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OVERVIEW OF THE VASCULAR PLANT FLORA OF THE REGIONAL COMPLEX SANCTUARY "KURGALSKY" (LENINGRAD REGION, RUSSIA)

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Original data on the flora of the regional complex sanctuary "Kurgalsky", based on the author's detailed investigations and all available information on vascular plants of the area were summarized, and an overview of the flora is represented. 791 vascular plant species were recorded on Kurgalsky Peninsula and the neighboring islands of the Gulf of Finland, included in the sanctuary. The main peculiarities of the flora as well as the causes of high species richness and diversity are discussed. The paper also contains a brief historic outline of the flora research in the sanctuary as well as the information on threatened plant species and valuable plant communities.

Keywords: vascular plants, flora, Kurgalsky Peninsula, sanctuary, protected species, Leningrad Region.

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INTRODUCTION

The regional complex sanctuary "Kurgalsky" (59950 hectares), one of the largest protected areas in the Leningrad Region, is situated on Kurgalsky Peninsula on the southern coast of the Gulf of Finland, near the boundary with Estonia (Fig. 1). It comprises also the adjoining water area up to the 10 m isobaths with a number of small islets. The territory was granted also a status of Ramsar Site as a valuable habitat of waterfowl (Red Data Book... 1999).

Kurgalsky Peninsula is one of the most botanically interesting areas of the North-Western Russia. The first data on vascular plants of the area are dated to the second half of 19th century (Шмальгаузен 1874). This publication contains information about 72 plant species, recorded by I.F. Shmalgauzen on the peninsula. Later mainly vegetation studies were carried out on the area, and the detailed research of vascular plant flora of Kurgalsky Peninsula was started only in 1990s. In 1992–1994 E.A. Glazkova (in 1992 together with V.A. Bubyreva and the students of the Department of Botany of Saint-Petersburg State University) carried out thorough study of the flora of the peninsula. The results of these investigations were published in the monograph on the vascular plant flora of Kurgalsky Peninsula (Глазкова & Бубырева 1997), containing the data about 754 species. However, the monograph does not include any analysis or overview of the flora of this unique territory.

Fig. 1. Location of Kurgalsky Peninsula.

The main aim of this research is to give an overview of the vascular flora of the sanctuary «Kurgalsky» on the base on new original data recently collected by the author, as well as on the analysis of all published data on the vegetation cover of Kurgalsky Peninsula.

MATERIAL AND METHODS

In 2011–2012, monitoring floristic investigations on Kurgalsky Peninsula were carried out by Elena Glazkova and Anna Doronina: 29.08.2011 — Narva Bay coast near the village of Bolshoe Kuzemkino; 25.06.–1.07.2012 — territory of the sanctuary "Kurgalsky". (within the borders, according to the sanctuary regulations accepted in 2000); 3.09.–7.09.2012 — the southern part of the peninsula. In addition, 13.08.–18.08.2012 the flora of the islands Reimosar, Remisaar, Seinetluda, Hangeloda, Herkaluda, and Yanisari, belonging to the sanctuary, was studied by Elena Glazkova, 207 vascular plant species having been recorded on these islands.

A traditional route method has been applied for the field flora investigations. Localities of rare and threatened in the North-Western Russia plant species were recorded and mapped using GPS navigation device.

RESULTS AND DISCUSSION

As the result of the author's own investigations and critical summarizing of all available data on the flora of Kurgalsky Peninsula, collected from published sources and herbarium specimens, 791 vascular plant species (including native, casuals, established aliens, and cultivation escapers) were registered on Kurgalsky Peninsula and the neighboring islands of the Gulf of Finland, included in the sanctuary. In 2011–2012 for the first time in the flora of Kurgalsky Peninsula and the neighbouring islands 37 new species were found, among them being such rare species as *Cypripedium calceolus* L., *Drosera intermedia* Hayne, *Lepidium latifolium* L.; many localities of protected species found in 1990s (Глазкова & Бубырева 1997) were confirmed; a lot of new localities of rare and threatened in the North-Western Russia and/or Russia plant species were recorded; more precise data on the distribution and frequency of rare plant species and occurrence of valuable plant communities were obtained.

