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Peninsula with specific communities dominated by the halophytes *Puccinellia phryganodes, Carex subspathacea, Carex glareosa,* and *Stellaria humifusa*.

Although species richness of this flora is somewhat less than of those of Taimyr floras in the same subzone, it is richer than Yamal floras and reflects all characteristic for arctic tundras peculiarities.

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11. Vegetation of a small arctic Island at the limit of the Tundra Zone, Sosnovets Island in the White Sea

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Biodiversity of arctic islands is highly vulnerable under anthropogenic pressure and climate change. Many arctic islands, being almost inaccessible, are hitherto poorly investigated, so that we even don't know the scale of presumed changes and possible losses in biodiversity. Our study and analysis of the vegetation of Sosnovets Island is to contribute to the knowledge about arctic island ecosystems.

Sosnovets Island (66°29' N, 40°41' E) is located 8 km southward the Arctic Circle, near the southeast part of the Tersky Coast, in the funnel-shaped opening of the White Sea to the Barents Sea. The area of the Island is 40.6 ha, and the shore height is 10–15 m above sea level. There is Sosnovets Lighthouse (in action since 1862) situated in the central part of the Island and a meteorological station in the southern part.

Sosnovets Island lies at the southern limit of tundra, and its placement to the tundra or the forest-tundra has been debated in various regional and circumpolar botanical and geographical schemes. In our work we consider the Sosnovets Island to belong to the southern tundra on the basis of its flora and vegetation.

We used the Braun-Blanquet approach for vegetation description and classification. 76 relevés were collected in August 2016, with geo-positioning and habitat descriptions. All of them were included in the TURBOVEG database. Herbarium specimens were deposited in Lomonosov Moscow State University (MW), University of Helsinki (H), Petrozavodsk State University (PTZ), Kandalakshsky Reserve (KAND), and Polar-Alpine Botanical Garden-Institute (KPABG).

Dwarf-shrub (*Empetrum hermaphroditum*) and lichen (*Cladonia arbuscula*, *Flavocetraria nivalis*) communities of class ***Loiseleurio procumbentis–Vaccinietea*** Eggler ex Schubert 1960 are formed on sandy deposits and occupy only a limited area – 0.4 ha (1 % of the Island's area). Vegetation of the permafrost peatland prevail on the major part of the Island. Cloudberry-crowberry-lichen and cloudberry-crowberry communities prevail on drained elevated sites of the peatland. They are

similar to those described from vast peatlands of East European tundra in the alliance ***Rubo chamaemori–Dicranion elongati*** Lavrinenko et Lavrinenko 2015, class ***Oxycocco-Sphagnetea*** Br.-Bl. et Tx. ex Westhoff et al. 1946. Nevertheless, the absence of characteristic species of the class ***Oxycocco-Sphagnetea,*** namely *Andromeda polifolia*, *Ledum palustre*, *Eriophorum vaginatum* and *Sphagnum* spp., is a characteristic feature of Sosnovets Island. This feature distinguishes the peatland of Sosnovets Island from peatlands on the mainland of Malozemelskaya and Bolshezemelskaya Tundras and brings it together with those on islands of the Barents Sea (Vaygach, Kolguev, and Dolgiy) where these species are absent or rare as well (Lavrinenko, Lavrinenko 2015).

The majority of cottongrass- and sedge-and-Sphagnum communities of the Island belong to the class ***Scheuchzerio palustris–Caricetea fuscae*** Tx. 1937. They occur in flarks and coastal extensions of dells draining the peatland. They are attributed to the suballiance ***Caricenion rariflorae*** Lavrinenko et al. 2016 of the alliance ***Sphagnion baltici*** Kustova in Lapshina 2010, due to the presence of characteristic species of these syntaxa: *Sphagnum lindbergii*, *S. balticum*, *Polytrichum jensenii*, *Eriophorum scheuchzeri* (Lavrinenko et al. 2016). Several sedge-Sphagnum dominated communities of the peatland flarks lack the abovementioned species but include *Straminergon stramineum*, *Warnstorfia exannulata*, *Epilobium palustre*. They are analogous to communities of the alliance ***Drepanocladion exannulati*** Krajina 1933. The communities of the suballiance ***Caricion rariflorae*** are widespread in the peatland flarks of the East European tundra, the communities of the north and high-altitude alliance ***Drepanocladion exannulati*** occur, although rarely, in flarks with flowing water (Lavrinenko et al. 2016).

