






DOI 10.23859/estr-230928

EDN ONZIH1

UDC 581.9

Article

Distribution, ecology and conservation of the *Potamogeton alpinus* Balb. (Potamogetonaceae Bercht. & J. Presl) on the southern border of range in European Russia

E.V. Ershkova^{1*} , I.G. Esina¹ , O.G. Grishutkin^{1, 2} ,
A.V. Chkalov³ 

¹ Joint Directorate of the Mordovia State Nature Reserve and National Park "Smolny", Krasnaya St. 30, Saransk, Republic of Mordovia, 430005 Russia

² Papanin Institute for Biology of Inland Waters, Russian Academy of Sciences, Borok 109, Nekouz District, Yaroslavl Oblast, 152742 Russia

³ Institute of Biology and Biomedicine, Nizhny Novgorod State University of N.I. Lobachevsky, prospect Gagarina 23, Nizhny Novgorod, 603022 Russia

*vargot@yandex.ru

Abstract. *Potamogeton alpinus* Balb. is a Holarctic arctoboreal aquatic plant species. In European Russia, it is a common species in the tundra and taiga. We have found that the southern border of the main part of the range of *P. alpinus* in the European Russia coincides with the southern border of the natural zone of mixed and broad-leaved forests. In the forest-steppe zone, there are single locations in the water bodies of large forests. In the eastern part of European Russia, the species is confined to the southern border of coniferous and mixed forests. Single locations of *P. alpinus* have also been recorded in lakes of the mountainous part of the Caucasus. In the north-east of European Russia, it grows on clay- and sandy-silty soils of lakes, oxbow lakes, ponds and slow-flowing rivers. It can be found in puddles and quarries, on damp pastures, in depressions between hummocks, in swamps, in streams, ditches, sometimes in fast rivers of mountains with a rocky bottom. To the south, it grows mainly in small rivers and streams, as well as associated reservoirs. It is also found in karst lakes, overgrown developed peatlands. It prefers sandy or sandy-silty grounds, with a low number of biogenic elements. It has been revealed that the main factors in the reduction of the number of species are pollution of reservoirs and watercourses, changes in hydrophysical parameters of water, overgrowing of reservoirs. It is necessary to conserve the populations of *P. alpinus* on the border of the range. Only some of the *P. alpinus* populations in the forest-steppe are located in the protected areas of European Russia. In order to conserve, it is need to include *P. alpinus* to the Red Lists of Tambov, Tula, Bryansk, Kursk, Voronezh, Samara, Orel, Smolensk, Kaluga, Ryazan regions; to monitor the state of the species' population and it habitats annually, search for new plant locations and take them under protection. Employees of environmental departments must constantly monitor the obligations of regional residents to comply with regulations of the Russian Federation in the field of environmental protection and provide measures for environmental education of the population.

Keywords: aquatic plants, vascular plants, range, rare plants, conservation

Funding. This research was performed within the scientific research "Studying of the rare species of the flora and fauna Mordovia State Nature Reserve and National Park "Smolny" and development of measures for their conservation and restoration"

Acknowledgements. The authors are grateful to our highly respected reviewers for their detailed review of the work and valuable comments. Also we are grateful to A.A. Bobrov (Ph.D in Biology), the head of the Laboratory of Systematics and Geography of Aquatic Plants IBIW RAS for the opportunity to work with the database of the Herbarium of the Papanin Institute of Biology Inland Waters RAS (IBIW).

ORCID:

E.V. Ershkova, <https://orcid.org/0000-0001-6998-3496>

I.G. Esina, <https://orcid.org/0000-0003-0410-2779>

O.G. Grishutkin, <https://orcid.org/0000-0003-1594-4461>

A.V. Chkalov, <https://orcid.org/0000-0002-3852-7663>

To cite this article: Ershkova, E.V. et al., 2025. Distribution, ecology and conservation of the *Potamogeton alpinus* Balb. (Potamogetonaceae Bercht. & J. Presl) on the southern border of range in European Russia. *Ecosystem Transformation* 8 (2), 115–136. <https://doi.org/10.23859/estr-230928>

Received: 28.09.2023

Accepted: 08.12.2023

Published online: 16.05.2025





DOI 10.23859/estr-230928

EDN ONZIH1

УДК 581.9

Научная статья

Распространение, экология и вопросы сохранения *Potamogeton alpinus* Balb. (Potamogetonaceae Bercht. & J. Presl) на южной границе ареала в Европейской России

Е.В. Ершкова^{1*} , И.Г. Есина¹ , О.Г. Гришуткин^{1, 2} ,
А.В. Чкалов³ 

¹ Объединенная дирекция Мордовского государственного природного заповедника и национального парка «Смольный», 430005, Россия, Республика Мордовия, г. Саранск, ул. Красная, д. 30

² Институт биологии внутренних вод им. И.Д. Папанина РАН, 152742, Россия, Ярославская обл., Некоузский р-н, пос. Борок, д. 109

³ Институт биологии и биомедицины Нижегородского государственного университета им. Н.И. Лобачевского, 603022, Россия, г. Нижний Новгород, пр. Гагарина, д. 23

Аннотация. В статье приводится обзор местонахождений *Potamogeton alpinus* Balb. на южной границе ареала в Европейской России. Основной ареал вида находится в природных зонах тундры и тайги. Нами установлено, что южная граница сплошного распространения *P. alpinus* в Европейской России совпадает с южной границей природной зоны смешанных и широколиственных лесов. В лесостепной зоне единичные местонахождения встречаются в водоемах крупных лесных массивов. На востоке Европейской России вид приурочен к южной границе хвойных и смешанных лесов. Единичные местонахождения *P. alpinus* отмечены также в озерах Кавказа. На северо-востоке Европейской России растет на глинисто- и песчано-илистых грунтах в разнообразных водоемах и водотоках. Южнее растет в основном в малых реках и ручьях и связанных с ними водоемах. Встречается также в карстовых озерах, зарастающих выработанных торфяниках. Предпочитает песчаные или песчано-илистые грунты с низким содержанием биогенных элементов. Выявлено, что основными факторами сокращения численности вида являются загрязнение водоемов и водотоков, их зарастание, изменение гидрофизических параметров воды. Сохранение популяций *P. alpinus* на границе ареала имеет большое значение для предотвращения сокращения площади ареала вида. В настоящее время только часть пограничных популяций находится на особо охраняемых природных территориях Европейской России. Для сохранения необходимо включить *P. alpinus* в Красные книги Тамбовской, Тульской, Брянской, Курской, Воронежской, Самарской, Орловской, Смоленской, Калужской, Рязанской областей, ежегодно проводить мониторинг состояния популяции вида и мест его обитания, искать новые местонахождения растений и организовывать их охрану.

Ключевые слова: водные растения, сосудистые растения, ареал, редкие растения, сохранение редких растений

Финансирование. Работа выполнена в рамках темы НИР ФГБУ «Заповедная Мордовия» «Изучение редких видов флоры и фауны на территории Мордовского заповедника и национального парка «Смольный» и разработка мер по их сохранению и восстановлению».

Благодарности. Авторы выражают благодарность заведующему Лабораторией систематики и географии водных растений ИБВВ РАН, к.б.н. А.А. Боброву за предоставленную возможность поработать с базой данных Гербария Института биологии внутренних вод РАН им. И.Д. Папанина (IBIW).

ORCID:

Е.В. Ершкова, <https://orcid.org/0000-0001-6998-3496>

И.Г. Есина, <https://orcid.org/0000-0003-0410-2779>

О.Г. Гришуткин, <https://orcid.org/0000-0003-1594-4461>

А.В. Чкалов, <https://orcid.org/0000-0002-3852-7663>

Для цитирования: Ершкова, Е.В. и др., 2025. Распространение, экология и вопросы сохранения *Potamogeton alpinus* Balb. (Potamogetonaceae Bercht. & J. Presl) на южной границе ареала в Европейской России. *Трансформация экосистем* 8 (2), 115–136. <https://doi.org/10.23859/estr-230928>

Поступила в редакцию: 28.09.2023

Принята к печати: 08.12.2023

Опубликована онлайн: 16.05.2025

Introduction

In modern conditions of active direct and indirect anthropogenic impact on ecosystems, there is a decrease in biodiversity (Le Roux et al., 2019). According to the Convention on the Conservation of Biological Diversity (1992), every species on our planet should be preserved, regardless of its economic value. The Convention on Biological Diversity provides for two types of biodiversity conservation – *in-situ* and *ex-situ*. *In-situ* conservation of species involves the conservation of ecosystems and natural habitats, as well as the maintenance and restoration of viable populations of species in their natural environment. Therefore, it is necessary to study species in connection with their habitats. In this article, we consider species morphology, range and ecological confinement of *Potamogeton alpinus* Balb. within the part of its distribution range in European Russia. This species undoubtedly deserves attention, as it is very sensitive to pollution (Borisova et al., 2014; Chukina et al., 2014; Søndergaard, 2009), and can serve as an indicator of the state of aquatic ecosystems (Pulido et al., 2015; Wani and Pandit, 2008).

On the published map¹ (<https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:603113-1#distributions>), the *P. alpinus* distribution range is mapped using the continuous range mapping method; the boundaries are drawn according to those of the botanical-geographical regions of the flora of Eastern Europe (Fedorov, 1979), and not actually. Therefore, there is no exact information about the southern border of the range of *P. alpinus* in European Russia. In the northern regions the species is common (Tsvelev, 2000). To the south, the occurrence of the species decreases. In a number of regions, *P. alpinus* is listed in the Red Data Books (Artemyeva et al., 2015; Chkalov, 2017; Gafurova, 2020; Nazirov, 2016; Nyankovsky, 2015; Silaeva, 2003, 2017; Zamotailov, 2012). But in most regions of European Russia, aquatic plants, including *P. alpinus*, are not included in the Red Data Books. Therefore, we have prepared a review of herbarium material and scientific research on the distribution and ecology of *P. alpinus* in European Russia. The aim of the review is to identify the *P. alpinus* distribution range border in European Russia; summarize the data on morphology, biology and ecology of *P. alpinus* in order to give recommendations for the conservation of the species.

Material and methods

We have summarized the literature data on morphology of the *P. alpinus* (Gubanov et al., 2002; Lisitsyna et al., 2010; Preston, 1995). Habitat of the *P. alpinus* is illustrated in the Figs. 1–3.

Southern locations of the *P. alpinus* in European Russia mapped using the service [earth.google.com](https://earth.google.com/web/) (<https://earth.google.com/web/>, accessed: 12.09.2023) (based on the data herbarium and publications). The main result of this study is a map (Fig. 4), which illustrates in detail the southern border of the species' range in European Russia. It largely clarifies the now published map¹. The map with south regional locations *P. alpinus* has important biogeographical significance. It will become the basis for conservation measures for *P. alpinus* in the regions of European Russia.

