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Opinion

Biodiversity of Eastern Siberia in a Changing Climate (On the Example of the Forest Scientific Station "Spasskaya Pad", Eastern Siberia)

Trofim Chr Maximov*

Department for Experimental Plant Biology of Permafrost Ecosystems, Institute for Biological Problems of Cryolithozone SB RAS, Russia

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***Corresponding author:** Trofim Chr. Maximov, Department for Experimental Plant Biology of Permafrost Ecosystems, Institute for Biological Problems of Cryolithozone SB RAS, Russia

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The Earth's climate is in a fever and this is the beginning of a natural collapse in the permafrost zone, as a result of which the system and structure of the natural environment and the nature of the interaction of its parts-the atmosphere, biosphere, hydrosphere and cryolithosphere-begin to be disturbed. It is quite obvious that what happens to the natural environment in Yakutia immediately responds to the climate of our entire planet. Yakutia, as a significant part of the North (3.103 million km^2), plays an important role in the climate system of the planet and is a free reserve of the biosphere within the Common Circumpolar Ecological Space. At present, it is in this region that the temperature increase is greatest and the response effect of the cryolithosphere on the atmosphere is more noticeable than anywhere else. All the main biotic and abiotic components of the North affected by climate change are represented here: the Arctic Ocean, permafrost, the northern border of forests, northern species and populations of plants and animals. All this has been a temporary benchmark, a starting point for the subsequent study of the dynamics of processes in flora and fauna in all our studies since 1991. In connection with the Arctic Ocean ice melting, flooding of lowlands, thawing of permafrost, a significant increase in the number of lakes in the territories, change in the nature of the soil-forming process, the transformation process of vast permafrost ecosystems and their components is intensifying-we are observing a change in the species composition of plants and animals, the expansion of the range of many species in a northerly direction. Some local species are replaced by more adapted aliens, which leads to a change in the structure and functioning of existing ecosystems [1]. Climate warming in Yakutia has led to changes in the productivity of easily vulnerable northern ecosystems, the disappearance of the main commercial species of plants and animals, the emergence of new parasites and pathogens, an increase in anomalous natural phenomena of precipitation-showers and snowfalls, winds, thunderstorms, lightning, landslides, droughts, etc. Climate change in Yakutia has caused large emissions of greenhouse gases into the atmosphere as a result of melting permafrost and an unprecedented increase in forest and tundra fires in recent years. Despite the negative aspects of climate change, we should not forget the positive consequences of global climate change for the region. They are associated with the expansion of the land use zone and its advancement to the north, along with changes in the productivity of permafrost ecosystems, with an increase in the growing season of plants and tangible changes in the cycle of substances in nature. Ultimately, the easily vulnerable permafrost ecosystems of Yakutia should be brought into a sustainable development course in accordance with the functioning of social, economic

and ecological systems. The species composition of plants and animals in Yakutia has changed greatly in recent decades due to climate warming. It is quite obvious that many species of animals and plants have entered the territory of Yakutia exactly in recent years. Thus, the number of higher plants increased by almost 60 species, birds and animals by 10 and 12 new species, respectively. As a result of our research, specific features for definite ecological systems were revealed in dominant plant species at morphological and physiological levels, expressed in the restructuring of donor-acceptor relationships of individual plant organs, changes in the number and ratio of cells and chloroplasts, carbon dioxide fixation (stomatal conductivity and intercellular concentration of CO_2) and water metabolism-water potential and transpiration rate [2]. It has been established, in particular, that the floras of Yakutia are very similar to those of Scandinavia and less similar to those of Japan. At the same time, 26% of the vascular plants of Yakutia are found in Japan, of which 30% are represented by alpine flora [3].

The species composition of drosophyllid flies and their vertical-storey distribution in the broad-leaved forests of Central Yakutia have been studied. Thirty-six species from eight genera have been identified. Moreover, one species is described as a new species for science (*Scaptomyza yakutica*). Three new species of Hemiptera have also been found [4]. In recent years, we have discovered a new infectious species of ixodid tick, the causative agent of encephalitis. The observed active transformation of permafrost ecosystems strongly affects the general circulation of substances in nature and the productivity of ecosystems. We have discovered a new species of the fungus *Rhizopogon laricinus sp.* [5], which will play a major role in nutrient cycling due to climate warming in the process of symbiotic mycorrhizal fungal activity. There is an increase in the number of species and biodiversity, expansion to the north by southern species of plants and animals, a change in the northern border of the forest-an expansion of the habitat of willow and larch. We have analyzed the species diversity of C3- and C4-plants in the flora of Yakutia. Based on the inventory of Yakutian plants, we found four plant species with C4-type carbon fixation (*Amaranthus retroflexus, Panicum miliaceum, Setaria viridis, Atriplex sp*.) and three species with cooperative C3- and C4-type carbon fixation (*Geranium pratense, Sedum purpureum, Rhodiola rosea*). These are primarily well-adapted weedy, naturalized and highly productive species. With a warming climate, the emergence of new species of plants, fungi, and insects is very important not only to enrich the nature of the boreal and arctic zone, but is also important for understanding the regional cycle of substances, especially carbon, in a changing climate. The Spasskaya Pad research station is rightfully considered a regional outpost of climate change research. With almost 20 years of data series, we are on the verge of catching the trends of large-scale changes in permafrost ecosystems, and further continuation of these monitoring studies will make it possible to predict global climate change and solve some issues of human adaptation to modern global challenges. Of course, all this is only possible if fundamental science interacts with society, stakeholders, and individuals.

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