

## EDITORIAL

## СЛОВО РЕДАКТОРА

RESEARCH IN THE KOSTOMUKSHA STATE NATURE RESERVE (RUSSIA)  
AND OTHER PROTECTED AREAS OF NORTHERN EUROPEEvgeny P. Ieshko<sup>1,\*</sup>, Oleg L. Kuznetsov<sup>1</sup>, Konstantin F. Tirronen<sup>1</sup>, Sergey V. Tarkhov<sup>2</sup><sup>1</sup>*Institute of Biology of Karelian Research Centre of RAS, Russia*\*e-mail: [ieshkoep@gmail.com](mailto:ieshkoep@gmail.com)<sup>2</sup>*Kostomuksha State Nature Reserve, Russia*

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Protected Areas (PAs) perform essential biological and landscape diversity conservation functions. They also serve as nature labs and experimental grounds for various sorts of monitoring research around the world. An object for environmental co-operation between neighbouring countries is an international PA, such as the Finnish-Russian Friendship Nature Reserve with Kostomuksha State Nature Reserve as its component part. Research in its Russian part has been conducted by scientists from the Russian Academy of Sciences, and Russian universities and PAs in collaboration with their foreign colleagues. This special issue of the journal *Nature Conservation Research* celebrates an anniversary of the foundation of the international Friendship Nature Reserve. It reports some results and current data on the state of ecosystems and their components both in the Kostomuksha State Nature Reserve and in some other PAs of Russia and Finland.

**Key words:** biodiversity, monitoring, rare and endangered species, boreal zone, terrestrial and aquatic communities, Valdai ice sheet

Kostomuksha State Nature Reserve is a Protected Area (PA), founded on 14.12.1983. It is situated in the Republic of Karelia (Russia) and adjoins the national border with Finland. Pristine north-taiga pine forests prevail in the PA, where the large Lake Kamennoe occupies 20% of its territory. On 26.10.1989, an intergovernmental agreement was signed establishing the Finnish-Russian Friendship Nature Reserve, which comprises the 490 km<sup>2</sup> of the Kostomuksha State Nature Reserve on the Russian side and five borderland PAs on the Finnish side, totalling 221 km<sup>2</sup>. On 18.09.1998, the Committee of Ministers of the Council of Europe awarded a European Diploma for Protected Areas to the Kostomuksha State Nature Reserve, recognising the high conservation status of its natural ecosystems. Since 14.06.2017, the Kostomuksha State Nature Reserve has been part of the UNESCO's Metsola Biosphere Reserve.

The Finnish-Russian Friendship Nature Reserve was established to promote environmental co-operation between Russia and Finland, in particular in nature protection and sane management of natural resources, long-term monitoring and research of the fauna, flora, and aquatic ecosystems. The designation of the Kostomuksha State Nature Reserve was preceded by massive research carried out by the Kostomuksha Integrated Expedition of the Karelian Branch of the AS USSR (currently – Karelian Research Centre of RAS) in 1971–1975 (Biske & Nestrenko, 1977). The results, produced by a wide range

of specialists from several institutes, formed the basis for the feasibility study in this PA (Belousova et al., 1988). For many years, the staff of the Karelian Research Centre of RAS has been conducting research in the Kostomuksha State Nature Reserve. Some of these results are reported in this Special Issue. These articles deal with the biodiversity in other PAs in Northern Russia and in Finnish PAs comprising the Finnish-Russian Friendship Nature Reserve.

Bakhmet et al. (2021) provide data from integrated studies of soils and the soil cover of the Kostomuksha State Nature Reserve with characteristics of the parent material and woody vegetation influencing soil-formation processes on the background. Soils of undisturbed areas in the Kostomuksha State Nature Reserve, their morphological and physico-chemical properties provide reference for monitoring forest ecosystems disturbed by human activity.

Under the current climate instability, research on the natural trends of vegetation development against global climate changes is of high relevance, especially in areas previously covered by the Valdai (Weichselian) ice sheet, and not altered substantially by human activities afterwards. A detailed reconstruction of the formation history of contemporary north-taiga pine (*Pinus sylvestris* L.) forests in the Kostomuksha State Nature Reserve (Filimonova, 2021), given against the backdrop of palaeoclimate changes in the Holocene, includes information on how they may change in the future under various climate scenarios. It was found

that deglaciation of the Finnish-Russian Friendship Nature Reserve area started around 9700 years before present (BP) and ended not later than  $9500 \pm 70$  BP (according to radiocarbon dating). A notable increase in the proportion of *Pinus* in the forests was observed from  $8750 \pm 50$  BP to a maximum in Late Boreal time, as evidenced by the dates  $8240 \pm 60$  BP and  $8090 \pm 200$  BP. Pine and birch-pine forests prevailed throughout the Atlantic period. In the warmer and more humid climate of that time, forests acquired a middle-taiga appearance, and the environment was favourable for the expansion of *Alnus* and, possibly, *Ulmus*. *Picea* started spreading in the Finnish-Russian Friendship Nature Reserve not later than 5700 BP, and since  $5440 \pm 40$  BP its role in the plant cover has been substantial. The expansion of spruce forests reached its maximum in Subboreal time, especially after  $3290 \pm 70$  BP, when they co-dominated together with pine forests. In this period, north-taiga forests formed in the area to persist until today. Since Subatlantic time, pine forests have dominated there.