The article presents a review of the herbarium material^{2, 3} (GMU, HMNR, IBIW, LE, NNSU, MHA, MW, PKM, UPSU and scientific research (including those conducted by the authors of this article) devoted to the distribution and ecology of *P. alpinus* in European Russia. Also we analyzed currently rarity status of *P. alpinus* in European Russia based on the data from regional flora synopses and Red Data Books.

¹ POWO, 2025. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. *Potamogeton alpinus*. Web page. URL: <https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:603113-1#distributions> (accessed: 29.11.2023).

² Index Herbariorum. New York Botanical Garden Steery Herbarium, 2025. Web page. URL: <http://sweetgum.nybg.org/science/ih> (accessed: 14.02.2025).

³ Depository of Live Systems. *Potamogeton alpinus*, 2025. Web page. URL: <https://plant.depo.msu.ru/open/public/search?searchBy=any&queryString=Potamogeton%20alpinus> (accessed: 12.09.2023).

Results and discussion

Description

Potamogeton alpinus (Figs. 1, 2) is a perennial aquatic plant known with a length of stem 5–200 cm. A thin strongly branched rhizome is formed in the bottom sediments. The stem is not branched, rounded in cross-section, often reddish in the upper part. It has sessile lance-shaped submerged leaves that are typically 6–25 cm long and 1–3.5 cm wide. Plants with leathery, strongly narrowed submerged leaves belong to the subspecies *P. alpinus* subsp. *tenuifolius* (Raf.) Hultén, which is found in North European Russia and Asian Russia (Baikov, 2012) and North America⁴. The floating leaves are leathery, obovate or oblong, with a clear network of veins. Stipules fall off early. Stems and leaves often have a reddish tint. The flowers are small, inconspicuous, collected in an inflorescence called a thick spike. The fruit (Fig. 3) is a nut 2.5–3 mm long with a sharp keel and a short spout (Gubanov et al., 2002; Preston, 1995). In European Russia, there are hybrids of *P. alpinus* with other species of genus *Potamogeton*, morphologically similar to the parent species: *P. alpinus* × *P. crispus* (= *P. × olivaceus* Baagöy ex G. Fish.), *P. alpinus* × *P. gramineus* (= *P. × nericius* Hagström), *P. alpinus* × *P. nodosus* (= *P. × subobtusus* Hagström), *P. alpinus* × *P. praelongus* (= *P. × griffithii* A. Bennett), *P. alpinus* × *P. lucens* (= *P. × nerviger* Wölg.) and *P. alpinus* × *P. perfoliatus* (= *P. × prussicus* Hagström) (Flora of North America⁴; Papchenkov, 2007; Preston, 1995; Zalewska-Galosz et al., 2018;), *P. alpinus* × *P. natans* (= *P. × exilis* Z. Kaplan et Uotila) (Bobrov and Chemeris, 2006; Kaplan and Uotila, 2011).

Distribution

Potamogeton alpinus is a Holarctic arctoboreal species. It is distributed in the Arctic, Scandinavia (Fedorov, 1979; MW, IBIW, LE; Tolmachev, 1974), Central (Drozdowski et al., 2015; Gerdol and Bragazza, 2001), Atlantic (Pulido et al., 2015) and Eastern (Fedorov, 1979) Europe, Caucasus (mountainous areas) (Akotov, 1986; Barsegyan, 1966), Western and Eastern Siberia, Far East (Baikov, 2012), Central Asia, China (mountainous areas), Japan (Ohwi, 1965; Wani and Pandit, 2008; Zhengyi and Raven, 2012), North America⁴. The area of its continuous range in the latitudinal direction is the boreal zone of coniferous forests and the Arctic tundra zone of the Northern Hemisphere (Fedorov, 1979; Flora of North America⁴; Baikov, 2012). It becomes rare in the zones of broad-leaved forests and forest-steppe (Gafurova, 2014; Lachacz and Pisarek, 2010; Mesters, 1995; Plaksina, 2001; Rakov et al., 2014; Reshetnikova et al., 2005; Saksonov and Senator, 2012; Seregin, 2012; Shcherbakov, 1990, 1999, 2010; Shcherbakov et al., 2018; Silaeva et al., 2010a; Sukhorukov, 2010). It is rarely found in mountainous areas of Europe (the Alps (Drozdowski et al., 2015; Gerdol and Bragazza, 2001), the Pyrenees (Pulido et al., 2015), the Carpathians (Kochjarova et al., 2010; Zeko et al., 2020), the Caucasus (Akotov, 1986; Barsegyan, 1966)), Asia (upland areas of Asian Russia, Kazakhstan, Afghanistan, Uzbekistan (Fedorov, 1979), China (Zhengyi and Raven, 2012), Pakistan, India, Myanmar (Wani and Pandit, 2008), Korea (Shin & Choi, 1998)), Japan (Hokkaido Island) (Ohwi, 1965) and North America⁴ at an altitude of 400–2500 m above sea level, where conditions similar to taiga conditions are formed. The indication in the “Flora of Iran” is based on an erroneous identification of the herbarium material (Shabnam et al., 2017).

In European Russia, the northernmost locations are found in the reservoirs and watercourses of the Kola Peninsula in the Paz River (Patsoyoki) and its tributaries, the vicinity of Nickel settlement (IBIW) (Fig. 4, point 01), in the Voryema River, 26 km northwest of Pechenga (IBIW; Kravchenko, 2020) (Fig. 4, point 02), the vicinity of Snezhnogorsk (IBIW) (Fig. 4, point 03) and 10 km northwest of the village of Dalniye Zelentsy of the Murmansk Region (IBIW) (Fig. 4, point 04), at the mouth of the Pechora River (MW) (Fig. 4, point 05).

It is a common species in Karelia (Chernov and Chernova, 1949; IBIW; Kravchenko, 2020), Murmansk, Vologda, Kostroma (Bobrov and Chemeris, 2008; IBIW, MW;), Leningrad, Pskov, Novgorod (LE; Tzvelev, 2000) regions, in the north-east of Russia (Arkhangelsk Region, Komi Republic, Nenets Autonomous Okrug) (Tetryuk, 2012; Tolmachev, 1974). It is much less common in the west of the riverbed of Volga, in Smolensk, Tver, Ivanovo (Maevsky, 2014), Vladimir (Seregin, 2012), Moscow (Shcherbakov, 1990), Ryazan (Kazakova, 2004) regions, as well as in the Udmurt Republic (Baranova et al., 1992; Kapitonova, 2019).

⁴ Flora of North America. *Potamogeton alpinus*. Web page. URL: http://floranorthamerica.org/Potamogeton_alpinus (accessed: 12.09.2023).

We have identified the southern border of the distribution range of *Potamogeton alpinus* in the plain part of European Russia based on the above-mentioned herbarium collections and literary review (Fig. 4). Its description is given below.

Smolensk Region

1) Demidovsky District, 3 km and 4 km south-east of Lake Baklanovskoye, in a river with a sandy and gravelly bottom flowing out of the lake; depth of about 0.5–1.0 m, fast stream course, 27.07.2000, N.M. Reshetnikova (MW, IBIW);

2) Demidovsky District, 8 km south of the village of Podosinki, in the village of Nizy, dam on the stream, 11.07.2011, N.M. Reshetnikova (MW);

3) Dukhovshchinsky District, 6 km south of the village of Ribshevo, in the Gobza River, depth about 0.5 m, fast stream course, 25.08.2001, N.M. Reshetnikova (IBIW).

Kaluga Region

4) Yukhonsky District, 5 km south-east of the village of Alexandrovka, National Park «Ugra», the Sobzha River, about 4 km above its mouth, rocky bottom, shallow depth, 12.08.2004, N.M. Reshetnikova (IBIW);

5) Iznoskovsky District, vicinity of the village of Mikhaly, the Shanya River, in the water and near the shore on wet clay, 24.06.2007, A.V. Krylov, E.L. Konstantinov (MW).

Moscow Region

6) Serpukhov District, near the village of Styakovo-2 and the village of Rudakovo, 12.08.1991, A. Skvortsov (MW);

7) Shatura District, 1 km north of the village of Pustosh, reclamation ditch, 19.07.1987, A. Shcherbakov, S. Daushkevich (MW).

Ryazan Region

8) Spassky District, Oka Biosphere State Nature Reserve, in Lakes Sievers, Ukhanskoye, oxbow Lake Sundritsa, the Chernaya River (Kazakova, 2004);

9) Klepikovskiy District, 2 km south of the village of Malakhovo, the Kursha River, boggy backwater, 25.06.1968, V. Tikhomirov, V. Ksenofontova (also gathered here in 1992; MW);

10) Kasimov District, near village of Kondrokov, overgrown oxbow lake of the Syntul River, 25.08.1975, V. Tikhomirov (Kazakova, 2004; MW).

Nizhny Novgorod Region

11) Ardatovskiy District, 3 km north of the village of Mukhtolovo, in Lake (karst) Nuxenskoye, 4.08.2014, E. Vargot (GMU, HMNR; Vargot and Ivashina, 2014);

12) Arzamas District, the vicinity of the Pustyn', the northeastern outskirts of the Svyatoye Lake, the oxbow lake of the Pechenzhui Stream, on the sandy bottom, 27.07.2015, O. Biryukova (IBIW, NNSU);

13) Pavlovskiy District, Lake Krasnoye, near south bank of lake, 17.07.1973, T. Deeva, E. Lukina, L. Sykchina (NNSU);

14) Nizhny Noivgorod, Moskovskiy District, in the water of a reclamation canal in the vicinity of the settlement of Torfopredriyatie, 11.06.1991, I.L. Mininon (IBIW, NNSU);

15) Borskiy District, Kerzhenskiy Reserve, quarter 74, 30 m west of the road to Lykovo, oxbow lake of the Rustaychik River, 25.05.1996, S.P. Urbanavichute (herbarium of the Kerzhenskiy Reserve);

16) Vorotynskiy District, village of Kuzmiyar, Lake Kuzmiyar, east coast, in shallow water, 6.09.2018, V. Vishnyakov (NNSU).

Chuvash Republic

17) Cheboksary Reservoir, the Parat River, the estuarine area flooded with water (IBIW; Papchenkov, 1993).

Republic of Mari El

18) Kilemarskiy District, near the village of Sinyushino, Cheboksary Reservoir, inter-island shallow waters, 27.07.2006, V.G. Papchenkov;

19) National Park «Mari Chodra», in the the Yushut River and a small lake among the swampy forest, August 1989 and 1990, V.G. Papchenkov;

20) Mari ASSR, Kuibyshev Reservoir (left bank, bay 2 km below the Ilet River, at a depth of 80 cm, 18.07.1965, V.A. Ekzertsev (all – IBIW).

Republic of Tatarstan

Known from the finds of the early twentieth century:

21) Zelenodolsk District, near the villages of Raif and Bishnya; Kazan;

22) Pestrechinskiy District, village of Kulayevo (Nazirov, 2016).



