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ТОРФЯНИКИ ЗАПАДНОЙ СИБИРИ И ЦИКЛ УГЛЕРОДА: ПРОШЛОЕ И НАСТОЯЩЕЕ

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SOUTH SIBERIAN MOUNTAIN MIRES: DIVERSITY AND TYPOLOGY

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Introduction

Unique pristine complexes of taiga forests, sub-alpine and alpine meadows, tundra and wetlands still exist in extensive territories in the southern Siberian mountains. These complexes function as natural ecosystems with rich biodiversity, including rare and endemic plant and animal species. Siberian mountain ecosystems include many peat mires which are sources of supply to many river basin heads, including the upper Ob' – the largest Siberian river.

Unfortunately, there are very limited data about the peat accumulating wetlands from this region. Our research objective was to establish a scientific basis for the protection of mountain mires – rare natural wetland type in continental Asia – at the territory of South Siberian mountain land – Altai (about N 49°04′–55°38′ and E 83°57′–89°52′).

Study site

Altai is a large mountain country (about 150 thousand km^2) in the south of Western Siberia with a range of various climate, relief, hydrology and vegetation conditions in different parts. Thus, the climate varies from hyper-humid on the western macro-slope of Kuznetsky Alatau ridge in the north of the Altai region where precipitation reaches 3000 mm per year to arid with only 120 mm per year in the South-Eastern Altai.

Results and discussion

As our research in the Altai Mountains confirmed, significant mires with thick peat deposits occur even in the most arid regions of the Altai. Mountain mires occupy concave and flat areas such as large depressions (7), high-mountain circuses (4), river valleys (8), saddles (2), flat tops (1), the slopes foots (5) and even gentle slopes (3) of the mountains (Fig. 2).

Peat deposits of mountain mires are relatively not deep (on the average 50 cm depth). This is because severe mountain conditions cause only a little biological productivity of peat-forming plants and there is slow decomposition of plant remains. But, considerable peat deposits can be found on occasion in the wettest areas of Western and Central Altai (maximal deposit depth exceeds 3 m) and Kuznetsky Alatau ridge (up to 3.9 m depth). Sedge (mainly the remains of *Carex altaica*), brown-moss-sedge and sphagnum peat types are found most frequently.

Mountain mires act as natural filters, reservoirs, and sources of clean water. Due to their position on the main streams, mountain peat mires have a significant influence on the hydrological regime of the territory and they are capable of removing pollutants (heavy metals, dust, etc.) from running waters. The filtration capacity of mires in the vicinity of the Kuznetsk Coal Basin (Kemerovo province) is revealed most strikingly by heavy metal pollution, which is precipitated from the atmosphere through rainfall on the mountain slopes. The content of many elements in the water of inlets to the studied mires is appreciably higher (1.5–10 times)

