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ОСОБЕННОСТИ ЛИХЕНОФЛОРЫ СЕВЕРО-ЗАПАДНОГО КАВКАЗА

PECULIARITIES OF THE LICHEN FLORA OF THE NORTH-WESTERN CAUCASUS

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Abstract. *The north-western Caucasus houses a European-type lichen vegetation that is much better preserved than in most parts of Europe, due to absence of air pollution and plantation forestry. Over a relatively small geographical distance, the north-western Caucasus spans the same oceanicity range as the whole of the Alps, with, consequently, high species diversity of contrasting phytogeographical elements. This includes also the "Tertiary relic" distribution type, scarcely present in Europe, well represented in the Nature Park "Bol'šoj Thač" of the Republic of Adygheya.*

Аннотация. *На северо-западном Кавказе представлена лишайниковая растительность европейского типа, но намного лучше сохранена чем в самой Европе благодаря отсутсвию загрязнения воздуха и плантационного типа лесного хозяйства. Северо-западной Кавказ на сравнительно небольшом расстоянии включает тот же спектр фитогеографического океаничества как Альпы в целом, в результате чего присутствует значительное биологическое разнообразие из представителей контрастующих фитогеографических елементов. В том числе встречаются виды представляющие тип распространения "третичных реликтов", едва встречающиеся в Европе, но хорошо представнены в Природном Парке "Большой Тхач" Республики Адыгея.*

Ключевые слова: *Северо-Западный Кавказ, Экология, загрязнение среды, реликты, лесное хоязйство*

Keywords: *Northwest Caucasus, Ecology, environmental pollution, relics, forestry*

The Caucasus is known as one of the Biodiversity Hotspots of the world. This is the more remarkable since most of these hotspots is situated closer to the equator (MUTKE & BARTHLOTT 2005). When looking at JÄGER's (1968) oceanicity/aridity map, we get an idea of factors that may contribute to the outstanding biological diversity of the Caucasus: On its relatively short range of about 1,000 km, it spans over 8 out of the 10 oceanicity/aridity levels that are distinguished by this author on earth in general. This is double the range that is observed in the Alps.

The cited studies are based on results concerning vascular plant flora. We will have a look here at lichens; a group that has evoked more and more interest since it became clear that lichens are excellent ecological indicators (e.g. NIMIS et al. 2002) and play a key role in ecosystem processes as habitat and fodder for several animals (e.g. PETTERSSON et al. 1995), as hosts of specific fungi (e.g. VON BRACKEL 2014), and also for biogeochemical processes (CORNELISSEN et al., 2007).

A problem is, however, that the lichen flora of the Caucasus is less well studied than that of vascular plants. Any larger lichenological expedition of the last years to the Caucasus revealed additional species that were not known from that region earlier (e.g. URBANAVICHUS & URBANAVICHENE 2014). Hence, the overall picture is less complete than in vascular plants. We will focus here on the better studied areas of the north-western Caucasus, in particular of the World Heritage Site “Western Caucasus” of Adygheya and adjacent

regions, based on our own results of the last 22 years, as well as on related literature. This area spans four oceanicity levels on JÄGER's (1968) scale, i.e. the range is comparable to that observed in the whole of the Alps. On the one hand we can find here species of dry Mediterranean areas, as e.g. *Pertusaria ilicicola*, *Physconia grisea* subsp. *algeriensis*, or *Roccella fucoides* that have their only Russian occurrences on the northern Caucasian Black Sea coast (OTTE 2005). On the other hand, only 200 km away, we find species that inhabit leafs of evergreen trees and shrubs, and that have their main occurrence in the Tropics, as e.g. *Gyalectidium caucasicum* (FERRARO et al., 2001).

Altogether, according to URBANAVICHUS & URBANAVICHENE (2014), approximately 1,500 lichen species have been recorded from the Russian Caucasus so far. This is only half of the number that was given for the Alps by NIMIS et al. (2018). Anyway, intensive studies on one-hectar-plots revealed remarkable numbers of species, compared with several parts of Europe (VONDRÁK et al., in press).