Fig. 1. *Potamogeton alpinus* in Lake Nuksenskoe (Russia, Nizhniy Novgorod Region, Ardatovskiy District, near Mukhtolovo Settlement).

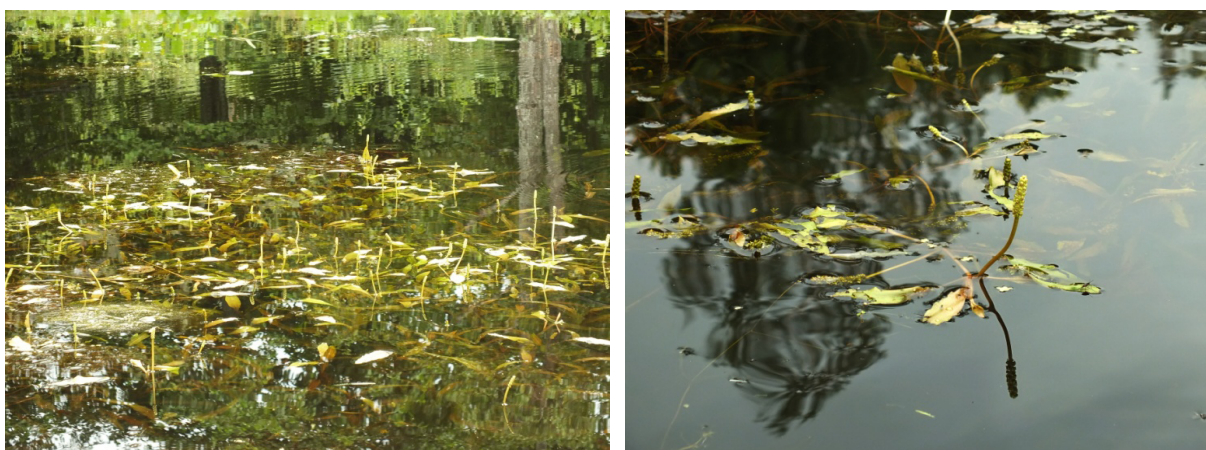


Fig. 2. *Potamogeton alpinus* in the Pushta River (Russia, Republic of Mordovia, Mordovia State Nature Reserve).

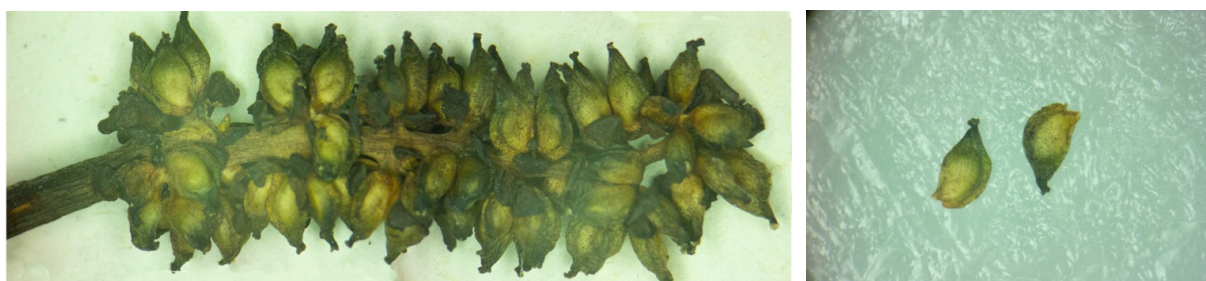


Fig. 3. Fruits of the *Potamogeton alpinus*.

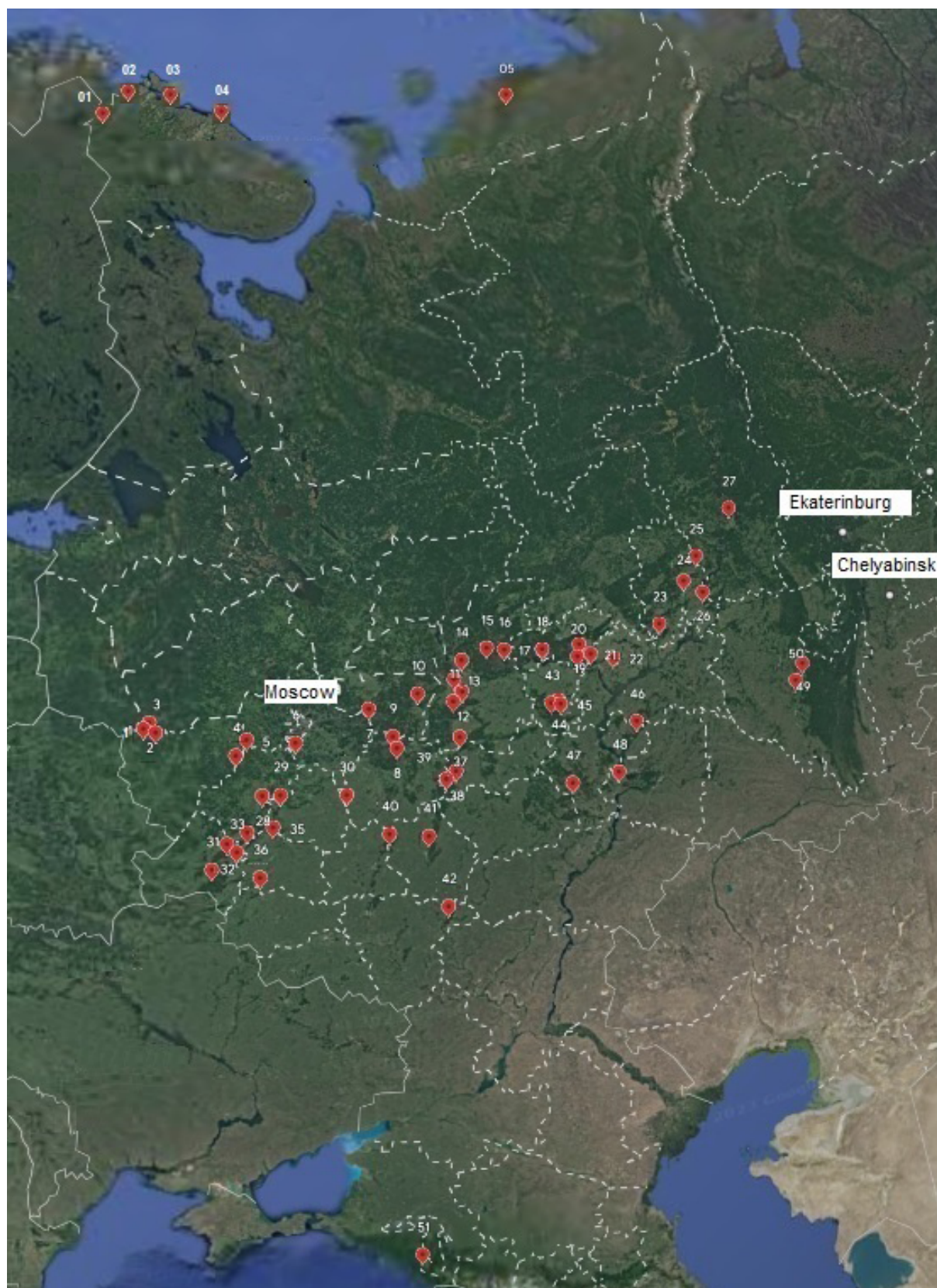


Fig. 4. Locations of *Potamogeton alpinus* Balb. at the southern border of species distribution range in European Russia (the numbers of points correspond to the numbers of locations in the text of the article).

Udmurt Republic

- 23) Kiznersky District, village of Bemyzh;
24) Izhevsk; 25) Sharkansky District, near the village of Karsashchur;
26) Sarapul, village of Simonikha (Baranova et al., 1992).

Perm Krai

- 27) the riverbed of the Kama River near Perm (Ovesnov et al., 2007).
South of the line Smolensk – Kaluga – Ryazan – Arzamas – Cheboksary – Kazan – Sarapul – Perm, there are isolated locations, including ones in the Caucasus (Fig. 4).

Kaluga Region

- 28) Kozel'sky District, in the Sosenska River on the right bank of the Zhizdra River, S.R. Mayorov (Reshetnikova et al., 2005).

Tula Region

- 29) Tula Province, Tula District (now Yasnogorsky District), in a swamp near the village of Melekhovka, 5.07.1899, N. Tsinger (LE, MW, MHA, Shcherbakov, 1999; TA).

Ryazan Region

- 30) Skopinsky District, village of Klekotky, on the Tabola River, to the village of Perebelka, 14.08.1925, V. Arsenyev (MW).

Bryansk Region

- 31) Navlinsky District, settlement of Navlya, N.N. Panasenko (<https://www.inaturalist.org/observations/36678897>, accessed: 12.09.2023).

- 32) Bryansk Forest State Nature Reserve (Shcherbakov et al., 2018);

Oryol Region

- 33) Shablykinsky District, oxbow lake of the Navlya River in the village of Glybochky, 25.07.1983, V.I. Radygina (OHHI; Shcherbakov, 2010);

- 34) Khotynetsky District, 1.5 km west of the office of the Lgovsky Forestry, in the water of the forest pond, 19.07.1998, A.V. Shcherbakov et al. (MW; Shcherbakov, 2010);

- 35) Bolkhovskiy District, 3 km west-northwest of the village of Grigorovo, under the eastern shore of the pond, 26.07.2007, A. Shcherbakov, N. Chaadaeva (IBIW, MW, MOSP, OHHI; Shcherbakov, 2010).

Kursk Region

- 36) Zheleznogorsk District, village of Bolshebobrovo, the Bely Nemed River, shore, 23.07.2011, N. Dektyarev, A. Poluyanov (IBIW).

Republic of Mordovia

- 37) Temnikovskiy District, Mordovia State Nature Reserve, in the Pushta River and in the Satis River (GMU, HMNR; Silaeva et al., 2013, 2014, 2019); Tengushevskiy District, Barashevskiy Forestry, in the forest stream, 13.07.1970, Katkova, Hamburger, Vishnyakova (GMU; Silaeva et al., 2010a, 2019);

- 38) in a forest stream near the village of Zubova Polyana (Litvinov, 1886);

- 39) Zubovo-Polyanskiy District, 3 km south-east of the railway station of Izvest, in a peat quarry at a depth of 1.2 m, 12.08.1999, S. Mayorov, T. Silaeva, A. Shcherbakov; quarter 79 of the Izvestkovskoye forestry, 1.5 km south-eastern of the settlement of Izvest', bog, 25.07.2010, A. Ageeva, A. Khapugin (GMU, MW; Silaeva et al., 2010b, 2019).

Tambov Region

- 40) Pervomaiskiy District, Khabotovski Forestry, 19.07.1959, Bagno (Sukhorukov, 2010; VOR);

- 41) Tambov Province, pond in the village of Tulinovka, 02.07.1922, E.K. Kardo-Sysoeva (LE; Sukhorukov, 2010).