Coastal vegetation of the Island belongs to intra-zonal classes ***Juncetea maritimi*** Br.-Bl. in Br.-Bl. et al. 1952 (alliances ***Puccinellion phryganodis*** Hadač 1946, ***Caricion glareosae*** Nordh. 1954, ***Armerion maritimae*** Br.-Bl. et De Leeuw 1936) and ***Ammophiletea*** Br.-Bl. et Tx. ex Westhoff et al. 1946 (alliance ***Agropyro–Honckenyion peploidis*** Tx. in Br.-Bl. et Tx. 1952). The grass species *Calamagrostis deschampsioides* is a characteristic feature of these communities. It has more eastern distribution in Fennoscandia, and is very rare on the Kola Peninsula.

The anthropogenic vegetation of Sosnovets Island is a result of the anthropogenic impact for more than 150 years and is quite diverse and extensive (5.0 ha, 12.3%). It takes the 2nd place on the Island, regarding its area, whereas the 1st place is taken by the vegetation of peatland. It is predominantly composed of alien meadow species (*Deschampsia cespitosa*, *Lathyrus pratensis*, *Trifolium repens*, *Alchemilla subcrenata*, *Vicia cracca*, *Ranunculus acris*). The invasive *Deschampsia cespitosa* occurs in the wet degraded flarks of the peatland and other species were found in moderately moist places.

Thus, the vegetation of Sosnovets Island is typical of the tundra zone and Sea shore. At the same time, due to the combination of the natural conditions and the long-term anthropogenic impact, the vegetation of Sosnovets Island has a high specificity among the small-size Arctic islands.

Keywords: vegetation; island vegetation; Braun-Blanquet classification; Murmansk Region.

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12. Vegetation of the White Sea islands within the boreal zone: Porya Guba Archipelago, White Sea, Russia

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Insular ecosystems have a certain level of peculiarity because of their restricted size and isolation, which makes them suitable for biodiversity studying but also leads to their vulnerability under climatic changes and anthropogenic pressure. This research includes vegetation description and mapping.

The aim of the study is the vegetation diversity of the Porya Guba Archipelago (66°41'—66°51' N, 33°32'—33°56' E) in the White Sea, which has not been studied properly yet.. The study area is located within the Kandalaksha Strict Nature Reserve. It is located within the Baltic shield and affected by post-glacial rebound, which allows the study of succession. The territory is within the northern taiga (boreal) zone, nevertheless tundra-like communities are formed on some islands.

Major part of archipelago is covered by pine (*Pinus sylvestris*) and spruce (*Picea × fennica*) boreal forests and crowberry (*Empetrum nigrum* ssp. *hermaphroditum*) tundra-like communities. Vegetation is also represented by mires, coastal vegetation, rock communities and secondary anthropogenic communities covered a smaller territory.

The field work was carried out in 2008-2013, 2015 by Mikhail Kozhin and in 2017, 2018 by Ekaterina Kudr. Phytosociological data were collected according to the relevé method of sampling vegetation at sites within areas of homogeneous microtopography and moisture. Plots of 400 sq. m. were used for the large-scale communities, mostly forests, and small-scale communities, tundra-like communities, mires and meadows. Phytosociological studies focused on the main types of the islands' vegetation. In total, 226 relevés were obtained. All of them were included in the TURBOVEG database. Relevés were classified by means of Braun-Blanquet approach. Vegetation map of the Archipelago was compiled according to a set of relevé and field observations. High resolution orthophoto map was used to determine borders of plant communities. The map legend was designed according to plant community classification based on the Russian ecologic-phytocoenotic approach. The main mapping units for homogenous vegetation correspond to associations or groups of associations, for heterogenous complexes, and ecological series. Vegetation mapping was done with ArcGIS software. Collected specimens of vascular plants, mosses, liverworts, and lichens were deposited in the herbaria of Lomonosov Moscow State University (MW), University of Helsinki (H), Kandalaksha State Nature Reserve, and Polar-Alpine Botanical Garden-Institute (KPABG).

