grasses of plant communities of the earlier phases.

Long cells domination over individual short cells type is in phytolith spectra Artemisia-Festuca degraded steppe (Fig. 1, F) again (Festuca valesiaca is dominant, Agropyron pectinatum can be found). Lanceolate cells in this phytoliths spectra are less than in previous. Presumably, such spectra with domination type of steppe grasses among diagnostic forms and domination trapeziform short cells (Festuca valesiaca-forms) among domination type of steppe grasses are characteristic for Artemisia-Festuca steppe, if phytoliths spectra have high value of long cells.

Thus, phytoliths composition of modern plants in phytocenosis of north and south part of Kulunda generally corresponds to phytoliths of soils. Dominance of long cells in soil phytoliths spectra proves the pronounced stage of pasture degradation, if specific part of spectra is extremely steppificated (trapeziform short cells are dominating). Significant abundance of forbs in plant associations translate into phytoliths spectra with dominating of long cells and more mesophytic phytoliths composition of soil spectra. Decrease of trapeziform short cells proportion can indirectly justify the plant formation prairiefication. The most significant qualitative difference of plant communities phytolith spectra between North and South Kulunda is lack of trapeziform polylobate in phytoliths composition of modern plants and phytolith spectra samples of pasture south Kulunda soil. Thus, forming phytoliths spectra is influenced not only by modern composition of plant association but also history of phytocenosis.

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References

[1] Goleva A A 2008 Microbiomorphic complexes of natural and anthropogenic landscapes 240 (in Russian, with English Abstract)

[2] Solomonova M Yu, Grebennikova A Yu, Kornievskaya T V and Mitus A A 2016 First results of the recent basis design for paleoecological phytolith researches of North Kulunda Privolzhsky Scientific Bulletin 11 11-6 (in Russian, with English Abstract)

[3] Solomonova M Yu, Speranskaja N Yu and Silantyeva M M 2014 Significance of morphometric and qualitative characteristics of phytoliths (for example trichomes) for reconstruction of transformation of pastoral ecosystems Bulletin of the Altai Science 4 (22) 186-91 (in Russian, with English Abstract)

[4] Kisileva N K 1989 Phytolitic analysis of zoogenic sediments and buried soils History of steppe ecosystems of the Mongolian People’s Republic, eds L G Denesman, N K Kisileva and A V Knyazev 15-36 (in Russian)