Voronezh Region

- 42) Novokhoperskiy District, Khoperskiy State Reserve, about 12 km north of the village of Varvarino, Lake Lebyazhye (quarters 47–48), 27.07.1987, E.V. Pechenyuk (IBIW).

Chuvash Republic

- 43) Yadrinskiy Province, Koshlaush Forestry, the Kirya River, 08.08.1927, N. Ermoshkina (Gafurova, 2014);

- 44) Ibresinskiy District, at the village of Malye Karmaly, upper reaches of the Kubnya River, 15.06.1987, 28.06.1987, V. Papchenkov (IBIW; Papchenkov, 1993);

- 45) Shemurshinskiy District, National Park "Chavash warmane", village of Mullinaya, in the stream at the bottom of a small ravine Abamsa in a pine forest, 1.07.2006, E. Petrova (Gafurova, 2020; Petrova and Utemova, 2008).

Ulyanovsk Region

46) Kuibyshev Reservoir, upper reaches of the Cheremshan River, 24.07. 1963, V.A. Ekzertsev (IBIW);

47) Nikolaevsky District, in suffusion Lake Beloye (UPSU; Artemyeva, 2015).

Samara Region

48) Shigonsky District, the Usa River in the area between the village of Bichevnoy and the village of Bayderyakovo, 24.06.2009, T.I. Plaksina, L.V. Kalashnikova, O.V. Kalashnikova (Kalashnikova, 2013); was found rarely in rivers, streams, small lakes along the Volga, on the Belaya River (Sterlitamak) and on the Syrt (the watershed of the Bolshaya and Malaya Churana rivers) (Plaksina, 2001).

The species found in Penza (PKM), has not yet been found in Saratov, Volgograd and Astrakhan regions (Maevsky, 2014).

In the eastern part of European Russia, the range boundary of *P. alpinus* probably coincides with the distribution boundary of coniferous and mixed forests.

There are also isolated locations found in the south of the Kama:

Republic of Bashkortostan

49) in the Zilim River at the mouth of the Avui River;

50) in the Usolka River near the Krasnousolsky plant (Alekseev et al., 1988).

The southernmost location of the species in European Russia is known in the Republic of Adygea.

Republic of Adygea:

51) Maikop District, Mount Gyuzeripl in the upper reaches of the Belaya River (1700–1850 m above sea level) (Akotov, 1986; Zamotailov, 2012).

Thus, the southern border of the main part of the distribution range of *P. alpinus* in the plain part of European Russia coincides with the southern border of the natural zone of mixed and broad-leaved forests, whose the extreme boundaries include the woodlands of the Bryansk, Smolensk, Oryol, Kaluga regions, the lowlands of the Moscow, Ryazan, Nizhny Novgorod regions, Mari-El, Chuvashia and Tatarstan. In the forest-steppe zone, there are single locations in the water bodies of large forests (Oksko-Tsninsky, Sursky), mainly on water-glacial and paleogene sandy and sandy loam deposits in the Ulyanovsk, Tambov, Samara, Voronezh, Kursk regions, Mordovia and Tatarstan. In the eastern part of European Russia, the species is confined to the southern border of coniferous and mixed forests of Udmurtia and Perm Krai, as well as the foothills of the Urals in Bashkiria. Single locations of *P. alpinus* have also been recorded in lakes of the mountainous part of the Caucasus.

Ecology and biology

In the north-east of Russia, one of the most common species of the genus *Potamogeton* forms dense thickets near the shores on the clay- and sandy-muddy bottom of lakes, oxbow lakes, ponds and slow-flowing rivers at a depth of 0.1–0.4 m. It also grows in puddles and quarries, on damp pastures, in depressions between hummocks, in swamps, in streams, ditches, sometimes inhabits the rocky bottom of fast mountain rivers (Tetryuk, 2012; Tolmachev, 1974;). In other places of the flat part of the range, it grows mainly in small rivers and streams, as well as associated reservoirs (upper ponds, channels between lakes, estuarine parts of reservoirs) (IBIW, GMU, HMNR, Maevsky, 2014; MW, PKM, LE, NNSU; Shcherbakov, 1990; Tsvelev, 2000). It is also found in karst lakes, overgrown quarries of developed peat bogs. *P. alpinus* grows in the Caucasus mountains at an altitude of 1700–1850 m a.s.l. in shallow, well-heated reservoirs with a saucer-shaped bed, where the salinity of water is 83–532 mg/l, pH 7.13–8.56, the content of ammonium and nitrate nitrogen – 0.324–0.728 mg/l, mineral phosphorus – 0.005–0.032mg/l (Akotov, 1986). There are other suitable habitats in the Caucasus (Prokin et al., 2019). On the southern border of the range, in one location – Lake (karst) Nuxenskoye in the Nizhny Novgorod Region, the water was hard, of the bicarbonate type, its mineralization on the surface was 127.3 mg/dm³, in the bottom layer 544.8 mg/dm³, pH – from 6.5 to 6.9 (Bayanov et al., 2014). *P. alpinus* does not tolerate water pollution with heavy metals and biogenic pollutants (Borisova et al., 2014; Chukina et al., 2014; Søndergaard, 2009). It prefers sandy or sandy-silty soils with a low content of biogenic elements (Pulido et al., 2015; Shcherbakov, 1990; Wani and Pandit, 2008). The species does not tolerate an increase in the concentration of suspended particles, excessive intake of nutrients, changes in hydrophysical parameters of water (for example, total electrical conductivity) (Mesters, 1995; Søndergaard et al., 2010; Wani and Pandit, 2008).

Growth of *P. alpinus* begins when water temperature is 5.4 ± 0.16 °C (Robionek et al., 2018). In reservoirs and watercourses, it shows different morphological signs (Robionek et al., 2015): 1) in

stagnant waters, floating leaves are poorly represented or completely absent (as, for example, in Lake Nuxenskoye, Nizhny Novgorod Region (Vargot and Ivashina, 2014)); 2) a large number of leathery elongated leaves floating on the water are formed on the current, which ensures the buoyancy of the entire shoot and the maintenance of peduncles above water. It blooms in June – July, bears fruit in July–August. The inflorescence spadix protrudes from the water during flowering, as the plants are pollinated by the wind. *P. alpinus* reproduces and spreads by seeds and vegetative propagules (Brux et al., 1987, 1988; Gubanov et al., 2002). There is evidence that *P. alpinus* seeds germinate better after passing through the digestive system of fish (Boedeltje et al., 2016).

Species conservation issues in European Russia

As it was shown above, *P. alpinus* is rare in European Russia outside the forest zone. In the forest-steppe of the European Russia and natural zones to the south the anthropogenic load on water bodies increases. Therefore, the ecological amplitude of *P. alpinus* narrows here, the species is confined to small rivers, ponds built on them, forest streams, karst lakes, overgrown peat pits, where pollution and eutrophication are minimal. Currently, the species has apparently disappeared in the Belgorod and Lipetsk regions (Maevsky, 2014). It is listed in the Red Data Books of Yaroslavl (Nyankovsky, 2015) (category 3 “Rare species”), Ulyanovsk (Artemyeva et al., 2015) (category 2 “Vulnerable species”) regions, the republics of Adygea (Zamotailov, 2012) (category 1 “Endangered species”), Tatarstan (Nazirov, 2016) (category 1 “Endangered species”), Mordovia (Silaeva, 2017) (category 1 “Endangered species”), Chuvash Republic (Gafurova, 2020) (category 3 “Rare species”). Outside of Russia, the species is protected in Poland (IUCN category (2016) – VU, taxon of high risk of extinction in the wild) (Kazmierczakowa, 2016). In the states of New Hampshire and New York (USA), *P. alpinus* is threatened; in New Jersey and Pennsylvania it is recognized as an endangered species⁵.

Based on our own observations and literature data, we have found that the main factors of the species population decline are pollution of reservoirs and watercourses (Borisova et al., 2014; Chukina et al., 2014; Søndergaard, 2009), eutrophication and overgrowth of water bodies (Pulido et al., 2015; Silaeva et al., 2013, 2014; Wani and Pandit, 2008). It is very important to conserve populations of *P. alpinus* on the border of the range (Fig. 4) in order to prevent the reduction of species range (Kestemont, 2019). We recommend to include *P. alpinus* to the Red Lists of region in the southern border of distribution range (Table 1) based on an analysis of the number of locations, their age and habitats.

Thus, if our recommendations are implemented, all known locations of *P. alpinus* in the southern border of range in European Russia will be taken under protection. We have previously recommended to include *P. alpinus* in the Red Data Books of the Ulyanovsk, Nizhny Novgorod regions, and the Chuvash Republic. The Red Data Book commissions of these regions took into account our research data, and the recommendations for *P. alpinus* were implemented (Artemyeva et al., 2015; Chkalov, 2017; Gafurova, 2020). Based on the collected data, we conclude that the species was undeservedly excluded from the Red Data Book of the Voronezh Region (2018). On the territory of the Voronezh, Kursk and Samara regions, it is necessary to conduct special studies on the search and survey of *P. alpinus* populations and organize their proper protection. Another necessary measure for the conservation of *P. alpinus* populations is the inclusion of water bodies – the species’ habitats – in existing protected areas of federal or regional significance or the organization of new protected areas in *P. alpinus* locations. Currently, only a part of the border populations is under protection (in the National Parks “Smolenskoye Poozerye”, “Ugra”, “Chavash varmane”, “Mari Chodra”, the Bryansk Forest Reserve, Kerzhensky, Oksky, Mordovia Reserves, on the territory of the nature monuments “Pustynskie Lakes” of the Nizhny Novgorod region and “Belye Lakes” of the Ulyanovsk Region).

In addition, we recommend organizing annual monitoring of the state of species populations in the regions should be carried out by botanists, employees of environmental departments or volunteers in order to conservation of *P. alpinus* on the territory of European Russia. It is also necessary to constantly update data on the aquatic flora of the regions, search for new habitats of species and take them under protection. Employees of regional environmental departments must constantly monitor the obligations of regional residents to comply with regulations of the Russian Federation in the field of environmental protection and provide measures for environmental education of the population.

⁵ iNaturalist, 2025. Web page. URL: <https://www.inaturalist.org/taxa/78704-Potamogeton-alpinus> (accessed: 14.02.2025).

Table 1. Recommendations for inclusion of *Potamogeton alpinus* to the Red Data Books of regions of European Russia.

