Arctic Floating University in the system of biomonitoring:
expedition "Terrae Novae -2018"

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Abstract. The biomonitoring within the framework of Arctic Floating University expeditions becomes especially relevant in the context of the changing climate, when levels of pollutants in wild fauna and flora are increasing, and the availability of traditional food can become significantly reduced for some of the Arctic populations. Through the collaboration of two large-scale research projects run by NarFU – the Arctic Floating University and the RF Government Mega-Grant No. 14.Y26.31.0009 – makes it possible to obtain series of unique data that allow assessing the health risk levels that the Arctic communities are exposed to.

1. Introduction

In 2017, M.V. Lomonosov Northern (Arctic) Federal University (NArFU) started a project titled “Developing a methodology for monitoring, evaluating, predicting and preventing risks associated with the transfer through biological pathways of the highly toxic pollutants accumulating in food chains and spreading in the Arctic ecosystems”, supported by the Government of the Russian Federation under Resolution No.220 dated April 9, 2010. For the purpose of this project, Russia’s first laboratory for arctic biomonitoring was established in NArFU, designed to explore the impact being caused by climate change on the volume of transboundary transfers to the Arctic of hazardous pollutants (persistent organic and inorganic pollutants) through biological pathways. The current systems for monitoring environmental pollution levels and habitats in the Russian Federation and globally, are based mainly on quantitative measurements of concentrations of harmful substances in a limited number of environmental bodies (atmospheric air, water, soil, and vegetation). This approach does not fully reflect the actual impact on living organisms, and especially on humans. The ingress of pollutants into human body, the most toxic being fat-soluble compounds, occurs not so much through ocean currents or atmospheric circulation, but rather through biological pathways – migrating birds, fish and marine mammals, serving as their main reservoirs and carriers. Especially relevant is this problem in the context of indigenous peoples, as they mainly subsist on migratory fish and birds, as well as meat and fat of terrestrial and sea animals. According to the results of international studies, dietary intake accounts for up to 80% of highly toxic persistent pollutants that enter our bodies.

2. Research objects and methods

To obtain initial sets of biomonitoring data, Nenets Autonomous Area was selected as a sampling site. Biological samples were taken (on the islands of Vaigach and Kolguev), prepared and delivered for laboratory analysis as part of the expedition of the Arctic Floating University, which lasted from July 10 to August 2, 2018 with itinerary encompassing Arkhangelsk - Solovetsky Islands - Russkaya.
Harbor (Novaya Zemlya) – Cape Zhelaniya (Novaya Zemlya) – Ledynaya Bay (Novaya Zemlya) – Varnek (Vaygach island) - Bugrino (Kolguev island) - Arkhangelsk (see Figure 1).

The biological samples were taken in the traditional way and delivered to NArFU Arctic Biomonitoring Laboratory frozen. Under the agreement with Nenets Central Policlinic and feldsher-midwife stations in the settlements of Varnek and Bugrino, samples of venous blood were taken from the local population and placed in thermally controlled containers, frozen, for further transportation to the laboratory for chemical analysis.

2.1. Characteristics of the survey area
In the survey area, Nenets Autonomous Area represents a core site. With unique flora and fauna, ethnic diversity and traditions of natural resources management, it is located conveniently in terms of transportation of biomaterials to the laboratory. It should be noted that the annually held expeditions of the Arctic Floating University, organized by NArFU, make stops in Bugrino village (Kolguev Island)
and Varnek (Vaygach Island). The other reason why Nenets Autonomous Area was chosen the core site within the Arctic biomonitoring system, is its experience in implementing international projects in the associated fields of research. For example, in the villages of Krasnoe, Indiga and Nelmin Nos, back in the 2000s, the first data were obtained on the content of persistent pollutants in the blood of local residents, as well as in traditional foods. In addition, the impact of some of the migratory fish species (Kara and White seas) on the diet of indigenous communities can be assessed by sampling the areas adjacent to the settlements of Amderma and Shoyna because of their transport accessibility. The key study areas in Nenets Autonomous Area are presented in Figure 2.

![Figure 2 - Key survey areas in Nenets Autonomous Area.](image)

In the Russian sector of the Arctic currently has an indigenous population of 82,500 (the total population size being 250,000 people). Most of them are settled residents of Nenets towns and villages, but some of them are nomads or semi-nomads practicing such traditional trades as reindeer herding, fishing, marine hunting, and gathering.