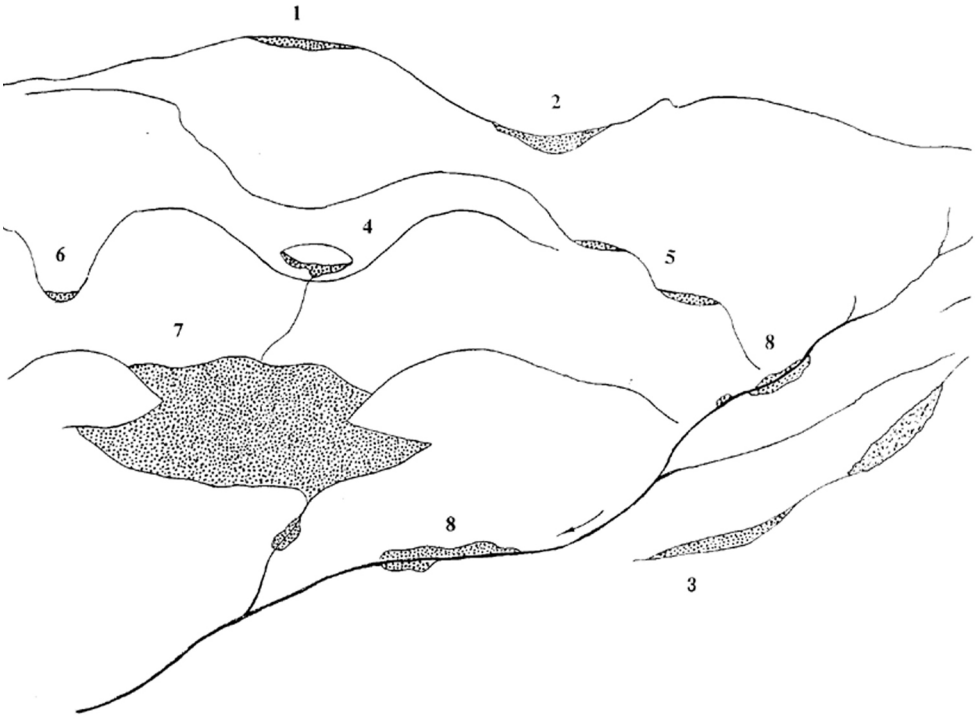

Fig. 1. *Topological classification of mountain mires of South Siberia (1-8 – mire massif (mire system) type*

Fig. 2. *Crooked birch Betula alba ssp. tortuosa – characteristic element of mire plant communities of the wettest and snowiest regions of Altai mountain land (Kuznetsky Alatau ridge)*

than in outlets [1]. The majority of heavy metals studied by us in the peat of mire complex 'Krestovskye mires' in Kuznetsky Alatau mountains at the north of Altai – such as zinc, mercury and lead – showed increased concentrations in the top layers of the peat deposits of mountain mires as well as in upper levels of slopes with mires. This is also characteristic of all other investigated mires of Altai. We refer this fact to industrial human activity.

Being the sources of rivers and streams, mountain mires control the level of groundwater and protect the surrounding landscapes from flood in periods of intense snowmelt.

Mountain mires make a significant contribution to biodiversity. They differ from other ecosystems by the large variety of habitats they include. This habitat diversity increases with the altitude and allows the existence of not only characteristic mire plants (sphagnum mosses, cranberry, marsh cinquefoil *Comarum palustre*, buckbean *Menyanthes trifoliata*, etc.) and animals, but also a significant amount of alpine and plain species (originating in steppe, tundra, forest). Many of these species are rare, endangered, or vulnerable. For example, six sedges, rare in the Altai Republic, grow here on mountain mires (*Carex bicolor*, *C. marina*, *C. tenuiflora*, *C. heleonastes*, *C. serotina*, *C. dioica*). The green moss *Calliergonella cuspidata* is found usually on extensive plain mires (fens) on the south of a taiga zone of Siberia, but is rare in Altai and occurs here in only a few sites, including the Aru mire massif (South-Eastern Altai) [2]. *Sphagnum subfulvum* Sjors was found by us firstly for Altai as well as for South Siberia. This species dominates in moss cover of shrub-sedge-sphagnum mire in the valley of Multa River in Central Altai, on other mires of Altai occurs rarely as singular plants. This finding is very interesting taking into account the distribution area of this species concentrated near to oceans. In the European Russia, *Sphagnum subfulvum* is widely distributed in the northern taiga subzone of the Kola Peninsula and Karelia and grows usually in eutrophic-mesotrophic mires of aapa-type.

A rare and rather decorative sub-alpine wet-meadow lousewort species *Pedicularis longiflora* occurs on streams at the Aru mire in South-Eastern Altai, being here at the north-west border of its habitat, which is concentrated in the Central Asian mountains.

The Red Data Book of Russia species – orchid *Liparis loeselii* – inhabits the territories of mountain mires of Kuznetsky Alatau, as well as *Rhynchospora alba*, *Listera cordata* and *Dactylorhiza*-species, which are rare in the Siberian mountains. Almost 5% of vascular plants inhabiting mires are endemic species of South Siberia.

South-Siberian mountain peatlands and mires sustain important populations of crooked birch (*Betula alba* ssp. *tortuosa*) (Fig. 2). These rare birch stands are included in the Green Data Book of Siberia [3], and occur only in the wettest and snowiest regions of the Altai Mountains (western macro-slope of Kuznetsky Alatau ridge) where the eastern border of their natural habitat is situated. Such communities are widespread in sub-continental mountain regions of Scandinavia on peat-covered and rocky slopes of humid high mountains.