Region	Категория редкости (статус угрозы) (по критериям: Гельтман, 2024)	Reasons for adding to the Red List of region
Tambov Oblast	0 (CR)	two locations in the region not found in the last 50 years
Tula Oblast	0 (CR)	one location in the region not found more than 100 years ago
Bryansk Oblast	1 (EN)	two present locations in the region with a low number of plants on the southern border of range
Kursk Oblast	1 (EN)	one present location in the region with a low number of plants on the southern border of range
Voronezh Oblast	1 (EN)	one present location in the region with a low number of plants on the southern border of range
Samara Oblast	1 (EN)	one present location in the region with a low number of plants on the southern border of range
Orel Oblast	3 (NT)	three present locations in the region with a low number of plants on the southern border of range
Smolensk Oblast	3 (NT)	three present locations in the region with a low number of plants on the southern border of range
Kaluga Oblast	1 (EN)	one present location in the region with a low number of plants on the southern border of range
Moscow Oblast	2 (NT)	two locations from the end of the 20th century with a small number of plants on the border of the natural zones of taiga, broad-leaved forests and forest-steppe zones
Ryazan Oblast	2 (NT)	four locations (three have not been confirmed for more than 50 years, one was confirmed at the end of the 20th century) on the border of the natural zones taiga, broad-leaved forests and forest-steppe zones

References

- Agafonov, V.A. (ed.), 2018. Krasnaya kniga Voronezhskoi oblasti. Tom 1: Rasteniya. Lishayniki. Griby [Red Data Book of the Voronezh Region. Vol. 1: Plants. Lichens. Mushrooms]. MODEK, Voronezh, Russia, 472 p. (In Russian).
- Akatov, V.V., 1986. Osnovnye tendentsii v zarastanii vysokogornykh ozer Severo-Zapadnogo Kavkaza [Main trends in overgrows of Alpine lakes in the North-Western Caucasus]. *Botanicheskiy Zhurnal [Botanical Journal]* **71** (6), 798–804. (In Russian).
- Alekseev, A.E., Alekseev, E.B., Gabbasov, K.K., Gorchyakovskiy, P.L., Gubanov, I.A. et al., 1988. Opredelitel' vysshikh rastenyi Bashkirskoi ASSR [Manual of higher plants of the Bashkir ASSR]. Nauka, Moscow, USSR, 316 p. (In Russian).
- Artem'eva, E.A., Maslennikov, A.V., Korepov, M.V. (eds.), 2015. Krasnaya kniga Ul'yanovskoi oblasti [Red Data Book of the Ulyanovsk Region]. Buki Vedi, Moscow, Russia, 550 p. (In Russian).
- Baikov, K.S. (ed.), 2012. Konspekt flory Aziatskoi Rossii: sosudistye rasteniya [Synopsis of the flora of Asian Russia: Vascular plants]. Publishing house of the Siberian Branch of Russian Academy of Science, Novosibirsk, Russia, 640 p. (In Russian).
- Baranova, O.G., Il'minskikh, N.G., Puzyrev, A.N., Tuganaev, V.V., 1992. Konspekt flory Udmurtii [Synopsis of flora of the Udmurtia]. Publishing house of the Udmurt University, Izhevsk, Russia, 140 p. (In Russian).
- Barseghyan, A.M., 1966. K poznaniyu vodno-bolotnoi flory i rastitel'nosti gornykh raionov Armenii [To the knowledge of wetland flora and vegetation of the mountainous regions of Armenia]. *Botanicheskiy Zhurnal [Botanical Journal]* **51** (9), 1330–1337. (In Russian).
- Bayanov, N.G., Krivdina, T.V., Loginov, V.V., 2014. Ozera yugo-zapadnoi chasti Nizhegorodskoi oblasti [Lakes in the south-west of the Nizhny Novgorod Region]. *Trudy gosudarstvennogo prirodnogo zapovednika imeni P.G. Smidovicha [Proceedings of the Mordovia State Nature Reserve]* **12**, 241–263. (In Russian).
- Bobrov, A.A., Chemeris, E.V., 2006. *Potamogeton* × *vepsicus* (Potamogetonaceae) – noviy gibrigid rdestov iz Verkhnego Povolzh'ya [*Potamogeton* × *vepsicus* (Potamogetonaceae) – a new hybrid Pondweed from the Upper Volga Region]. *Botanicheskiy Zhurnal [Botanical Journal]* **91** (1), 71–84. (In Russian).
- Bobrov, A.A., Chemeris, E.V., 2008. Rechnye rdesty (*Potamogeton*, Potamogetonaceae) na severe evropeiskoi Rossii [River pondweed (*Potamogeton*, Potamogetonaceae) in the north of European Russia]. *Lektsii i materialy dokladov Vserossiiskoi shkoly-konferentsii "Ekosistemy malykh rek: bioraznoobrazie, biologiya, okhrana" [Lectures and materials of reports of the All-Russian School-Conference "Ecosystems of small rivers: biodiversity, biology, conservation"]*, Borok, 18–21 November 2008. Yaroslavl Printing House, Yaroslavl, Russia, 79–82. (In Russian).
- Boedeltje, G., Jongejans, E., Spanings, T., Verberk, W.C.E.P., 2016. Effect of gut passage in fish on the germination speed of aquatic and riparian plants. *Aquatic Botany* **132**, 12–16. <https://doi.org/10.1016/j.aquabot.2016.03.004>
- Borisova, G., Chukina, N., Maleva, M., Majeti, P., 2014. *Ceratophyllum demersum* L. and *Potamogeton alpinus* Balb. from Iset' River, Ural Region, Russia differ in adaptive strategies to heavy metals exposure – a comparative study. *International Journal of Phytoremediation* **16** (6), 621–33. <https://doi.org/10.1080/15226514.2013.803022>
- Brux, H., Todeskino, D., Wiegand, G., 1987. Growth and reproduction of *Potamogeton alpinus* balbis growing in disturbed habitats. *Archiv fur hydrobiologie. Beihefte* **27**, 115–127.

- Brux, H., Herr, W., Todeskino, D., Wiegleb, G., 1988. A study on structure and dynamics of communities with *Potamogeton alpinus* Balbis in north German waters. *Aquatic Botany* **32**, 23–44.
- Chernov, V.N., Chernova, E.P., 1949. Flora ozer Karelii [Flora of lakes of Karelia]. State Publishing House of the Karelo-Finnish SSR, Petrozavodsk, USSR, 162 p. (In Russian).
- Chkalov, A.V. (ed.), 2017. Krasnaya kniga Nizhegorodskoi oblasti. Vtoroe izdanie, pererabotannoe i dopolnennoe. Tom 2: sosudistye rasteniya, mokhoobraznye, vodorosli, lishainiki, griby [Red Data Book of the Nizhny Novgorod Region. 2nd edition, corrected and supplemented. Vol. 2: Vascular plants, Bryophytes, Algae, Lichens, Fungi]. ROST-DOAFK, Kaliningrad, Russia, 304 p. (In Russian).
- Chukina, N., Borisova, G., Maleva, M., 2014. Antioxidant status of hydrophytes with different accumulative ability illustrated by *Potamogeton alpinus* Balb and *Batrachium trichophyllum* (Chaix) Bosch. *Inland Water Biology* **7** (4), 401–405. <https://doi.org/10.1134/S1995082914040038>
- Convention on Biological Diversity, 1992. United Nations, 28 p.
- Drozdowski, I., Mrkvicka, A.C., Mrkvicka, G.F., 2015. Die Wasserpflanzenflora stehender Gewässer des steirischen Salzkammergutes (Österreich) sowie Anmerkungen zum Vorkommen von Großmuscheln, Krebsen und Amphibien. *Biodiversität und Naturschutz in Ostösterreich – BCBEA* **1/2**, 233–251 (In German).
- Fedorov, A.A. (ed.), 1979. Flora Evropeiskoi chasti SSSR. Tom IV [Flora of European part of the USSR. Vol. IV]. Nauka, Leningrad, USSR, 355 p. (In Russian).
- Gafurova, M.M., 2014. Sosudistye rasteniya Chuvashskoi Respubliki. Tom III [Vascular plants of the Chuvash Republic. Flora of the Volga Basin. Vol. III]. Cassandra, Togliatti, Russia, 333 p. (In Russian).
- Gafurova, M.M. (ed.), 2020. Krasnaya kniga Chuvashskoi Respubliki. Tom 1. Chast' 1: Redkie vidy rastenyi i gribov. Izdanie 2-e [Red Data Book of the Chuvash Republic. Volume 1. Part 1: Rare species of plants and fungi. Edition 2nd]. Buki Vedi, Moscow, Russia, 332 p. (In Russian).
- Geltman, D.V. (ed.), 2024. Krasnaya kniga Rossiiskoi Federacii. Rasteniya i Griby, 2-e ofitsialmoye izdanie [Red Data Book of the Russian Federation. Plants and Fungi. 2nd official edition]. VNIИ Ekologiya, Moscow, Russia, 944 p. (In Russian).
- Gerdol, R., Bragazza, L., 2001. Syntaxonomy and community ecology of mires in the rhaetian Alps (Italy). *Phytocoenologia* **31** (2), 271–299. <https://doi.org/10.1127/phyto/31/2001/271>
- Gubanov, I.A., Kiseleva, K.V., Novikov, V.S., Tikhomirov, V.N., 2002. Illyustrirovannyi opredelitel' rastenyi Srednei Rossii. Tom 1: Pteridophyta, Equisetophyta, Lycopodiophyta, Gymnospermae, Angiospermae (Monocotyledones) [Illustrated manual of plants of Central Russia. Vol. 1: Pteridophyta, Equisetophyta, Lycopodiophyta, Gymnospermae, Angiospermae (Monocotyledones)]. KMK Scientific Press Ltd, Institute of Technological Research, Moscow, Russia, 526 p. (In Russian).
- Kalashnikova, O.V., 2013. Novye dannye po flore pravoberezhniya Volgi v Samarskoi oblasti [New data on the flora of the right bank of the Volga in the Samara region]. *Izvestiia Samarskogo nauchnogo tsentra Rossiiskoi akademii nauk [Bulletin of the Samara Scientific Center of the Russian Academy of Sciences]* **15**, 3 (2), 836–840. (In Russian).
- Kapitonova, O.A., 2019. Gidrofil'naya flora Vyatsko-Kamskogo Predural'ya i eyo ekologicheskie i biologicheskie osobennosti [Hydrophilic flora of the Vyatka-Kama Cis-Urals and its ecological and biological features]. *Doctor of Sciences in Biology thesis*. Tobol'sk, Russia, 291 p. (In Russian).
- Kaplan, Z., Uotila, P., 2011. *Potamogeton* × *exilis* (*P. alpinus* × *P. natans*), a new hybrid pondweed from Finland. *Nordic Journal of Botany* **29**, 477–483.

