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## ЭКОЛОГИЯ

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### THE INTERNATIONAL SYMPOSIUM «THE CONNECTION BETWEEN CLIMATE CHANGE AND BIOLOGICAL AND LANDSCAPE DIVERSITY CHANGE IN THE ARCTIC AND SUBARCTIC REGIONS»

*Alyona Yu. Levykh<sup>1</sup>, Juri P. Kurhinen<sup>2, 3</sup>, Otso Ovaskainen<sup>2, 4, 5</sup>,  
Tomas Roslin<sup>2, 6</sup>, Nadezhda V. Ganzherli<sup>7</sup>*

<sup>1</sup>Arctic Research Center, Salekhard, Russia

<sup>2</sup>University of Helsinki, Helsinki, Finland

<sup>3</sup>Forest Research Institute of Karelian Research Centre, Russian Academy of Sciences, Petrozavodsk, Russia

<sup>4</sup>University of Jyväskylä, Jyväskylä, Finland

<sup>5</sup>Norwegian university of science and technology, Trondheim, Norway

<sup>6</sup>Swedish University of Agricultural Sciences, Uppsala, Sweden

<sup>7</sup>Tyumen State University, Tyumen, Russia

<sup>1</sup>*aljurlev@mail.ru*

<sup>2, 3</sup>*kurhinenj@gmail.com*

<sup>2, 4, 5</sup>*otso.ovaskainen@helsinki.fi*

<sup>2, 6</sup>*tomas.roslin@helsinki.fi*

<sup>7</sup>*n.v.ganzherli@utmn.ru*

**Abstract.** The article provides general information on the international symposium “The Relationship between Climate Change and Changes in Biological and Landscape Diversity in the Arctic and Subarctic” held on December 2-3, 2021, led by the Arctic Research Center (Salekhard, the Yamal-Nenets Autonomous District, Russia). This information includes: the purpose of the symposium, the issues discussed, the list of organizers and participants, the main proposals to develop interregional and

international cooperation in the study of climate change and its impact on the ecosystems of the Arctic and Subarctic.

**Keywords:** climate change, biodiversity, landscape diversity, environmental and climatic risks, Arctic zone.

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Modern climate change is a multifaceted global problem, yet it shows a clear regional character. The problem takes on particular significance for the Arctic and Subarctic regions. Here, over the last decades a more significant increase of air temperature compared to the mean global values was registered, and a combined influence of climate change and human economic activities is observed and expected to have the most considerable ecological, social and economic consequences [1-10]. Ensuring a sustainable development of the northern regions takes an unbiased assessment of the nature of the climate change at a given territory, assessment of the influence of the changing climate on landscapes and ecosystems, economic sectors (including nature management) and social sphere, takes making ad hoc decisions for social and economic development. A problem worthy of separate attention is identification and management of ecologic and climatic risks to public health.

All the above facts called forth our international symposium “The Connection between Climate Change and Biological and Landscape Diversity Change in the Arctic and Subarctic Regions” (hereinafter referred to as “Symposium”). It was held on December 2-3, 2021 at the initiative of the Arctic Research Center (Salekhard, Russia). The Symposium was organized and held with the help of the Arctic Research Station of Institute of Plant and Animal Ecology of the Ural Branch of the Russian Academy of Sciences (RAS) (Labytnangi, Russia), University of Helsinki (Helsinki, Finland), Forest Research Institute of Karelian Research Center, RAS (Petrozavodsk, Russia), Institute for Water and Environmental Problems of the Siberian Branch (SB), RAS (Barnaul, Russia), Tyumen State University (Tyumen, Russia), Tyumen Scientific Center, SB RAS (Tyumen, Russia).

The purpose of the Symposium was to organize professional communication between research institutions from Russia and other countries to jointly analyze modern climate change influence on the Arctic and Subarctic ecosystems, develop an international research agenda and identify areas for future international and interregional cooperation.