Forest communities belong mainly to the class *Vaccinio-Piceetea*. Oligotrophic pine forests were attributed to the alliance *Cladinio stellaris – Pinion sylvestris*; mesic spruce, pine and secondary birch forests – to the alliance *Empetro – Piceion obovatae*; palludified spruce forests with horsetail – to the alliance *Piceion excelsae*; wooded oligotrophic mires – to the alliance *Vaccinio uliginosi – Pinion sylvestris* alliance; birch krummholz — to the alliance *Empetro hremaphroditi – Betulion pumilae* alliance; eutrophic spruce forests with rich herb layer — to the class *Mulgedio aconitetea* (alliance *Mulgedion alpini*).

Tundra-like communities with dwarf-shrubs and lichens belong to the class *Loiseleurio procumbentis – Vaccinietea* (alliance *Phyllodoco – Vaccinion myrtilli*). However, the peatland communities are closely related in terms of species composition to class *Oxycocco-Sphagnetea.*

Mire communities are represented by three classes: Oxycocco – Sphagnetea, Scheuchzerio palustris – Caricetea fuscae, and Betulo carpaticae – Alnetea viridis. Oligotrophic Sphagnum bogs

were attributed to the class Oxycocco – Sphagnetea (alliance Oxycocco microcarpi – Empetrion hermaphroditi). Within the class Scheuchzerio palustris – Caricetea fuscae minerotrophic brown moss fens were attributed to the alliance Stygio – Caricion limosae and sedge-moss rich fens – to the alliance Sphagno warnstorfii – Tomentypnion nitentis. Swamp willow thickets belong to the class Betulo carpaticae – Alnetea viridis (alliance Salicion phylicifoliae).

Coastal vegetation was attributed to the classes *Juncetea maritima* (alliance *Caricion glareosae*) and *Ammophiletea* (alliance *Agropyro-Honckenyion peptiloidis*) and various associations. Plant communities of open rocks close to *Juncetea trifidi* (*Carici – Juncion trifidi*).

Anthropogenic vegetation of the archipelago is represented by meadow (class *Molinio – Arrhenatheretea,* alliance *Arrhenatherion elatioris*).

Thus, according to results of our preliminary study plant communities of the Archipelago were attributed to 15 alliances, 14 orders, and 10 classes. Vegetation is distinguished by great diversity and complex horizontal vegetation structure. In order to perform spatial analysis of vegetation and to estimate impact of different factors on its formation we created vegetation map of the territory. The map represents 209 islands, total area of the mapped islands equals 521 ha. Map legend includes 51 units, that correspond to associations or groups of associations according to the Russian ecologic-phytocoenotic approach. The highest diversity of plant communities is observed within forests, mires and tundra-like communities. Forests cover significant area on islands in the inner part of the Archipelago, while tundra-like communities prevail on islands in the outer islands. Mires cover insignificant area, nevertheless they show a great variability. On some big islands with calcareous groundwater seepage complex mire systems are formed.

According to island equilibrium model (MacArthur and Wilson (citation?)) size of the island affects species diversity of this island and number of species increases on bigger islands. We assume that the same model may describe patterns of vegetation diversity. The Arrhenius equation formula was used to describe dependence of vegetation diversity and size of an island as well as the coefficients' values were calculated: $y=3.3*x^{0.25}$. On average communities of 3 different classes were observed on island of 1 ha.

So then, a great diversity of plant communities is represented on the Porya Guba Archipelago. The vegetation map demonstrates distribution patterns of plant communities due to impact of geographical factors.