- Kazakova, M.V., 2004. Flora Ryazanskoi oblasti [Flora of the Ryazan Region]. Russkoe Slovo, Ryazan', Russia, 387 p. (In Russian).
- Kaźmierczakowa, R. (ed.), 2016. Polska czerwona lista paprotników i roślin kwiatowych [Polish red list of pteridophytes and flowering plants]. Instytut Ochrony Przyrody, Polska Akademia Nauk, Kraków, Poland, 44 p. (In Polish).
- Kestemont, B., 2019. The bottom-up assessment of threatened species. *Nature Conservation Research* 4 (3), 93–106. <https://doi.org/10.24189/ncr.2019.036>
- Kochjarová, J., Hrivnák, R., O'ahel'ová, H., 2010. Recent chorological and ecological knowledge about aquatic plants in the Orava region. *Bulletin Slovenskej botanickej spoločnosti* 32 (2), 37–46. (In Slovak).
- Kravchenko, A.V., 2020. Sosudistye rasteniya Zapovednika Pasvik i sopredel'nykh territoriyi Murmanskoi oblasti [Vascular plants of the Pasvik strict nature reserve and adjacent parts of the Murmansk Region]. Karelian Scientific Centre RAS, Petrozavodsk, Russia, 281 p. (In Russian).
- Łachacz, A., Pisarek, W., 2010. Rare species of vascular plants in the valley of the Czarna River on the Mazurska Plain. *Fragmenta Floristica et Geobotanica Polonica* 17 (1), 3–8.
- Le Roux, J.J., Hui, C., Castillo, M.L., Iriondo, J.M., Keet, J.-H. et al., 2019. Recent anthropogenic plant extinctions differ in biodiversity hotspots and coldspots. *Current Biology* 29 (17), 2912–2918.e2. <https://doi.org/10.1016/j.cub.2019.07.063>
- Lisitsyna, L.I., Papchenkov, V.G., Artemenko, V.I., 2009. Flora vodoemov volzhskogo basseina [Flora of waterbodies of the Volga basin]. KMK, Moscow, Russia, 219 p. (In Russian).
- Maevskiy, P.F., 2014. Flora srednei polosy Evropeiskoi chasti Rossii. 11-e izdanie, ispravlennoe i dopolnennoe [Flora of Middle belt of the European part of Russia. 11th edition, edited and supplemented]. KMK, Moscow, Russia, 640 p. (In Russian).
- Mesters, C.M.L., 1995. Shift in macrophyte species composition as a result of eutrophication and pollution in Dutch transboundary streams over the past decades. *Journal of Aquatic Ecosystem Stress and Recovery* 4 (4), 295–305. <https://doi.org/10.1007/BF00118010>
- Nazirov, A.A. (ed.), 2016. Krasnaya kniga Respubliki Tatarstan: zhyvotnye, rasteniya, griby. Tret'e izdanie [Red Data Book of the Republic of Tatarstan: Animals, Plants, Mushrooms. 3rd edition]. Ideal Press, Kazan, Russia, 760 p. (In Russian).
- Nyankovskiy, M.A. (ed.), 2015. Krasnaya kniga Yaroslavskoi oblasti [Red Data Book of the Yaroslavl Region]. Academia 76, Yaroslavl, Russia, 472 p. (In Russian).
- Ohwi, J., 1965. Flora of Japan. Smithsonian Institution, Washington, D.C., USA, 1067 p.
- Ovesnov, S.A., Ephimik, E.G., Kos'minykh, T.V., Baranova, O.G., Kamelin, R.V. et al., 2007. Illyustrirovannyi opredelitel' rastenyi Permskogo kraja [Illustrated manual of plants of Perm'sky Krai]. Knizhnyi Mir, Perm', Russia, 747 p. (In Russian).
- Papchenkov, V.G., 1993. Rdesty (*Potamogeton* L., Potamogetonaceae) Srednego Povolzhiya [Pondweeds (*Potamogeton* L., Potamogetonaceae) of the Middle Volga]. *Samarskaya Luka* 4, 225–238. (In Russian).
- Petrova, E.A., Utemova, L.D., 2008. Dopolneniya k flore natsionalnogo parka "Chavash varmane" [Additions to the flora of the Chavash Varmane National Park]. *Nauchnye trudy natsional'nogo parka "Chavash Varmane" [Scientific Proceedings of the Chavash Varmane National Park]* 2, 22–38. (In Russian).

- Plaksina, T.I., 2001. *Konspekt flory Volgo-Ural'skogo regiona* [Synopsis of flora of Volga-Ural region]. Samara University, Samara, Russia, 388 p. (In Russian).
- Preston, C.D., 1995. *Pongweeds of Great Britain and Ireland*. Botanical society of the British Isles, London, UK, 352 p.
- Prokin, A.A., Sazhnev, A.S., Philippov, D.A., 2019. Water beetles (Insecta: Coleoptera) of some peatlands in the North Caucasus. *Nature Conservation Research* 4 (2), 57–66. <https://doi.org/10.24189/ncr.2019.016>
- Pulido, C., Riera, J.L., Ballesteros, E., Chappuis, E., Gacia, E., 2015. Predicting aquatic macrophyte occurrence in soft-water oligotrophic lakes (Pyrenees mountain range). *Journal of Limnology* 74 (1), 143–154. <https://doi.org/10.4081/jlimnol.2015.965>
- Rakov, N.S., Saksonov, S.V., Senator, S.A., Vasyukov, V.M., 2014. *Sosudistye rasteniya Ul'yanovskoi oblasti. Flora volzhskogo basseina. Tom II* [Vascular plants of the Ulyanovsk region. Flora of the Volga basin. Vol. II]. Cassandra, Togliatti, Russia, 295 p. (In Russian).
- Reshetnikova, N.M., Skvortsov, A.K., Mayorov, S.R., Voronkina N.V., 2005. *Sosudistye rasteniya natsional'nogo parka Ugra (Annotirovannyi spisok vidov)* (Flora i fauna natsional'nykh parkov. Vypusk 6) [Vascular plants of the Ugra National Park (Annotated list of species) (Flora and fauna of National Parks. Issue 6)]. RAS Commission on Biodiversity Conservation, Institute of Ecology and Evolution Problems RAS, Moscow, Russia, 143 p. (In Russian).
- Robionek, A.E., Banaś, K., Chmara, R., Szmeja, J., 2015. The avoidance strategy of environmental constraints by an aquatic plant *Potamogeton alpinus* in running waters. *Ecology and Evolution* 5 (16), 3327–3337. <https://doi.org/10.1002/ece3.1598>
- Robionek, A.E., Banaś, K., Chmara, R., Szmeja, J., 2018. Periodic events of *Potamogeton alpinus* in NW Poland (Pomerania region). *Oceanology and Hydrobiological Studies* 50 (1), 41–49. <https://doi.org/10.1515/ohs-2018-0005>
- Saksonov, C.V., Senator, S.A., 2012. *Putevoditel' po Samarskoi flore (1851–2011)* (Flora volzhskogo basseina. Tom 1) [Guide the Samara flora (1851–2011) (Flora of the Volga Basin. Vol. 1)]. Cassandra, Togliatti, Russia, 516 p. (In Russian).
- Seregin, A.P., 2012. *Flora Vladimirskei oblasti: Konspekt i atlas* [Flora of Vladimir Region, Russia: Checklist and Atlas]. Grif & K, Tula, Russia, 618 p. (In Russian).
- Shabnam, A., Afsharzadeh, S., Dinarvand, M., Wiegleb, G., 2017. Synopsis of Potamogetonaceae in Iran with supplements to the Flora Iranica and a new identification key. *Phytotaxa* 311 (1), 1–21. <https://doi.org/10.11646/phytotaxa.311.1.1>
- Shcherbakov, A.V., 1990. *Flora vodoyomov Moskovskoi oblasti* [Flora of water bodies of Moscow region]. *PhD in Biology thesis*. Moscow, Russia, 481 p. (In Russian).
- Shcherbakov, A.V., 1999. *Atlas flory vodoyemov Tul'skoi oblasti* [Atlas of water bodies flora of the Tula region]. Grif & K, Moscow, Russia, 45 p. (In Russian).
- Shcherbakov, A.V., 2010. *Vodnaya sosudistaya flora Orlovskoi oblasti* [Aquatic vascular flora of Orel region]. KMK Scientific Press Ltd, Moscow, Russia, 90 p. (In Russian).
- Shcherbakov, A.V., Panasenko, N.N., Luybeznova, N.V., 2018. Spisok sosudistykh vodnykh rasteniy Bryanskoi oblasti [Checklist of vascular aquatic plants of Bryansk region]. *Fitoraznoobrazie Vostochnoi Evropy* [Phytodiversity of Eastern Europe] 12 (2), 124–134. (In Russian).

- Shin, H., Choi, H.K., 1998. Taxonomic examination on *Potamogeton alpinus* Balbis (Potamogetonaceae) in Korea. *Journal Plant Biology* **41**, 146–148. <https://doi.org/10.1007/BF03030402>
- Silaeva, T.B. (ed.), 2003. Krasnaya kniga Respubliki Mordovia. Tom 1. Redkie vidy rastenyi, lishainikov i gribov [Red Data Book of the Republic of Mordovia. Vol. 1. Rare species of plants, lichens and fungi]. Mordovia Book Publishing House, Saransk, Russia, 288 p. (In Russian).
- Silaeva, T.B. (ed.), 2017. Krasnaya kniga Respubliki Mordovia. Rasteniya i griby. Izdanie vtoroje, pererabotannoe [Red Data Book of the Mordovia Republic. Plants and Fungi. Edition 2, revised]. Mordovia Book Publishing House, Saransk, Russia, 396 p.
- Silaeva, T.B., Kiryukhin, I.V., Chugunov, G.G., Levin, V.K., Mayorov, S.R. et al., 2010a. Sosudistye rasteniya Respubliki Mordoviya (konspekt flory) [Vascular plants of the Republic of Mordovia (synopsis of flora)]. Publishing House of the Mordovia State University, Saransk, Russia, 352 p. (In Russian).
- Silaeva, T.B., Kiryukhin, I.V., Chugunov, G.G., Ageeva, A.M., Vargot, E.V. et al., 2010b. Redkie rasteniya i griby: materialy vedeniya Krasnoi knigi Respubliki Mordovia za 2010 god [Rare plants and fungi: materials for maintenance of the Red Data Book of the Republic of Mordovia for 2010]. Publishing House of the Mordovia State University, Saransk, Russia, 44 p. (In Russian).
- Silaeva, T.B., Vargot, E.V., Khapugin, A.A., Ageeva, A.M., Ivoylov, A.V. et al., 2013. Redkie rasteniya i griby: materialy vedeniya Krasnoi knigi Respubliki Mordovia za 2013 god [Rare plants and fungi: materials for maintenance of the Red Data Book of the Republic of Mordovia for 2013]. Publishing House of the Mordovia State University, Saransk, Russia, 152 p. (In Russian).
- Silaeva, T.B., Vargot, E.V., Khapugin, A.A., Urbanavichus, G.P., Urbanavichene, I.N. et al., 2014. Redkie rasteniya i griby: materialy vedeniya Krasnoi knigi Respubliki Mordovia za 2014 god [Rare plants and fungi: materials for maintenance of the Red Data Book of the Republic of Mordovia for 2014]. Publishing House of the Mordovia State University, Saransk, Russia, 92 p. (In Russian).
- Silaeva, T.B., Khapugin, A.A., Ershkova, E.V., Ageeva, A.M., 2019. Spisok sosydistykh rasteniy Respubliki Mordovia v predelakh basseyna reki Oki [List of vascular plants of the Republic of Mordovia within the Oka River Basin]. *Trudy Mordovskogo gosudarstvennogo prirodnogo zapovednika imeni P.G. Smidovicha [Proceedings of the Mordovia State Nature Reserve]* **22**, 175–221. (In Russian).
- Søndergaard, M., Johansson, L.S., Lauridsen, T.L., Jørgensen, T.B., Liboriussen, L., Jeppesen, E., 2010. Submerged macrophytes as indicators of the ecological quality of lakes. *Freshwater Biology* **55** (4), 893–908. <https://doi.org/10.1111/j.1365-2427.2009.02331.x>
- Sukhorukov, A.P. (ed.), 2010. Opredelitel' sosudistyx rasteniy Tambovskoi oblasti [The identification manual of vascular plants of the Tambov region]. Grif & K, Tula, Russia, 350 p. (In Russian).
- Teteryuk, B.Y., 2012. Flora drevnikh ozer Evropeiskogo Severo-Vostoka Rossii [Flora of ancient lakes in the European North-East of Russia]. *Izvestiia Samarskogo nauchnogo tsentra Rossiiskoi akademii nauk [Bulletin of the Samara Scientific Center of the Russian Academy of Sciences]* **14** (1), 82–90. (In Russian).
- Tolmachev, A.I. (ed.), 1974. Flora Severo-Vostoka Evropeiskoi chasti SSSR. Tom I [Flora of North-East of the European part of the USSR. Vol. I]. Nauka, Leningrad Department, Leningrad, USSR, 275 p. (In Russian).
- Tsvelev, N.N., 2000. Opredelitel' sosudistyx rasteniy Severo-Zapadnoi Rossii (Leningradskaya, Pskovskaya i Novgorodskaya oblasti) [Manual of the vascular plants of the North-Western Russia (Leningrad, Pskov and Novgorod regions)]. Publishing House of Saint-Peterburg State Chemical-Pharmatsevtical Academy, Saint-Peterburg, Russia, 781 p. (In Russian).

