

Born summiteer: scientists about the amazing abilities of Siberian stone pine

Scientists of Siberian Federal University for the first time have studied coniferous forests growing on the upper forest line in the West Sayan Ridge, mainly consisting of Siberian pine (*Pinus sibirica* Du Tour) and Siberian fir (*Abies sibirica* L.). It turned out that Siberian pine, or, as it is often called by locals, Siberian cedar adapts better to high altitude — the species has learned to develop comprehensive protection against hazards awaiting at the height (excessive insolation, abrupt temperature fluctuations).



Fir, although it is also a climber-species, is obviously outplayed in these indices, and its role in the movement of the mountain forest line to the peaks under global climate warming is currently much less than that of the pioneering pine. The main results of the study [have been published](#) in reputable journal *Forests*.

The SibFU scientists have previously conducted a series of studies that have shown that climate warming which has been going on over the past decades and is manifested by an increase in average yearly temperatures with the retained same level of precipitation, affects both the species composition of forests and the movement of trees to the areas new for them, for example, mountain systems of the south of Siberia. The trees most obviously responding to climate change are those growing on the upper line of the forest.



‘Mountain systems are peculiar because in a certain sense they reproduce, but on a more compact territory, those patterns of forest growth that we can observe in latitudinal zonation. That is, the "height" of the forests' composition is about the same as the "width", but tracking it is much easier. Exploring certain areas of mountain forest systems, you can find out how and due to what factors the composition of forests is changing. We asked ourselves: what strategies do these two different species of conifers — pine and fir — demonstrate living in a common environment?’ answered **Nina Pakharkova**, associate professor of the Department of Ecology and Natural Resource Management at Siberian Federal University.

During the research, the researchers took samples of needles at several altitudes (from 1413 to 1724 metres above sea level), and measured the content of chlorophyll a and b, carotenoids, and the temperature of the needles and soil in all the samples.

‘We hypothesized that pine and fir would shift the upper edge of the forest differently in the mountains. Indeed, pine new growth was found at the altitude of 1700 metres above sea level and higher, but we find neither young nor mature firs there. And we still have to understand why this is happening. In labs, it was found that the studied species revealed serious changes in the pigment complex which are observed with the increasing height. A decrease in the content of chlorophylls and an increase in carotenoids in needles with the increasing altitude above sea level are more pronounced in pine than in fir. To put it simply, Siberian pine has larger reserves of carotenoids i. e. pigments that protect the photosynthetic apparatus from excess light,’ explained professor **Pakharkova**.

The researcher clarified that the adverse conditions, from the point of view of conifers, are a sharp kick-off of positive temperatures and intense sunlight in early spring. In high-mountain regions, these factors turn on earlier than the trees resume their finely tuned mechanism of photosynthesis. This resembles a sharp awakening of a person during the time non-habitual for his body. The temperature of the needles both in cloudy and sunny weather is higher in fir (10.5 and 43.3 °C) than in pine (3.8 and 24.2 °C).

'Imagine what these climber-trees have to face: there is no water in the soil because the snow has not melted yet, and the sun is already shining with all its might. The tree has not yet awakened properly, but it is forced to resume nutrition through photosynthesis, in which the needles inevitably evaporate part of the moisture gained - but there is absolutely no place to quench its thirst yet! Under such stressful conditions, pine proved to be more drought-resistant and suitable for the role of a pioneer than fir as the fir's defence mechanisms are less pronounced. Conifers, like people, for instance, with different phototypes (from fair-skinned and red-haired to dark-haired with dark complexion), adapt to extreme conditions, in particular, increased doses of sunlight, in completely different ways,' the researcher emphasized.

The co-authors of the article believe that the upper forests line in Siberia will be changing intensively in the short run, and the Siberian pine will be the pioneer among conifers, but fir, perhaps, will follow it, although, now it prefers to settle in shaded and humid lowlands.

'There are these concepts in ecology — physiological and ecological optimum. They do not always match. Physiological one is ideal living conditions for a certain species. And ecological means possible (tolerable) conditions with wide borders. Plants occupy those niches where they can technically (albeit, not very well) live. Living in the mountains for pine and fir is like living in a small but generally suitable apartment for us. Things could have been better, but we have what we have. Of course, the high-mountain pines will be shorter than their lowland cousins, and their trunks and branches more gnarled. Nevertheless, they will still advance, conquering a new living space,' **Nina Pakharkova** summed up.

17 march 2020

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