The flora of Kurgalsky Peninsula is very rich and diverse. The main factor resulting in a considerable plant species richness and originality of the flora of the area is a significant diversity of landscapes, which in its turn has lead to a great variety of habitat types. Another very important factor is climatic peculiarities. The climatic conditions, on the one hand, are favorable for the occurrence of some "northern" elements of the flora (e.g., *Empetrum hermaphroditum* (Lange) Hagerup, *Puccinellia coarctata* Fern. et Weath.) due to relatively low air temperature in summer, strong winds, the delayed beginning of growth season and a rather severe ground temperature regime in winter. On the other hand, a long autumn (hence a longer vegetation period) and rather mild winters facilitate spreading of many "southern" species (e.g., *Festuca altissima* All., *Filipendula vulgaris* Moench, *Dentaria bulbifera* L., *Sanicula europaea* L.). Many vascular plant species of Kurgalsky Peninsula occur there on the boundaries of their basic distribution areas, including some Fennoscandian and Baltic Sea endemic species. The species on their northern (e.g., *Festuca altissima*, *F. sabulosa* (Anderss.) Lindb. f., *Filipendula vulgaris* Moench, *Dentaria bulbifera* L., *Rumex hydrolapathum* Huds., *Ononis arvensis* L., *Scutellaria hastifolia* L., *Selinum carvifolia* (L.) L., *Sieglingia decumbens* (L.) Bernh.) and north-eastern/eastern (e.g., *Atriplex calotheca* (Rafn) Fries, *A. littoralis* L., *Carex arenaria* L., *Drosera intermedia* Hayne, *Centaurium littorale* (D. Turner) Gilmour, *Isatis tinctoria* L., *Rhynchospora fusca* (L.) Ait., *Dactylorhiza baltica* (Klinge) Nevski, *Helictotrichon pratense* (L.) Bess.) boundaries prevail in the flora, with a smaller number being on the southern (*Carex glareosa* Wahl., *Chamaepericlymenum suecicum* (L.) Aschers. et Graebn.) and south-western (*Puccinellia coarctata*) limits of their basic distribution areas. In addition, Kurgalsky Peninsula and the neighboring islands have been closed for free access for a long time, because of "a strict border zone" regime, that caused better safeness of the ecosystems of the sanctuary.

The reasons of plant species richness and diversity on Kurgalsky Peninsula were partly discussed earlier (Глазкова & Бубырева 1997). During the investigations in 2012, an impressive richness and originality of a number of plant communities in the southernmost part of the peninsula was observed. It is this region, occupying the area from the mouth of the Narova River up to the northern end of Lake Vaykne and 2–3 km northwards along the coast of Narva Bay and including a large mire complex Kader, which is very rich of vascular plant species. Dune pine forests and psammophytic grass communities along Narva Bay coast are unique in the Leningrad Region. Only on Kurgalsky Peninsula in these communities occurring in plenty are such rare and protected species as *Epipactis atrorubens* (Hoffm. ex Bernh.) Bess., *E. helleborine* (L.) Crantz, *Pulsatilla pratensis* (L.) Mill., *P. patens* (L.) Mill., *Anthyllus baltica* Juz. ex Kloczkova, *Silene tatarica* (L.) Pers., *Dianthus arenarius* L. In dune pine forest on the shore of Narva Bay *Cypripedium calceolus* L. has been recorded in 2012 by E. Glazkova for the first time on Kurgalsky Peninsula. In the Leningrad Region as a whole, typical dune forests are usually characterized by rather poor vascular plant composition. On Kurgalsky Peninsula, in contrary, dune forests along Narva Bay in the southernmost part of the sanctuary have a very rich and original vascular plant flora. Besides the above-mentioned species, occurring in these plant communities are *Polygala amarella* Crantz, *Equisetum hyemale* L. A great amount and diversity of orchids (*Epipactis atrorubens*, *E. helleborine*, *Cypripedium calceolus*, *Listera ovata* (L.) R. Br., *Platanthera bifolia* (L.) Rich.) and species of *Pyrolaceae* (*Chimaphila umbellata* (L.) W. Barton, *Moneses uniflora* (L.) A. Gray, *Pyrola rotundifolia* L., *P. minor* L., *P. chlorantha* Sw., *Moneses uniflora* (L.) A. Gray) takes place. In the Leningrad Region such species as *Cypripedium calceolus* and *Epipactis atrorubens* grow mainly in the areas with calcareous soils (Ефимов 2011). On Kurgalsky Peninsula, with its non-calcareous soils, the occurrence of these species can be probably explained by some enrichment of coastal sands with calcium, which reaches the coast of Narova Bay in the southern part of the sanctuary with alluvium of the Narova River. The River Narova

flows in its middle current through the Ordovic Plateau composed of lime-stones. The same explanation could be offered to the fact of high species richness of dry grasslands on the right bank of the Rosson' River near the villages Korostel' and Sarkylya. Here occur such species as *Filipendula vulgaris*, *Senecio jacobaea* L., *Veronica spicata* L, *Trommsdorffia maculata* (L.) Bernh., *Jasione montana* L., *Vicia tetrasperma* (L.) Schreb., *Trifolium arvense* L., *Dianthus deltoides* L., *Campanula cervicaria* L. etc. One of the dominant species on the grasslands near Sarkyla village is *Armeria vulgaris* Willd., a protected species in the Russian Federation and the Leningrad Region.