- Vargot, E.V., Ivashina, A.A., 2014. Nakhodki redkikh vodnykh i bolotnykh rastenii v Nizhegorodskoi oblasti [Findings of rare aquatic and bog plants in the Nizhny Novgorod region]. Collection on maintaining the Red Book of the Nizhny Novgorod region, 25–27. (In Russian).
- Wani, S.A., Pandit, A.K., 2008. Ecological disturbances and floristic diversity change in Nilang, a high altitude Himalayan lake under threat. *Proceeding of Taal 2007: The 12th world lake conference*, 430–434.
- Zamotailov, A.S. (ed.), 2012. Krasnaya kniga Respubliki Adygeiya: redkie i ugrozhaemye ob'ekty flory i fauny. Vtoroe izdanie. Chast' 1: Vvedenie: Rasteniya i Griby [Red Data Book of the Republic of Adygea: rare and endangered objects of flora and fauna. Second edition. Part 1: Introduction: Plants and Fungi]. Kachestvo, Maykop, Russia, 340 p. (In Russian).
- Zalewska-Gałosz, J., Kaplan, Z., Kwolek, D., 2018. Reinterpretation of *Potamogeton* × *nerviger*: solving a taxonomic puzzle after two centuries. *Preslia* **90**, 135–149. <https://doi.org/10.23855/preslia.2018.135>
- Zeko, A., Šegota, V., Vilović, T., Koletić, N., Alegro, A., 2020. Aquatic plants of Croatia: Data derived from the ZA herbarium collection. *Natura Croatica* **29** (2), 205–216.
- Zhengyi, W., Raven, P.H. (eds.), 2012. Flora of China illustrations. Vol. 23: Acoraceae through Cyperaceae. Science Press, Beijing; Missouri Botanical Garden Press, St. Louis, 136–156.

Список литературы

- Агафонов, В.А. (ред.), 2011. Красная книга Воронежской области. Т. 1: Растения. Лишайники. Грибы. МОДЭК, Воронеж, Россия, 472 с.
- Акатов, В.В., 1986. Основные тенденции в зарастании высокогорных озер Северо-Западного Кавказа. *Ботанический журнал* **71** (6), 798–804.
- Алексеев, А.Е., Алексеев, Е.Б., Габбасов, К.К., Горчаковский, П.Л., Губанов, И.А. и др., 1988. Определитель высших растений Башкирской АССР. Наука, Москва, СССР, 316 с.
- Артемяева, Е.А., Масленников, А.В., Корепов, М.В. (ред.). Красная книга Ульяновской области. Буки Веди, Москва, Россия, 550 с.
- Байков, К.С. (ред.), 2012. Конспект флоры Азиатской России: сосудистые растения. Издательство СО РАН, Новосибирск, Россия, 640 с.
- Баранова, О.Г., Ильминских, Н.Г., Пузырев, А.Н., Туганаев, В.В., 1992. Конспект флоры Удмуртии. Издательство Удмуртского университета, Ижевск, Россия, 140 с.
- Барсебян, А.М., 1966. К познанию водно-болотной флоры и растительности горных районов Армении. *Ботанический журнал* **51** (9), 1330–1337.
- Баянов, Н.Г., Кривдина, Т.В., Логинов, В.В., 2014. Озера юго-западной части Нижегородской области. *Труды государственного природного заповедника имени П.Г. Смидовича* **12**, 241–263.
- Бобров, А.А., Чемерис, Е.В., 2006. *Potamogeton* × *vepsicus* (Potamogetonaceae) – новый гибрид рдестов из Верхнего Поволжья. *Ботанический журнал* **91** (1), 71–84.
- Бобров, А.А., Чемерис, Е.В., 2008. Речные рдесты (*Potamogeton*, Potamogetonaceae) на севере европейской России. *Лекции и материалы докладов Всероссийской школы-конференции «Экосистемы малых рек: биоразнообразие, биология, охрана», Борок, 18–21 ноября 2008 г.* Ярославский печатный двор, Ярославль, Россия, 79–82.

- Варгот, Е.В., Ивашина, А.А., 2014. Находки редких водных и болотных растений в Нижегородской области. Сборник по ведению Красной книги Нижегородской области, 25–27.
- Гафурова, М.М., 2014. Сосудистые растения Чувашской Республики. Флора Волжского бассейна. Т. III. Кассандра, Тольятти, Россия, 333 с.
- Гафурова, М.М. (ред.), 2024. Красная книга Чувашской республики. Т. 1. Ч. 1: Редкие виды растений и грибов. Издание 2-е. Буки Веди, Москва, Россия, 332 с.
- Гельтман, Д.В. (ред.), 2024. Красная книга Российской Федерации. Растения и грибы. 2-е официальное издание. ВНИИ Экология, Москва, Россия, 944 с.
- Губанов, И.А., Киселева, К.В., Новиков, В.С., Тихомиров, В.Н., 2002. Иллюстрированный определитель растений Средней России. Т. 1: Папоротники, хвощи, плауны, голосеменные, покрытосеменные (однодольные). Товарищество научных изданий КМК, Институт технологических исследований, Москва, Россия, 526 с.
- Замотайлов, А.С. (ред.), 2012. Красная книга Республики Адыгея: редкие и находящиеся под угрозой исчезновения объекты животного и растительного мира. Издание второе. Ч. 1: Введение: Растения и грибы. Качество, Майкоп, Россия, 340 с.
- Калашникова, О.В., 2013. Новые данные по флоре правобережья Волги в Самарской области. *Известия Самарского научного центра Российской академии наук* 15 (3 (2)), 836–840.
- Капитонова, О.А., 2019. Гидрофильная флора Вятско-Камского Предуралья и ее эколого-биологические особенности. *Диссертация на соискание ученой степени доктора биологических наук*. Тобольск, Россия, 291 с.
- Казакова, М.В., 2004. Флора Рязанской области. Русское слово, Рязань, Россия, 387 с.
- Кравченко, А.В., 2020. Сосудистые растения заповедника Пасвик и сопредельных территорий Мурманской области. КарНЦ РАН, Петрозаводск, Россия, 281 с.
- Лисицына, Л.И., Папченков, В.Г., Артеменко, В.И., 2009. Флора водоемов волжского бассейна. КМК, Москва, Россия, 219 с.
- Маевский, П.Ф., 2014. Флора средней полосы европейской части России. 11-е издание, исправленное и дополненное. Товарищество научных изданий КМК, Москва, Россия, 635 с.
- Назирова, А.А. (ред.), 2016. Красная книга Республики Татарстан: животные, растения, грибы. Издание 3-е. Идеал-пресс, Казань, Россия, 759 с.
- Нянковский, М.А. (ред.), 2015. Красная книга Ярославской области. Академия 76, Ярославль, Россия, 470 с.
- Овеснов, С.А., Ефимик, Е.Г., Козьминых, Т.В., Баранова, О.Г., Камелин, Р.В. и др., 2007. Иллюстрированный определитель растений Пермского края. Книжный мир, Пермь, Россия, 743 с.
- Папченков, В.Г., 1993. Рдесты (*Potamogeton* L., Potamogetonaceae) Среднего Поволжья. *Самарская лука* 4, 225–238.
- Петрова, Е.А., Утемова, Л.Д., 2008. Дополнения к флоре национального парка «Чаваш Вармане». *Научные труды национального парка «Чаваш Вармане»* 2, 22–38.
- Плаксина, Т.И., 2001. Конспект флоры Волго-Уральского региона. Самарский университет, Самара, Россия, 388 с.