The problem of health care services in remote areas of the Russian Arctic are especially relevant among the indigenous communities today, as the nomadic population has limited access to hospital and policlinic services. To the nomads of tundra, even general practitioners, let alone specialist doctors, are often unavailable. Although the Russian Arctic is least affected by anthropogenic impact, the health risk levels in this area are associated with the spread of toxicants from nearby areas, as well as through transboundary transport with migratory animal species [5].

2.2. Major PTS (persistent toxic substances)

Due to low income levels and high unemployment rate, many of the indigenous Arctic communities enjoy very little portions in their diet of grocery store foodstuffs, some eating only local food (fish and meat) and therefore exposing themselves to PTS (persistent toxic substances).

The accumulation of PTS in the foods consumed by local population largely relates to the nutrition, habitats and migratory routes followed by some of the bird species. For example, the herbivorous *Anatidae* – *Anser fabalis*, *Anser albifrons*, *Anser erythropus* and *Branta leucopsis* – winter in Germany, Netherlands, and Asia, where they feed on agricultural lands and are likely to consume PTS, as the agricultural lands in Europe and Asia are known to have been extensively treated earlier with pesticides containing organochlorine compounds. These bird species breed on the territory of the Russian Arctic, being the main source of food for the indigenous peoples in spring and fall [1].
Food contamination is also associated with the traditional ways of food treatment and storage. It has been proven, for instance, that storing, processing and cooking meat at home, as well as fermenting it in the ground, increases its concentration of PTS [2].

Most PTS (especially heavy metals, polychlorinated biphenyls and other organochlorine compounds) have a negative effect on endocrine system. With hormone-like properties but not being true hormones, they disrupt human endocrine system, affecting also the reproductive system [3].

What aggravates the problem is that these pollutants are highly capable of moving along not only when trophic chains, but also within human population. Due to their high lipid solubility, PTSs are easily absorbed by from food and transfer easily through placental barrier and into fetus with mother’s blood, as well as during breastfeeding with milk. Even though much focus is laid on the health levels among the indigenous people of the Arctic, the studies lack consistency. Since the effect of PTS on the body is long-term, constant monitoring should be in place to identify trends and patterns.

2.3. Biomonitoring system within the Arctic Floating University

As part of the Arctic Floating University - 2018: Terrae Novae, the Arctic biomonitoring laboratory has sampled 30 fish species (cod Gadus morhua and haddock Melanogrammus aeglefinus) inhabiting the waters of 3 fishing grounds – Gusiny Bank, Kanin-Kolguev Bank, and Kanin peninsula. Under the agreement with the Nenets Central Policlinic, blood sampling facilities were delivered to Varnek and Bugrino, where the local paramedics conducted also a survey questionnaire on health levels among local people. 38 blood samples and questionnaires were delivered from the Island of Kolguev to the research vessel Professor Molchanov for further transportation, as well as 10 samples of haddock Melanogrammus aeglefinus, cod Gadus morhua, char Salvelinus alpinus, flounder Pleuronectes platessa; and 10 samples of Anser albifrons geese. 17 blood samples and questionnaires were obtained from Varnek settlement. Further studies are designed to determine the content of persistent toxic substances and shed more light on their transmission along food chains. Despite the short duration of the expedition and difficult weather conditions, the laboratory staff had managed to obtain a unique biomaterial that will allow assessing the risks PTS exposure, so that methods for early detection and monitoring of hazardous, biologically spread pollutants could be tested.

3. Conclusion

In the context of the changing climate, when levels of pollutants in wild fauna and flora are increasing, and the availability of traditional food can become significantly reduced for some of the Arctic populations, the biomonitoring program led by the Arctic Floating University becomes especially relevant. Further research is needed for more profound insights into the health risks associated with the current levels of PTS exposure in the Arctic environment. It is important that similar studies cover other islands in the Arctic zone of the Russian Federation and all circumpolar countries, so that a more comprehensive biomonitoring data could be obtained (on PTS content in biota and human body) by practising a shared, international approach ensuring comparability of data at the global level and allowing for shared preventive action plans – a point important in the sense of performance evaluation in the framework of international agreements.

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