Of particular botanical interest is a large ombrogenic bog Kader located in the southernmost part of the sanctuary, between Narva Bay coast and the River Rosson'. Very high species richness and originality of its flora was observed by the author already in 1990s (Глазкова & Бубырева 1997). During the investigations in 2012 many new vascular plants, including threatened and rare species (e.g., *Drosera intermedia* и *Eupatorium cannabinum* L.) were found by E. Glazkova and A. Doronina on Kader Bog. It was noted, that besides typical plant species of raised bogs, there are a lot of species characteristic of swamps and transitory mires: *Drosera intermedia*, *Rhynchospora fusca* (L.) Ait., *Trichophorum alpinum* (L.) Pers., *Carex rostrata* Stokes, *C. pseudocyperus* L., *C. acuta* L., *C. diandra* Schrank, *Dactylorhiza fuchsii* (Druce) Soó, *Thelypteris palustris* Schott, *Phragmites australis* (Cav.) Trin. ex Steud. etc.; as well as some species, not typical of natural bog communities (e.g., *Eupatorium cannabinum*, *Platanthera bifolia* (L.) Rich.). Estonian mire scientists (Карофельд 1991, Karofeld 1994, Kaasik et al. 2001 etc.) carried out a long-term monitoring research of vegetation successions on raised bogs of the North-Eastern Estonia near local thermal electric power plants and came to the conclusion, that great changes in bog vegetation cover were caused by alkaline atmospheric pollution due to air transfer of oil shale fly ash. Russian mire researchers (Смагин & Галанина 2003, Рудаков & Галанина 2013) suppose, that changes in the vegetation cover of Kader Bog on Kurgalsky Peninsula also could be explained by air pollution from the biggest in the world thermal electric plants, located near Narva in NE Estonia. As a result of burning oil shale in NE Estonian electric power plants, oil shale fly ash is transferred by air masses to the neighboring regions and deposits on mire surface, causing their eutrophication (Karofeld 1994, Kaasik et al. 2001, Смагин & Галанина 2003, Karofeld et al. 2008, Рудаков & Галанина 2013, etc.). The oil shale fly ash is very rich in calcium (contains about 30 % CaO and several other alkaline oxides in addition) (Kaasik et al. 2001), with the result that calcium is delivered to the bogs instead of nitrogen and phosphorus, two last-named usually causing anthropogenic eutrophication of natural ecosystems. As consequence, the changes in bog vegetation have more natural character (Смагин & Галанина 2001). Estonian researchers (Karofeld 1994, Karofeld et al. 2008) have registered on the northeastern Estonian bogs under pressure of alkaline atmospheric pollution the following changes: a substantial increase in bog water pH and quantity of minerals and nutrients; almost disappeared *Sphagnum* species; a significant increase in the number of other moss and vascular plant species, especially calciphilous ones; a notable increase of the ash content in still surviving *Sphagnum*. Similar changes in vegetation cover were revealed by Russian scientists (Смагин & Галанина 2001; field observations by E. Glazkova in 2012) on bog Kader. *Sphagnum* species have practically disappeared, whereas the number of other moss and especially vascular plant species has increased significantly, many species of eutrophic and mesotrophic mires have appeared as well as some species not typical of natural bog cenoses. As a result, the bog of Kader has a specific appearance with a very rich and diverse species composition. However, the measurements of ecological indexes on Kader bog, carried out in the laboratory of geoecological monitoring of the Faculty of Geography and Geoecology of Saint-Petersburg State University in 2011, showed that pH in the bog water and the ash content in *Sphagnum* samples did not in general exceed the indexes values typical of natural raised bogs: pH = 3,6–3,8 is typical for ombrogenic bogs,

and the ash content in *Sphagnum* (2,3–3,2 %) is normal for almost all natural mires (Рудаков & Галанина 2013). In depressions of the bog Kader, a value of pH in the bog water is slightly higher (4,96 %) (Рудаков & Галанина 2013). For comparison, the ash content in *Sphagnum* of the northeastern Estonian bogs near local thermal electric power stations, measured in 1990s, was 6–8 % (Карофельд 1991). Thus, to confirm the hypothesis about possible impact of air pollution by the oil shale fly ash from the NE Estonian thermal electric plants, further additional investigations are required. But irrespective of factors caused a very specific character of Kader, this bog is undoubtedly unique in the Leningrad Region and deserves special protection and further research.