The Symposium welcomed over 50 speakers from five countries: Russia, Finland (University of Helsinki, University of Jyväskylä), Norway (UiT Arctic University of Norway in Tromsø; Norwegian University of Science and Technology, Trondheim; Nansen Environmental and Remote Sensing Center, Bergen), Sweden (Swedish University of Agricultural Sciences, Uppsala), the USA (George Washington University, Washington DC). Russian delegates came not only from the organizing institutions, but also from Severtsov Institute of Ecology and Evolution, RAS (Moscow), A.M. Obukhov Institute of Atmospheric Physics, RAS (Moscow), Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch of RAS (Vladivostok), Saint Petersburg University (Saint Petersburg), Lomonosov Moscow State University (Moscow), National Research Tomsk State University (Tomsk), Surgut State University (Surgut), the Little Sosva (Malaya Sosva) Nature Reserve (Sovetsky), Kondinsky Lakes Nature Park (Sovetsky), Sikhote-Alin Nature Reserve (Primorsky Krai), “Clean Hands, Clean Rivers” Ecological Project (Moscow), Russian Geographical Society, KHAMAO-Ugra Branch (Khanty-Mansiysk).

The Symposium discussed the following: methods and results of climate change monitoring; space and time dynamics of Arctic and Subarctic terrestrial and aquatic geosystems under climate change; climate change influence on biological diversity and biotic communities sustainability of the Arctic and Subarctic regions; ecological and climatic risks to social and economic development of the Arctic zone and their prevention.

The event’s program included 7 plenary and 22 panel talks. Some of these discussed results of interregional and international projects, including research of Western Siberia as a whole, and of Yamal-Nenets Autonomous Okrug (YNAO) in particular. For example, Dr. Vladimir Kirillov (Water Ecology Laboratory, Institute for Water and Environmental Problems, SB RAS, Barnaul, Russia) and a group led by Prof. Andrey Soromotin (Scientific Research Institute for Ecology and Efficient Use of Natural Resources, Tyumen State University, Tyumen, Russia) reported results of their researches under the West-Siberian Interregional World-Class Scientific and Research Center project “Ecological Safety of the Ob-Irtysh River Basin” aiming at assessing the amount and content of pollutants carried by the Ob River to its delta and the Gulf of Ob, at studying dynamics of hydrochemical and hydrobiological characteristics in the context of global climate change and intensified human impact [11-12].

Another group lead by Dr. Dmitrii Chernykh (Laboratory of Landscape and Water Ecological Research and Nature Management, Institute for Water and Environmental Problems SB RAS, Barnaul, Russia) discussed results of a complex (landscape, soil, geobotanical, dendrochronological, cartographic) investigation within the project “Modern Climate Change and Its Influence on the Yamal-Nenets Autonomous Okrug Landscape Structure” aimed at developing procedures and methods of researching the autonomous okrug

landscapes' reactions to climate change, as well as at revealing its consequences for the landscape structure and region's ecosystems.

Dr. Victoria Miles (Nansen Center, Bergen, Norway) presented results of an international project studying microclimate of urban Arctic territories with the help of remote sensing data. This project is headed by Prof. Igor Esau (Norwegian Arctic University, Tromsø, Norway) and by Prof. Andrey Soromotin (Tyumen State University). The research revealed urban temperature anomalies (the so-called "urban heat islands") in the Arctic cities (one of these cities is Nadym, YNAO, Russia) [13-14].

In his talk titled "Biodiversity Research: Old Questions, New Methods", the head of the international project "Chronicle of Nature: Large Scale Analysis of Changing Eurasia Ecosystems" Prof. Otso Ovaskainen (University of Helsinki, University of Jyväskylä, Finland; Norwegian University of Science and Technology, Trondheim, Norway) examined methodologies of data collecting, statistic analysis of big data describing biodiversity in connection with climate change parameters, and approaches to joint species distribution modelling, as well as further international collaboration [15].

Prof. Tomas Roslin (University of Helsinki, Finland; Swedish University of Agricultural Sciences, Uppsala, Sweden) showed an analysis of phenological shifts in species from different taxonomic groups and trophic levels as connected to the modern climate change. The report is based off 70,709 observations covering six decades of systematic monitoring in boreal zone nature reserves of Russia and its neighbouring countries. The data were collected within the framework of the Chronicle of Nature, a project already mentioned above. The analyzed territories included those bordering YNAO (Khanty-Mansi Autonomous Okrug (KhMAO): the Little Sosva (Malaya Sosva) Nature Reserve and Kondinsky Lakes Nature Park) [16].