- Раков, Н.С., Саксонов, С.В., Сенатор, С.А., Васюков, В.М., 2014. Сосудистые растения Ульяновской области. Флора Волжского бассейна. Т. II. Кассандра, Тольятти, Россия, 295 с.
- Решетникова, Н.М., Скворцов, А.К., Майоров, С.Р., Воронкина, Н.В., 2005. Сосудистые растения национального парка «Угра» (Аннотированный список видов) (Флора и фауна национальных парков. Вып. 6). Комиссия по сохранению биоразнообразия РАН, ИПЭЭ РАН, Москва, Россия, 143 с.
- Саксонов, С.В., Сенатор, С.А., 2012. Путеводитель по Самарской флоре (1851–2011) (Флора Волжского бассейна. Т. 1). Кассандра, Тольятти, Россия, 511 с.
- Серёгин, А.П., 2012. Флора Владимирской области: Конспект и атлас. Гриф и К, Тула, Россия, 620 с.
- Силаева, Т.Б. (ред.), 2003. Красная книга Республики Мордовия. Т. 1. Редкие виды растений, лишайников и грибов. Мордовское книжное издательство, Саранск, Россия, 288 с.
- Силаева, Т.Б. (ред.), 2017. Красная книга Республики Мордовия. Растения и грибы. Издание второе, переработанное. Мордовское книжное издательство, Саранск, Россия, 396 с.
- Силаева, Т.Б., Кирюхин, И.В., Чугунов, Г.Г., Левин, В.К., Майоров, С.Р. и др., 2010а. Сосудистые растения Республики Мордовия (конспект флоры). Издательство Мордовского университета, Саранск, Россия, 352 с.
- Силаева, Т.Б., Кирюхин, И.В., Чугунов, Г.Г., Агеева, А.М., Варгот, Е.В. и др., 2010б. Редкие растения и грибы: материалы для ведения Красной книги Республики Мордовия за 2010 год. Издательство Мордовского университета, Саранск, Россия, 48 с.
- Силаева, Т.Б., Варгот, Е.В., Хапугин, А.А., Агеева, А.М., Ивойлов, А.В. и др., 2013. Редкие растения и грибы: материалы для ведения Красной книги Республики Мордовия за 2013 год. Издательство Мордовского университета, Саранск, Россия, 152 с.
- Силаева, Т.Б., Варгот, Е.В., Хапугин, А.А., Урбанавичюс, Г.П., Урбанавичене, И.Н. и др., 2014. Редкие растения и грибы: материалы для ведения Красной книги Республики Мордовия за 2014 год. Издательство Мордовского университета, Саранск, Россия, 92 с.
- Силаева, Т.Б., Хапугин, А.А., Ершкова, Е.В., Агеева, А.М., 2019. Список сосудистых растений Республики Мордовия в пределах бассейна реки Оки. *Труды Мордовского государственного природного заповедника имени П.Г. Смидовича* 22, 175–221.
- Сухоруков, А.П. (ред.), 2010. Определитель сосудистых растений Тамбовской области. Гриф и К, Тула, Россия, 349 с.
- Тетерюк, Б.Ю., 2012. Флора древних озер Европейского Северо-Востока России. *Известия Самарского научного центра Российской академии наук* 14 (1), 82–90.
- Толмачев, А.И. (ред.), 1974. Флора северо-востока европейской части СССР. Т. I. Наука, Ленинградское отделение, Ленинград, СССР, 275 с.
- Фёдоров, А.А. (отв. ред.), 1979. Флора Европейской части СССР. Т. IV. Наука, Ленинград, СССР, 355 с.
- Цвелев, Н.Н., 2000. Определитель сосудистых растений северо-западной России (Ленинградская, Псковская и Новгородская области). Издательство СПХФА, Санкт-Петербург, Россия, 781 с.
- Чернов, В.Н., Чернова, Е.П., 1949. Флора озер Карелии. Государственное издательство Карело-Финской ССР (Сортавальская книжная типография), Петрозаводск, СССР, 162 с.

- Чкалов, А.В. (ред.), 2017. Красная книга Нижегородской области. 2-е издание, переработанное и дополненное. Т. 2: Сосудистые растения, моховидные, водоросли, лишайники, грибы. РОСТ-ДОАФК, Калининград, Россия, 304 с.
- Щербаков, А.В., 1990. Флора водоемов Московской области. *Диссертация на соискание ученой степени кандидата биологических наук*. Москва, СССР, 481 с.
- Щербаков, А.В., 1999. Атлас флоры водоемов Тульской области. Русский Университет, Москва, Россия, 45 с.
- Щербаков, А.В., 2010. Сосудистая водная флора Орловской области. Товарищество научных изданий КМК, Москва, Россия, 92 с.
- Щербаков, А.В., Панасенко, Н.Н., Любезнова, Н.В., 2018. Список сосудистых водных растений Брянской области. *Фиторазнообразие Восточной Европы* **12** (2), 124–134.
- Boedeltje, G., Jongejans, E., Spanings, T., Verberk, W.C.E.P., 2016. Effect of gut passage in fish on the germination speed of aquatic and riparian plants. *Aquatic Botany* **132**, 12–16. <https://doi.org/10.1016/j.aquabot.2016.03.004>
- Borisova, G., Chukina, N., Maleva, M., Majeti, P., 2014. *Ceratophyllum demersum* L. and *Potamogeton alpinus* Balb. from Iset' River, Ural Region, Russia differ in adaptive strategies to heavy metals exposure – a comparative study. *International Journal of Phytoremediation* **16** (6), 621–33. <https://doi.org/10.1080/15226514.2013.803022>
- Bruh, H., Todeskino, D., Wiegleb, G., 1987. Growth and reproduction of *Potamogeton alpinus* balbis growing in disturbed habitats. *Archiv fur hydrobiologie. Beihefte* **27**, 115–127.
- Bruh, H., Herr, W., Todeskino, D., Wiegleb, G., 1988. A study on structure and dynamics of communities with *Potamogeton alpinus* Balbis in north German waters. *Aquatic Botany* **32**, 23–44.
- Chukina, N., Borisova, G., Maleva, M., 2014. Antioxidant status of hydrophytes with different accumulative ability illustrated by *Potamogeton alpinus* Balb and *Batrachium trichophyllum* (Chaix) Bosch. *Inland Water Biology* **7** (4), 401–405. <https://doi.org/10.1134/S1995082914040038>
- Convention on Biological Diversity, 1992. United Nations, 28 p.
- Drozdowski, I., Mrkvicka, A.C., Mrkvicka, G.F., 2015. Die Wasserpflanzenflora stehender Gewässer des steirischen Salzkammergutes (Österreich) sowie Anmerkungen zum Vorkommen von Großmuscheln, Krebsen und Amphibien. *Biodiversität und Naturschutz in Ostösterreich – BCBEA* **1/2**, 233–251 (In German).
- Gerdol, R., Bragazza, L., 2001. Syntaxonomy and community ecology of mires in the rhaetian Alps (Italy). *Phytocoenologia* **31** (2), 271–299. <https://doi.org/10.1127/phyto/31/2001/271>
- Kaplan, Z., Uotila, P., 2011. *Potamogeton* × *exilis* (*P. alpinus* × *P. natans*), a new hybrid pondweed from Finland. *Nordic Journal of Botany* **29**, 477–483.
- Kaźmierczakowa, R. (ed.), 2016. Polska czerwona lista paprotników i roślin kwiatowych [Polish red list of pteridophytes and flowering plants]. Instytut Ochrony Przyrody, Polska Akademia Nauk, Kraków, Poland, 44 p. (In Polish).
- Kestemont, B., 2019. The bottom-up assessment of threatened species. *Nature Conservation Research* **4** (3), 93–106. <https://doi.org/10.24189/ncr.2019.036>
- Kochjarová, J., Hrivnák, R., O'ahel'ová, H., 2010. Recent chorological and ecological knowledge about aquatic plants in the Orava region. *Bulletin Slovenskej botanickej spoločnosti* **32** (2), 37–46. (In Slovak).

- Łachacz, A., Pisarek, W., 2010. Rare species of vascular plants in the valley of the Czarna River on the Mazurska Plain. *Fragmenta Floristica et Geobotanica Polonica* **17** (1), 3–8.
- Le Roux, J.J., Hui, C., Castillo, M.L., Iriondo, J.M., Keet, J.-H. et al., 2019. Recent anthropogenic plant extinctions differ in biodiversity hotspots and coldspots. *Current Biology* **29** (17), 2912–2918.e2. <https://doi.org/10.1016/j.cub.2019.07.063>
- Mesters, C.M.L., 1995. Shift in macrophyte species composition as a result of eutrophication and pollution in Dutch transboundary streams over the past decades. *Journal of Aquatic Ecosystem Stress and Recovery* **4** (4), 295–305. <https://doi.org/10.1007/BF00118010>
- Ohwi, J., 1965. Flora of Japan. Smithsonian Institution, Washington, D.C., USA, 1067 p.
- Preston, C.D., 1995. Pongweeds of Great Britain and Ireland. Botanical society of the British Isles, London, UK, 352 p.
- Prokin, A.A., Sazhnev, A.S., Philippov, D.A., 2019. Water beetles (Insecta: Coleoptera) of some peatlands in the North Caucasus. *Nature Conservation Research* **4** (2), 57–66. <https://doi.org/10.24189/ncr.2019.016>
- Pulido, C., Riera, J.L., Ballesteros, E., Chappuis, E., Gacia, E., 2015. Predicting aquatic macrophyte occurrence in soft-water oligotrophic lakes (Pyrenees mountain range). *Journal of Limnology* **74** (1), 143–154. <https://doi.org/10.4081/jlimnol.2015.965>
- Robionek, A.E., Banaś, K., Chmara, R., Szmeja, J., 2015. The avoidance strategy of environmental constraints by an aquatic plant *Potamogeton alpinus* in running waters. *Ecology and Evolution* **5** (16), 3327–3337. <https://doi.org/10.1002/ece3.1598>
- Robionek, A.E., Banaś, K., Chmara, R., Szmeja, J., 2018. Periodic events of *Potamogeton alpinus* in NW Poland (Pomerania region). *Oceanology and Hydrobiological Studies* **50** (1), 41–49. <https://doi.org/10.1515/ohs-2018-0005>
- Shabnam, A., Afsharzadeh, S., Dinarvand, M., Wiegleb, G., 2017. Synopsis of Potamogetonaceae in Iran with supplements to the Flora Iranica and a new identification key. *Phytotaxa* **311** (1), 1–21. <https://doi.org/10.11646/phytotaxa.311.1.1>
- Shin, H., Choi, H.K., 1998. Taxonomic examination on *Potamogeton alpinus* Balbis (Potamogetonaceae) in Korea. *Journal Plant Biology* **41**, 146–148. <https://doi.org/10.1007/BF03030402>
- Søndergaard, M., Johansson, L.S., Lauridsen, T.L., Jørgensen, T.B., Liboriussen, L., Jeppesen, E., 2010. Submerged macrophytes as indicators of the ecological quality of lakes. *Freshwater Biology* **55** (4), 893–908. <https://doi.org/10.1111/j.1365-2427.2009.02331.x>
- Wani, S.A., Pandit, A.K., 2008. Ecological disturbances and floristic diversity change in Nilang, a high altitude Himalayan lake under threat. *Proceeding of Taal 2007: The 12th world lake conference*, 430–434.
- Zalewska-Gałosz, J., Kaplan, Z., Kwolek, D., 2018. Reinterpretation of *Potamogeton × nerviger*: solving a taxonomic puzzle after two centuries. *Preslia* **90**, 135–149. <https://doi.org/10.23855/preslia.2018.135>
- Zeko, A., Šegota, V., Vilović, T., Koletić, N., Alegro, A., 2020. Aquatic plants of Croatia: Data derived from the ZA herbarium collection. *Natura Croatica* **29** (2), 205–216.
- Zhengyi, W., Raven, P.H. (eds.), 2012. Flora of China illustrations. Vol. 23: Acoraceae through Cyperaceae. Science Press, Beijing; Missouri Botanical Garden Press, St. Louis, 136–156.