Boychuk (2021) has synthesised the available data and compiled an annotated list of 180 moss (Bryophyta) species in the Kostomuksha State Nature Reserve. This accounts for 70% of the moss flora of the Kuitozero-Leksozero floristic province and 35% of moss flora in the Republic of Karelia. Twenty-six species are reported for the Kostomuksha State Nature Reserve for the first time. Six of them (*Campyliadelphus elodes* (Lindb.) Kanda, *Racomitrium fasciculare* (Hedw.) Brid., *Didymodon rigidulus* Hedw., *Eurhynchium angustirete* (Broth.) T.J. Kop., *Grimmia elatior* Bruch ex Bals.-Criv. & De Not., *G. torquata* Drumm.) are new to the Kuitozero-Leksozero floristic province. Five species are listed in the Red Data Book of the Republic of Karelia (2020): *Campyliadelphus elodes* (3 VU), *Eurhynchium angustirete* (3 VU), *Necckera pennata* Hedw. (3 NT), *Diobelonella palustris* (Dicks.) Ochyra (3 VU), and *Sphagnum auriculatum* Schimp. (3 VU). For the first three Red Data Book species, the Kostomuksha State Nature Reserve is the northernmost locality, and for *Diobelonella palustris* it is the only locality in the Republic of Karelia.

Data on the lichen species richness of the Vodlozersky National Park, a unique natural ecosystem in Lake Vodlozero and River Ileksa drainage basin, in the eastern margin of Fennoscandia, are presented using in a comparative approach (Tarasova et al., 2021). The lichen collection (565 herbarium specimens) gathered by Finnish researchers T. Ahti and O. Vitikainen from the Vodlozersky National Park and stored in the herbarium of the University of Helsinki Botanical Museum (H) was put to a detailed review. The known

species diversity of lichens and the related fungi in the PA is 473 taxa, including 445 species and subspecies of lichens, 11 species of non-lichenised, and 13 species of lichenicolous fungi. Vodlozersky National Park harbours 18 species listed in the Red Data Book of the Republic of Karelia (2020) and 16 species in the Red Data Book of the Arkhangelsk Region (2020).

Of particular interest are the results of the comparative studies of the bat (Chiroptera) fauna of eight PAs in the forest zone of European Russia (Belkin et al., 2021). Records from the middle-taiga subzone include nine bat species: *Myotis nattereri* Kuhl, 1817, *M. mystacinus* Kuhl, 1817, *M. brandtii* Eversmann, 1845, *M. daubentonii* Kuhl, 1817, *M. dasycneme* Boie, 1825, *Plecotus auritus* Linnaeus, 1758, *Nyctalus noctula* Schreber, 1774, *Eptesicus nilssonii* Keyserling & Blasius, 1839, *Vespertilio murinus* Linnaeus, 1758. *Myotis nattereri* and *M. mystacinus* were not detected in the northern taiga subzone previously. Ultrasonic signals from *P. auritus*, *N. noctula* and *V. murinus* were regularly recorded up to  $66^\circ$  N, which is much farther north than the species ranges indicated on IUCN Red List maps. An overall trend in the bat species richness is a regular increase in the number of species from north to south of the forest zone. Long-term specialised bat censuses in the Republic of Karelia and Arkhangelsk Region have demonstrated that *E. nilssonii* dominates in bat communities in the PAs, which happens only in the northern- and middle-taiga subzones.

An important group in the monitoring and assessment of the state of forest communities in PAs is formed by the numerous and taxonomically diverse small mammals. According to the long-term data presented here (Yakimova & Gaidysh, 2021), the population of this group of animals in the Friendship Nature Reserve is typical of north-boreal Fennoscandia. The number of species encountered in the areas over the study period was significantly lower than in Finland or in the Republic of Karelia on average, primarily because the subject has been understudied. A comparison of the species composition and abundance of small mammals among the areas surveyed within the Friendship Nature Reserve showed that the universal dominants were *Sorex araneus* Linnaeus, 1758 and *Myodes glareolus* Schreber, 1780, while the presence of other species in the communities varied. An important fact is agreement in abundance variations between some small mammal species in the area over the study period.

A key animal species in the international Friendship Nature Reserve is *Rangifer tarandus fennicus* (Lönnerberg, 1909). The Metsola Biosphere Reserve, within which the Russian part of the Friendship

Nature Reserve is situated, contains habitats of the Kuhmo-Kiitehenjärvi subpopulation of *R.t. fennicus* and is of great importance for this animal (Panchenko et al., 2021). The Friendship Nature Reserve mainly includes its summer pastures, rutting and calving areas, but some animals also use the area in winter. Telemetric tracking of the animals' locations and movements proved that *R.t. fennicus* continue their seasonal migrations across the Russian-Finnish border. This is evidence that the continuity and genetic entity of the animals living in the Finnish Kainuu region and in the Republic of Karelia are maintained. This is a precondition for the future well-being of this endemic member of the North European fauna.