A number of talks discussed regional peculiarities of climate change and space and time dynamics of landscape components. Prof. Igor Esau elaborated on satellite data analysis, showing climate change peculiarities in the Arctic zone, the so-called "Arctic amplification of global warming", influencing many physical and biological processes in the region. Prof. Evgenii Abakumov and his colleagues (Saint Petersburg University; Arctic Research Center, Salekhard, Russia) described results of their research into YNAO soils and main reasons of its modern dynamics, making specific mention of compiling YNAO Red Data Book of Soils [17-18]. Plenary talks of Dr. Boris Tkachev (Russian Geographical Society, KhMAO-Ugra Branch, Khanty-Mansiysk, Russia) and Mr. Pavel Orekhov (Arctic Research Station, Institute of Plant and Animal Ecology of the Ural Branch of the Russian Academy of Sciences, Labutnangi; Tyumen Scientific Center SB RAS, Tyumen, Russia) feature material evidencing changes in a number of YNAO aquatic and terrestrial ecosystems' parameters resulting from geocryologic changes induced in its turn by climate change [19-20].

The Symposium speakers tackled a series of controversial theoretical and methodological issues. For example, in their plenary talk “The Value of Interspecies Resource Interaction in a Dispute over Climatic or Anthropogenic Influence on Ranges and Abundance of Large Arctic Herbivores”, Dr. Sofia Rozenfeld (Severtsov Institute of Ecology and Evolution, RAS, Moscow, Russia) and Dr. Ilya Sheremetyev (Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch of RAS) showed that the climate and landscape changes played a key role in influencing North Asia herbivores’ ranges and population size until the Late Pleistocene and the Holocene around 7,000 years ago, while nowadays these are influenced primarily by anthropic activity [21-22]. In their report “Alien Freshwater Mollusks in Western Siberia: More Questions Than Answers”, Dr. Evgenii Babushkin (Surgut State University, Surgut, Russia) and Prof. Maksim Vinarski (Saint Petersburg University, Saint Petersburg, Russia) argued that the problem of new invasive mollusk species range expansion is more complex than it seems. The alien malacofauna species are heterogeneous and do not come from one taxonomic or biogeographic group. Some of the species are probably regaining their ranges lost in the Pliocene-Pleistocene glaciations [23-24].

Answering a difficult methodologic question: “How to differentiate between changes of ecosystems (or at least their individual components driven by climate dynamics) and changes caused by human factor?”, Dr. Juri Kurhinen (University of Helsinki, Helsinki, Finland; Karelian Research Center, Petrozavodsk, Russia) and Dr. Elena Potikha (Sikhote-Alin Nature Reserve, Primorsky Krai, Russia) showed that the influence of the modern climate change may be representatively analyzed if there are long time series of observations of objects and processes from undisturbed territories (from climax ecosystems), for example, from conservation areas where starting from the 1930s all yearly observations of ecosystems and their components are put down in the Nature Chronicle books [25]. The researchers did a correlation analysis of small mammal species composition and abundance at a model site of Sikhote-Alin Nature Reserve and average annual ground air temperatures from 1952 to 2020. The investigation showed significant changes in the community structure, total abundance of small mammals, abundance of certain species growing with average annual temperature, variability increasing in mouse-like rodents abundance and community structure from 2000 to 2020.

On the whole, most of the investigations reported at the Symposium provided evidence of amplified Arctic and Subarctic climate warming and such events connected with it as biologic and landscape diversity changes, permafrost degradation, changes in landscape structure and dynamics, movement of nature zones and certain biota elements from the south to the north, changes in certain species abundance, changes in radial tree growth, and so on.