On the territory of the regional complex sanctuary "Kurgalsky", a great deal of rare and valuable plant communities have been revealed. During the field investigation in 2012 new data on the occurrence and species composition of the most valuable plant communities of the area were received and their list was compiled:

• Relict broad-leaved and spruce-broad-leaved forests on the slopes of Kurgalskoye plateau between villages Gakkovo and Kurgolovo as well as in "Kaibolovsky canyon" (a stream valley) with rich complex of typical nemoral species, including a great number of rare and protected in the Leningrad Region plants: *Allium ursinum* L., *Festuca altissima*, *Carex remota* L., *Neottia nidus-avis* (L.) Rich., *Dentaria bulbifera*, *Sanicula europaea*, *Corydalis intermedia* (L.) Merát. The first two species occur in the Leningrad Region only on Kurgalsky Peninsula.

• Coastal meadows and seashores, which are habitats of many rare and protected in the Leningrad Region species: *Allium schoenoprasum* L., *Carex mackenziei* V. Krecz., *C. glareosa* Wahl., *Blysmus rufus* (Huds.) Link, *Centaurium pulchellum* (Sw.) Druce, *C. littorale* (D. Turner) Gilmour, *Myrica gale* L., *Scutellaria hastifolia* L., *Tripolium vulgare* Nees, *Tripleurospermum maritimum* (L.) Koch, *Dactylorhiza baltica* (Klinge) Nevski, *Eleocharis parvula* (Roem. et Schult.) Bluff, Nees et Schauer, *Euphorbia palustris* L., *Luzula campestris*, *Potentilla crantzii*, *Ononis arvensis* L., *Senecio paludosus* L., *Puccinellia coarctata* Fern. et Weath. etc.

• Psammophytic grass communities and dune pine forests along Narva Bay coast, which are unique in the Leningrad Region. Occurring in these communities are such threatened species as *Carex arenaria* L., *Epipactis atrorubens*, *Pulsatilla pratensis*, *P. patens*, *Silene tatarica*, *Dianthus arenarius*, *Cypripedium calceolus.*

• Halophytic aquatic plant communities in shallow waters of the Gulf of Finland, which are habitats of some protected in the Leningrad Region species: *Najas marina* L., *Ruppia brachypus* J. Gay.

• Aquatic and semiaquatic plant communities of slightly salty (2–3‰) Lake Lipovskoe and canal Sileme, connecting the lake with the Gulf of Finland, with such rare and threatened in the Leningrad Region species as *Tripolium vulgare*, *Tillaea aquatica* L., *Alisma gramineum* Lej., *Ruppia brachypus*, *Najas marina.*

• Oligotrophic Lake Beloye with a specific complex of species, many of which are rare and protected in the Leningrad Region: *Isoëtes echinospora* Durieu, *I. lacustris* L., *Juncus supinus* Moench, *Lobelia dortmanna* L., *Littorella uniflora* (L.) Aschers.

• Bog Kader, rich of rare species: *Hammarbya paludosa* (L.) O. Kuntze, *Rhynchospora fusca*, *Drosera intermedia*, *Eupatorium cannabinum* etc.

• Dry meadows along the right bank of Rosson' River with *Armeria vulgaris, Jasione montana*, *Senecio jacobea*, *Campanula cervicaria* etc.

Due to the peculiar natural features of the territory and high safety of the ecosystems of Kurgalsky Peninsula, its flora contains a great number of threatened vascular plant species: 11 species are listed in the Red Data Book of Russian Federation (2008): *Armeria vulgaris*,

Cypripedium calceolus, *Dactylorhiza baltica*, *Isoëtes echinospora*, *I. lacustris*, *Littorella uniflora*, *Lobelia dortmanna*, *Myrica gale*, *Pulsatilla pratensis*, *Rhynchospora fusca*, *Tillaea aquatica*, and 50 species are included in the Red Data Book of Nature of the Leningrad Region (2000). Many of them, being very rare plants in the Leningrad Region, are common and abundant on Kurgalsky Peninsula and present typical components of its plant communities.

The monitoring investigations carried out in 2011–2012, have revealed that despite forest fires and cuttings on the territory of Kurgalsky Peninsula during last decades, the regional complex sanctuary "Kurgalsky" remains one of the most valuable, biologically diverse and rich protected areas of the Leningrad Region.

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