Looking at the identity of the species, most of them are well-known to European lichenologists, i.e. the overall character of the Caucasian lichen flora is European (OTTE 2001). However, what makes the Caucasian lichen flora quite interesting is the fact that in vast parts of Europe the lichen flora has suffered very much from anthropogenic influences. Many lichen species have turned out to be very sensitive to air pollution, and have disappeared from considerable areas during the 20th century. Meanwhile, in most parts of Europe industrial air pollution has considerably declined and many lichens are returning (GILBERT 1992). But still there are not a few species that have not come back so far (OTTE et al. 2014), and a new problem is the deposition of nitrogen-containing compounds from intensive agriculture, which is hazardous to many lichen species. The north-western Caucasus is situated sufficiently distant from sources of both groups of pollutants (Umweltbundesamt 2000), and lichenologists are excited to find out that species that were reported from some parts of Europe only by 19th century records are well developed in the north-western Caucasus.

Another factor that has turned out crucial for many lichen species is forestry. Intensive plantation forestry with plots of only one single tree species, arranged in age-classes and with cutting cycles very far from the natural age limit of the involved tree species, are clearly not the habitat that many lichen species prefer, and in particular typical forest lichens have considerably declined in Europe (HAUCK et al. 2013). In the north-western Caucasus, some areas were spared from forestry, and this combination of beneficiary factors: absence of air pollution in areas not suffering from intensive forestry is hardly to be found elsewhere in Europe. The forest reserves of Europe are more or less exposed to the influence of pollutants, in particular those of the broad-leaf zone; even in the famous forest of Białowieża in eastern Poland the more sensitive species that were recorded in the past have disappeared (CIEŚLIŃSKI & TOBOLEWSKI 1988). In contrast, the north-western Caucasus provides unique opportunities for ecological studies of European forests with minimal anthropogenic influence. In Adygheya, the Caucasian Biosphere Reserve is complemented by the Nature Park "Bol'šoj Thač" in an ideal manner, the latter being situated at a lower mean elevation compared with the Caucasian Reserve and thus including a larger share of the broad-leaf (= beech) forest belt (OTTE, 2007).

Europe has a particular global responsibility for the protection of beech forests, resulting in the establishment of the UNESCO World Heritage Site "European beech forests". If not being part of the World Heritage Site "Western Caucasus" already, the Caucasian reserves would merit inclusion in that heritage site as well. This is also true from the point of view of nature protection in Russia, with 10 of the 11 Russian Federal Red Data Book lichen species known from the Caucasus occurring in the Nature Park "Bol'šhoj Thač", that is 24% of all Red Data Book lichens of Russia (OTTE, 2007).

However, the Caucasus is much more than just a model for natural European ecosystems. During our studies, we have found more and more species that are not known from Europe. It turned out that all these species (e.g.

Myelochroa aurulenta, *Phaeophyscia rubropulchra*) are more widespread in broadleaf forests of East Asia and/or eastern North America. They show exactly that distribution pattern of the so-called "Tertiary relics", i.e. taxa that had been more widespread in Europe during the Tertiary. There are two general theories explaining that distribution pattern: The one supposes that these species were expelled by the Ice Age and were not able to return due to their limited dispersal capabilities (e.g. WIRTH 2010). The other theory supposes that distribution patterns of species are more or less in equilibrium with those environmental conditions that are crucial for their occurrence, and current distribution reflects their ecological limits (e.g. OTTE et al. 2005).

This is not only a matter of basic research, but has quite practical consequences for nature protection strategies: If species are not well able to migrate, but are relatively robust concerning climatic oscillations, it is obvious that, under the current climate change, protection strategies must be quite different from those that are necessary when supposing that species distribution will change in accordance with climatic alterations. The Caucasus provides the opportunity to observe occurrence of contrasting (European/"relic") distribution types in one area. Our studies support the idea that current ecological factors are crucial, with the "relic" species preferring areas that are simultaneously warm and moist in summer, which is the normal situation in East Asia, but not in Europe (MEUSEL & JÄGER 1989). These species are well represented in the Nature Park "Bol'šoj Thač", with its large beech forest areas of the lower and middle mountain belt (OTTE 2007). The particular physiological mechanisms behind these observations may differ among the species, and deserve more studies.

Altogether, keeping in mind the broad interest that lichens have found during the last decennia, recently including e.g. also their use as climate change indicators (VDI 2017), studying Caucasian lichens may contribute to the resolution of some of the ecological key questions of our era.

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