13. The syntaxonomic composition of vegetation as a basis for reindeer pastures monitoring

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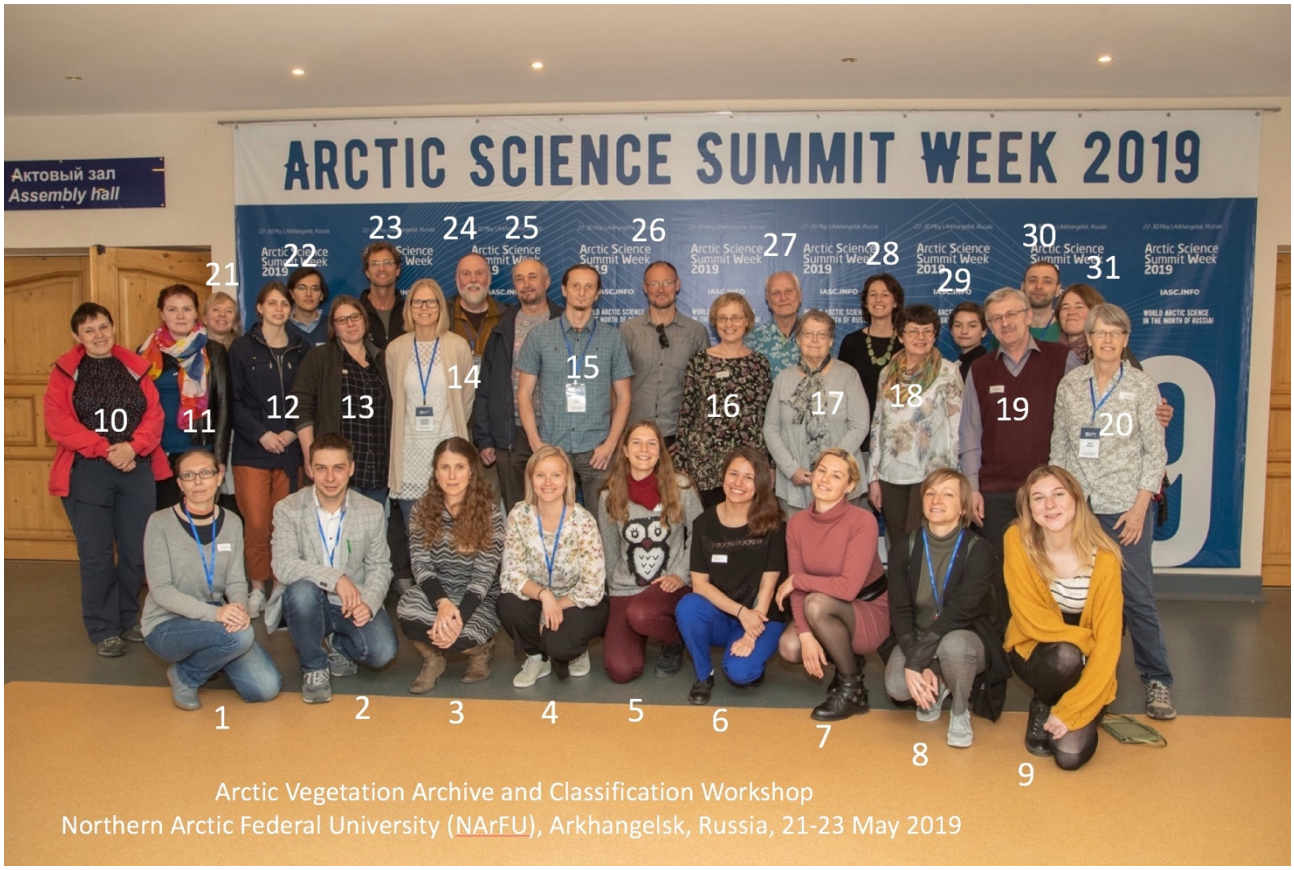
We present comparative data regarding dry phytomass of lichens and green parts of plants of all life forms (including mosses) from syntaxa of two vegetation classes located in the Ural-Novaya Zemlya province (the eastern macroslope of the Polar Urals and the Vaigach island) and the Kanin-Pechora province (the continental regions of the East European tundras in the Pechora river delta). The Polar Urals site and the Pechora delta are located in the southern tundras (subzone E, CAVM Team, 2003), Kolguev island – in typical tundras (subzone D, CAVM Team, 2003), on Vaygach Island in typical tundras (subzone C, CAVM Team 2003).

The analysis included 62 relevés made by O. V. Khitun in the Polar Urals during geobotanical survey conducted by the A.N. Severtsov Institute in 2018, and 192 samples by S. A. Uvarov in

Arkhangelsk Workshop Participants



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