

Algae protection, conservation areas and the red data book of the Republic of Karelia

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Abstract

The conservation of algal species diversity as a component of natural ecosystems is recognized.

The problem can be solved by: 1) making up a list of endangered species and including the algae in Red Data Books and Red Lists of Protected Species; 2) selecting water bodies to be protected and restored or including them in already protected areas, since the protection of an individual alga species is fairly problematic.

In this article the principles and methods of freshwater algae conservation in Karelia Republic (Northwestern Russia), as well as problems related thereto, are analyzed.

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RESULTS AND DISCUSSION

Algological studies in the Republic of Karelia have been conducted for a long time. Over 600 publications on the systematics, environments and production of algae in Karelian water bodies are known (Komulainen 2007).

This is not surprising since the Republic of Karelia has a well-developed hydrographic network that forms a part of the White Sea (57%) and Baltic Sea (43%) basins. Karelia has 61.1 thousand lakes that cover a total area of ca. 18,000 km². The percentage of the territory covered by lakes (12%) is one of the world's highest. Ninety-five percent of these lakes cover an area of less than 1 km². Karelia has 26.7 thousand watercourses totaling over 83.0 thousand km in length. Watercourses which are less than 10 km long, dominate (95%). Only 30 rivers are over 100 km long. The hydrographic network density is generally 0.53 km⁻². Most water bodies are not affected by human activities and are in a natural state.

The goal of most algological studies, carried out as a part of integrated purpose-oriented hydrobiological research in Northern Europe, is to assess the bioproduction and commercial fishing potential of water bodies. Unfortunately, some authors confined themselves to a general description of the structure of algal cenoses without taking the trouble to carefully study the species composition and structure of algal communities. Therefore, their publications only contain a list of dominant species responsible for the production of water bodies.

Over the past 10–15 years, the Karelian Research Centre has been conducting annual inventories to assess Karelia's biological diversity (Biotic diversity of Karelia 2003). Organisms and communities in both terrestrial and water ecosystems are studied. Algae are an obligatory target of such studies. Attention is focused on undisturbed ecosystems that fortunately occur in Karelia to this day. Based on the results, monographs that contain lists of algae species and an analysis of the biodiversity formation pattern are prepared.

Karelian algal flora now consists of more than 1200 alga species (Komulainen 2002, 2003, 2008, 2009; Komulainen et al. 2006). The algal flora of the water bodies of the Republic of Karelia exhibit characteristics of boreal and Middle European types. The species diversity of the algal flora is formed by the diatomaceous, green, blue-green and yellow-green algae that make up over 90% of the floristic list. Phytoplankton and phytoperiphyton are typically dominated by cosmopolitan forms, and boreal and north-alpine species form a large share, showing that they are cold-loving. Species which are indifferent to salinity and pH prevail in the water bodies. Most saprobity-indicator species are oligo-, oligo-beta- and beta-mesosaprobic forms, suggesting that human activities do not have a considerable impact on the water bodies.

The taxonomic structure of periphyton displays a tendency for the concentration of inter- and intraspecies taxons in a small number of genera and families while at the same time forming a considerable number of genera and families comprised of few species, which reflects the complexity of florogenetic processes. This trend suggests that allochthonous development plays a significant role in the formation of periphyton in the study area.

Biodiversity of periphyton is stipulated by its zonal situation and region history, as well as by characteristic features of the landscape which determine the morphometry of the basin. Most of the mass algae species are typical of cold water oligotrophic basins. Northern features characteristic of the periphyton algae flora are observed in various of the taxonomic analyses.

Algal community diversity develops either due to the introduction of new taxons or at the expense of combinatorial change within the same species. The first is determined for phytoperiphyton by the introduction of allochthonous species from plankton algae communities and for phytoplankton by the introduction of attached forms from periphyton communities.

The structures of fluvial and lacustrine algal floras differ markedly. The algal floras of the water bodies scattered throughout Karelia have their own distinctive patterns that depend on the degree of paludification and, consequently, the colour index and pH of water as well as the composition of bedrock and Quaternary deposits responsible for water mineralization.

This does not mean, however, that every time we discover unique water bodies we find unique algal flora, but our research helps lengthen a list of species and expand the distribution areas of known species. It is essential that our study covers the upper courses of rivers that are often more diverse than river mouths. The rivers flow from lakes that differ in nutrient content, from genetically different mires or from underground sources differing in the chemical composition of water.

The main result of our research is the development of recommendations for establishing new nature conservation areas and expanding existing ones.

Since the most efficient way of protecting the gene pool of living organisms is to establish various types of conservation areas, and individual protection of microscopic algae is not efficient, it is the establishment of reserves that would contribute to the conservation of alga species and their habitats.

The wildlife reserves of the Republic of Karelia cover a total area of 1029.4 thousand hectares (5.75% of Karelia's total area) and consist of 224 conservation facilities (Feasibility Study of the Protected Area Network Development in Republic of Karelia 2009), including 7 areas of Federal rank., such as 2 state nature reserves (Kostomuksha and Kivach), 3 national parks (Paanajärvi, Vodlozero and Kalevala) and 2 nature conservation areas (Kizhi and Olonets).

The second task of our research is the preparation of data for the inclusion of algae in the red book of Karelia Republic.