The mires also include habitats for rare birds and animals. Thus, Altai mountain mires and wetlands provide the food sources and nesting place for birds, including Red Data Book species, such as ruddy sheldrake (*Tadorna ferruginea*), demoiselle (*Anthropoides virgo*), common crane (*Grus grus*) and the extremely rare black stork (*Ciconia nigra*). Nests of *Gallinago solitaria*, which is a rare mountain bird species, can be discovered on high sphagnum ridges in mire territories.

There is great variety in the genesis and structure of Altai mountain mires. In the northern regions of Altai, the mire formation is connected to humid

Fig. 3. *The largest mire of Altai, Tugurukskoje mire*

climate, while in the arid south part of the region basic mire-forming factors are relief and geology defining the groundwater level. In regions with permafrost, main paludification factors are the existence of a waterproof layer of frozen ground, and the low average air- and ground temperature. These factors result in low evaporation and, as a result, mires can appear and develop even with low precipitation. For example, the largest mire of Altai, Tugurukskoje mire (Fig. 3.), owes its existence not only to the barrier effect of the Terektinsky mountain ridge that intercepts and condenses the precipitation, but also to temperature inversions. Cold air accumulates above the bottom of the extensive Tugurukskaja mountain depression. This determines not only low evaporation but also peat freezing and, as a result, impermeability to water.

Low average temperatures and permafrost contribute also to the development of numerous mires on the Ukok plateau in the southern Altai Republic with extremely low precipitation. Another large mire, the Aru mire, exists in the arid region of South-Eastern Altai mainly at the expense of ground water. In the midst of current climate changes, that mire shows the steady shrinking connected with groundwater level decrease. Its former borders can be established in accordance with the borders of distribution of frost-formed ground hummocks, accompanying ground water outputs. The observed rate of change allows us to suggest, that some unique mountain mire ecosystems are degrading and disappearing. An analysis of the rate and direction of changes in mire landscapes reflects the tendencies of environmental changes both on the regional and global (biosphere) level. We may with confidence consider Siberian mountain mires to be an important object for monitoring climate change dynamics.

Conclusion

One of the most interesting natural phenomena in the mountains of Siberia is the peat-forming wetlands – mires. Mountain mires act as natural filters, reservoirs, and sources of clean water as well as providing a significant contribution to biodiversity. There is no doubt that mires have a critical role in the carbon cycle, and hence, in the maintenance of biosphere stability under conditions of increasing human impact.

Research on mires can be useful in solving many important fundamental and applied scientific problems, from the reconstruction of past climate based on analysis of peat strata, to optimisation of land use and biodiversity conservation. Mires as vital landscape features are critical for conserving and promoting biodiversity and are apparent especially in arid regions of Altai, where they are natural refuges for hygrophilous plants, animals and their communities.

While a strategy of natural resource management and wise use is developed for the Altai region, there should be special attention given to mires and other wetlands. The study of mires will help solve a number of problems of science and nature protection and will promote the performance by the Russian Federation of its international obligations, accepted in frameworks of the Ramsar Convention on Wetlands and the Convention on Biodiversity. Undoubtedly, some of the Altai mountain mires deserve the status of wetlands of international importance as unique mires (peatlands, wetlands) of intra-continental mountain systems of Asia.

1. Volkova II, Bajkov KS., Syso AI. Mires of the Kuznetsky Alatau as natural filters of environmental waters // Contemporary problems of ecology. - 2010. - 17(3). - P. 379-388.
2. Volkova I., Volkov I., Kuznetsova A. Mountain mires of South Siberia: biological diversity and environmental functions // International Journal of Environmental Studies. - 2009. - Vol. 66, No. 4. - P. 465–472.
3. Green Book of Siberia: Rare and Requiring Protection Plant Communities. - Novosibirsk: Nauka, 1996. - 396 pp. (in Russian, English summary).