Insects in this special issue are represented by fungus gnats in the Kostomuksha State Nature Reserve. This is the name most authors use to denote several families within the superfamily Sciaroidea. According to long-term surveys (Polevoi, 2021), the list of fungus gnats comprises 177 species, belonging to the families Bolitophilidae, Diadocidiidae, Kero-platidae, and Mycetophilidae. The revealed diversity is relatively low and most of the recorded taxa are common in Fennoscandia. However, a number of rare and remarkable species was found, indicating a potentially rich fauna. Five species (*Mycomya obliqua* (Say, 1824), *Sciophila krysheni* Polevoi, 2001, *Sytemna morosa* Winnertz, 1863, *Mycetophila devioides* Bechev, 1988, *Mycetophila haruspica* Plassmann, 1990) are reported for the first time from the Republic of Karelia and Russia. *Mycomya obliqua* is also new for the Palaearctic region.

Important information for integrated ecological assessment of edaphic conditions in PAs can be derived from studies of soil nematode communities. Surveys have demonstrated (Sushchuk & Matveeva, 2021) that the soil nematode fauna of coniferous forests in the international Friendship Nature Reserve is made up of 45 nematode genera belonging to 29 families, with the highest diversity demonstrated by bacterial feeders (42% of the total number of taxa detected). A general trend for all the surveyed forests was a decrease in nematode abundance and biomass from the forest floor towards the mineral soil layer, which was more pronounced in soils on the Finnish side. Analysis of the relative abundance of functional guilds of nematodes showed that forests in Eastern Finland had the nematode fauna more uniformly distributed across soil horizons. Analysis of the eco-trophic structure of nematode communities in soils under the coniferous forests revealed a high abundance of bacterial feeders, fungal feeders and nematodes associated with plants, while plant parasites were scarce or missing.

The state and abundance of the populations of juvenile *Salmo salar* Linnaeus, 1758 and *Margaritifera margaritifera* Linnaeus, 1758 are reliable ecological indicators of the well-being of northern riverine ecosystems. In this sense, the Kostomuksha State Nature Reserve performs an important mission of conserving these endangered species of the European fauna. The conditions for cohabitation of juvenile *S. salar* and *M. margaritifera* in the River Kamennaya (Kem River catchment, White Sea drainage basin) were studied (Zotin et al., 2021). Data on the abundance, spatial distribution and age structure of juvenile *S. salar* and *M. margaritifera* are presented. The patterns of *M. margaritifera* glochidial infection in *S. salar* juveniles at different ages, determining the reproductive performance of *M. margaritifera*, are characterised. The rates of growth and metamorphosis of *M. margaritifera* glochidia encysted on juvenile *S. salar* gills were described using histological methods. The results of this study will be used to prepare recommendations for the conservation of the *M. margaritifera* and *S. salar* populations in the River Kamennaya. The primary concern here is augmentation of juvenile *S. salar* numbers and *M. margaritifera* settlement in the river's rapids with a high density of young individuals.

Economic development of the Republic of Karelia is closely related to utilisation of natural resources, particularly forest resources. These high-impact activities should focus on a three-fold task: i) preservation and restoration of natural ecosystems, ii) securing ecological safety in this area, iii) sustainable development of the economy. This is the only way to achieve both high efficiency of nature conservation, and success of socio-economic programs that guarantee abandonment of development harming people and the environment. These tasks predetermine the topics of research carried out by the institutes constituting Karelian Research Centre of RAS and other Russian research organisations. Long-term studies of the populations of various groups of organisms and ecosystems in PAs of Eastern Fennoscandia and North European Russia generate a solid background for the monitoring and modelling of the dynamics of natural ecosystems under global climate change.

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## ИССЛЕДОВАНИЯ В КОСТОМУКШСКОМ ЗАПОВЕДНИКЕ (РОССИЯ) И НА ДРУГИХ ОСОБО ОХРАНЯЕМЫХ ПРИРОДНЫХ ТЕРРИТОРИЯХ СЕВЕРНОЙ ЕВРОПЫ

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Особо охраняемые природные территории (ООПТ) выполняют важнейшие функции по сохранению биологического и ландшафтного разнообразия. Они служат также природными лабораториями и полигонами для различных мониторинговых исследований во всем мире. Объектами для сотрудничества соседних стран в области охраны окружающей среды выступают международные ООПТ. Таковым является российско-финляндский заповедник «Дружба», включающий российский заповедник «Костомукшский». Научные исследования на ООПТ России ведутся учеными Российской академии наук, университетов и ООПТ при сотрудничестве с иностранными коллегами. Предлагаемый читателю специальный выпуск журнала «Nature Conservation Research. Заповедная наука» посвящен юбилею создания международного заповедника «Дружба». В нем представлены некоторые итоги и современные данные о состоянии экосистем и их компонентов, как в Костомукшском заповеднике, так и некоторых других ООПТ России и Финляндии.

**Ключевые слова:** биоразнообразие, Валдайский ледник, наземные и водные сообщества, мониторинг, редкие и исчезающие виды, тайга