Very few freshwater algal species are listed in the Red Data Book of Russia (The Red Book of Russia 2008). The main reason for that is lack of reliable information on their real "*scarcity*". For many areas, it is difficult to even name species to be monitored and protected "*by all available means*" (Kondrat'eva 1994) and to identify which species do not require protection or monitoring.

Out of the 35 alga species included in the Red Data Book of Russia, only five species, such as Charophyta and red algae, were found in freshwater ecosystems. A greater variety of freshwater algae is described in regional Red Data Books, e.g. algae from the Moscow, Leningrad and Kirovsk regions. Proposals to include algal species in the Red Data Book of the Komi Republic have been made.

Altogether, 100 freshwater algal species are listed in the Red Data Books of the above regions. They belong to 6 divisions: Cyanophyta – 27, Chrysophyta – 1, Bacillariophyta – 11, Xanthophyta – 2, Chlorophyta – 39, Charophyta – 13 and Rhodophyta – 9 species. The number of species included in regional Red Data Books varies markedly. The Red Data Book of the Leningrad region contains 71 species that belong to 5 divisions (The Red Book of Leningrad district 2000), whereas only one species is described in the Red Data Book of the Kirovsk region (The Red Book of Kirovsk district 2001).

It is not always clear why one or another species is listed as scarce in Red Data Books. For example, the Red Data Book of Kamchatka (The Red Book of Kamchatka 2007) contains six species of the genus *Phormidium* Kütz. However, the only species really characteristic of hot springs are *P. thermophilum* Elenk. and *P. laminosum* (Ag.) Gom. Other taxa exhibit a wide environmental spectrum and occur in different regions in both freshwater and brackish water bodies and in soils.

The listing of unicellular diatoms, and yellow-green and green algae in some Red Data Books also raises doubts. It would probably be reasonable to limit the number of scarce algae in favor of multicellular forms, primarily macroalgae.

Problems in preparing Red Data Books are understandable. There is no country, let alone a region, that has a team of skilled algologists familiar with all taxa. Therefore, some systematic groups of algae are well-studied and others are not. Interest in algal communities also varies considerably. Phytoplankton has been studied much more thoroughly than microphytobenthos or phytoperiphyton. Lakes have been studied better than rivers, and practically no attention has been given to aerophilic algae.

References to the occurrence or absence of species are often based on old publications that need critical revision, which is only possible if detailed

descriptions and illustrations or collections of species are available, but this is not always the case.

Unfortunately, available data on the resistance of most Red Data Book species to unfavorable conditions and a relationship between the abundance and the degree of adaptation of a population are still too scanty to evaluate species to be included in Red Data Books.

By now, 11 freshwater alga species, listed in the Red Data Book of Russia and several regional Red Data Books, have been discovered in the Republic of Karelia (Komulaynen et al. 2006). Examples of blue-green algae are *Phormidium rezii* and *Nostoc pruniforme* Ag. ex Born, et Flah. and those of red algae are *Chantransia chalybia* (Roth.) Tries, *Batrachospermum moniliforme* Roth. Furthermore, some diatomaceous, green and blue-green algae of rare taxa that need protection in other regions of Russia have been revealed in Karelian water and terrestrial ecosystems.

A list of red freshwater algae, recommended for inclusion into the Red List of Finnish Species, is also of interest. Three species listed, *Batrachospermum atrum* (Huds.) Harv., *Hildenbrandia rivularis* (Liebmann) J. Agardh and *Tuomeya americana* (Kütz.) Papenf (The 2000 Red list of Finnish species), may well occur in the algal cenoses of Karelian water bodies. Algae that form macroscopic thallomes, mostly red algae and Charophyta, are not abundant. Many of them have a narrow environmental range and prefer clean water bodies unaffected by economic activities.

This does not mean that the above species should automatically be recommended for inclusion into the Red Data Book of the Republic of Karelia. Like higher plants, algal species should be listed on the basis of data on “variations in their abundance, distribution area and habitats to show that urgent measures are needed to protect them” (Kondrat'eva 1994).

An algae conservation programme should be outlined with regard for the generally accepted and, if necessary, transformed concepts of and approaches to rare and endangered higher plant species conservation, using floristic, phytogeographic, evolutionary-genetic, general biological, environmental, scientific-research, economic and other conservation criteria.

In view of the above, our primary goals are:

1. To sum up and analyze available data on rare or endangered algal species. To estimate the value and uniqueness of a species in the study area.
2. To estimate the number of habitats of a species and to evaluate its vulnerability.
3. To assess the condition of biotopes where rare and endangered algal species can exist. In Karelia, special attention should be given to the upper courses of rivers. It is the morphometric, hydrological and

hydrochemical diversity of river sources that forms the algal floral diversity of a territory. The upper courses of rivers are often destroyed by economic activities in catchment areas. Of special interest are water bodies on Zaonezhsky Peninsula, more heavily mineralized than those in other areas of Karelia, and “green belt” water bodies affected by human activities to a smaller degree.

4. To study already established nature conservation areas (and water areas) to reveal sites rich in rare algal species and suitable for so-called “*algal reserves*”.
5. A list of algal species for the Red Data Book of the Republic of Karelia cannot be proposed until the above studies are completed.

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