Realizing the importance of studying global climate change and its influence

on the ecosystems of the Arctic and Subarctic, the Symposium participants recognize that it is necessary to:

1) continue studying the connection of climate change with changes in the biologic and landscape diversity of the Arctic and Subarctic paying special attention to interdisciplinary research and involvement of domain specialists coming from as many fields of science as possible, as well as continue searching for landscape and biologic indicators of climate change in specific natural environments;

2) continue working with nature reserves analysing data from ecosystems observations in the changing climate as part of the international project “Chronicle of Nature: Large Scale Analysis of Changing Eurasia Ecosystems” led by the University of Helsinki;

3) taking into consideration the successful experience of the Symposium in the field of international and interregional interaction, consider holding “The Connection between Climate Change and Biological and Landscape Diversity Change in the Arctic and Subarctic Regions” symposium at least biennially.

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### *Information about the authors*

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**Alyona (Alena) Yurievna Levykh**, born in 1969, in 1991 she graduated from the Tyumen State University (Tyumen, Russia) in Biology, qualified biologist, teacher of biology and chemistry, Candidate of Sciences in Biology (PhD), Docent. In 1991-2020 she held classes in Ishim P.P.Eshov Teachers Training Institute, Tyumen State University. In 2005-2010 and 2012-2020 she was Chairlady of Biology, Geography and Their Teaching Methods Chair. Starting from 2021 she heads Chemical Analysis Laboratory, the Arctic Research Center (Salekhard, Russia). Research interests: small mammals population biology, vertebrate population and community ecology, general ecology.

**Yuri Pavlovich Kurhinen**, born in 1955, a graduate of Petrozavodsk State University, doctor of sciences (Biology), Professor, a leading researcher of the University of Helsinki (Finland), a leading researcher of the Forest Institute of the Karelian Research Center of the Russian Academy of Sciences (Russia), a coordinator of the international project “Eurasia Nature Annals: large-scale analysis of changing ecosystems”, the head of international projects on the study of the range, genetics and ecology of the voles (*Pteromys volans* L., 1758) of Eurasia; the population dynamics of grouse birds in modern conditions; changes in community structure and population dynamics of small mammals under climate change conditions. Area of scientific interests: population and community ecology, landscape ecology, forest ecosystem protection, evolutionary biology.

**Otso Ovaskainen**, born in 1970, a graduate of the University of Helsinki, doctor of mathematics (1998) and professor of mathematical ecology (2009). Since 2011, he has been leading the international project “Eurasian Chronicle of Nature: a large-scale analysis of changing ecosystems”. From 2006 to 2017 he had been a member of the Finnish Council of Europe (the Center of Excellence in Metapopulation Research), in 2018 with four other researchers he founded the “Ecological Change Research Center (REC)”. Currently, he leads the Statial Ecology Research Group (SERG), which specializes in developing new statistical methods to maximize the use of ecological data. Area of scientific interests: ecological modeling, metapopulation biology, population genetics and evolutionary biology.

**Tomas Roslin**, born in 1969, graduated from the University of Helsinki with a PhD in zoology (1999). Since 2015, he serves as professor of insect ecology at the Swedish University of Agricultural Sciences (SLU) and a visiting professor at

the University of Helsinki (UH). Currently, he leads the Unit of Insect Ecology at SLU and the Spatial Foodweb Ecology Group (SFEG) at SLU and UH, a research group specialized in ecological communities and interaction networks. Roslin is a keen participant in project “Eurasian Chronicle of Nature: a large-scale analysis of changing ecosystems”, as lead by prof. Ovaskainen, and a co-PI of the “Research Center for Ecological Change (REC)”. Ovaskainen and Roslin (with prof. David Dunson) are also the leaders of project LIFEPLAN, a global biodiversity project funded by a 6-year ERC Synergy grant. Areas of scientific interests: metacommunities, ecological interaction networks, community assembly theory, arctic and global change.

**Nadezhda Vladimirovna Ganzherli**, born in 1984, in 2007 she graduated from the Tyumen State University in Linguistics, MA in Linguistics (2015) from the Tyumen State University, Tyumen, Russia. In 2008-2018 was an interpreter/translator at UTair Aviation Company. Since 2017 she has been a teacher at English Philology and Translation Chair, Tyumen State University, Tyumen, Russia. Research interests: computer linguistics, humor, nenets language, ecology.

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