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RARE MACROSCOPIC ALGAE SPECIES IN THE PECHORA AND VYCHEGDA RIVER BASINS (NORTH-EASTERN PART OF EUROPEAN RUSSIA)

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Abstract

Patova E., Sterlyagova I., Shabalina Y., 2014: Rare macroscopic algae species in the Pechora and Vychegda River basins (north-eastern part of European Russia) [Retos makroskopinių dumblių rūšys Pečoros ir Vyčegdos upių baseinuose (Rusijos europinės dalies šiaurės rytai]. – Bot. Lith., 20(2): 77–86.

Ten rare species of macroscopic algae were found in freshwater ecosystems of the Pechora and Vychegda River basins, belonging to four divisions: *Cyanoprokaryota* – 1 species, *Rhodophyta* – 3, *Chrysophyta* – 1, *Charophyta* – 5. Some of these were included in the regional Red Data Books of Nenets Autonomous District and Komi Republic, others were recommended to be included. Areas of distribution were marked; algae development conditions and limiting factors were described.

Keywords: freshwater ecosystems, north-eastern part of European Russia, Pechora and Vychegda Rivers, rare endangered macroscopic algae, Red Data Book.

INTRODUCTION

In aquatic ecosystems of Komi Republic and Nenets Autonomous District (NAD), about 2000 algae species from eight divisions were found (Ponomarev & Pystina, 2012). In freshwater ecosystems of these northern regions, algae with macroscopic thalli are rare. They are mainly represented by green, red and blue-green algae (Getsen, 1985; Getsen et al., 1994). Many of these have narrow ecological amplitude and live in water bodies not affected by anthropogenic impact.

The problems related to the protection of natural water bodies and diversity of their inhabitants (including algae) have become more urgent with an increase of anthropogenic impact associated primarily with the production of oil and gas. Due to insufficient knowledge and lack of specialists interested in studying of algae diversity and distribution, only few regional Russian Red Lists of Threatened Species have chapters on algae, which generally include from one to ten species with macroscopic thalli (Šepovskix, 1995; Dmitriev, 2001; Dobrinskij & Korytin, 2001; Konečnaja & Suslova, 2004; Lavrinenko & Lavrinenko, 2006; Paškov, 2006; Degteva, 2009). Leningrad (Cvelev, 2000), Tatarstan (Šepovskix, 1995) and Bashkortostan (Valuev, 2002) are the leading regions by the number of protected species included into the Red Data Books (71, 22 and 19 species, respectively). In the north-eastern part of European Russia, the identification of rare species as well as their inclusion in the lists of endangered species has just started.

The purpose of the current study was to reveal rare endangered macroscopic algae inhabiting the water bodies in the Pechora and Vychegda River basins, and present the description of habitat conditions.

MATERIALS AND METHODS

The obtained data are the result of long-term studies (1997–2012 vegetation seasons), which were

carried out in NAD and Komi Republic (Fig. 1). A total of 102 water bodies were investigated in the Pechora and Vychegda River basins: 14 rivers, 15 streams and 73 lakes. Algal samples were collected using standard techniques (Rott, 1991). A total of 250 samples of algae were investigated. Samples were analysed as fresh and fixed with 4% formalin solution. Morphological characteristics were revised using Nikon Eclipse 80i microscope and photographed with Nikon digital sight DS-2Mv camera. Identification of the species was performed according to the identification guides (Gollerbax et al., 1953; Matviyenko, 1954; Vinogradova et al., 1980; Gollerbax & Krasavina, 1983; Komárek & Anagnostidis, 1989; Krause, 1997; Kucera & Marvan, 2004; Eloranta & Kwandrans, 2007; Komárek, 2013). In addition, the data from literature sources were used (Getzen, 1978; Shubina, 1986; Getsen et al., 1994; Langangen & Zhakova, 2002).

Fig. 1. Map of the studied area showing sampling sites and protected area: 1 – Nenetskij Reserve, 2 – Yugyd Va National Park, 3 – Pechora-Ilych Nature Reserve, 4 – Paras′kiny Lakes Natural Monument

To indicate the level of species rarity within the surveyed area, we used the following scale (Kondratyeva & Zarenko, 2008): extremely rare – up to 3 locations in the study area; very rare – up to 5 locations; rare – up to 10 locations; moderately frequent – from 10 to 30 locations; frequent – from 30 to 100 locations; very frequent – the number of finds is so big that no longer valued. The rare species were allocated to the first three groups.

Water temperature, conductivity, oxygen concentration and pH were measured under field conditions using the Water Test (Hanna Instruments) and Anion – 7051 (Infraspak–Analit, Russia) systems. Analyses of other hydrochemical parameters (nutrient ions, microelements, permanganate oxidability, etc.) were carried out in the Ecoanalytical Laboratory of the Institute of Biology, Komi Scientific Centre, Ural Division, Russian Academy of Sciences (certificate № РОСС RU.0001.511257, GOST R ISO/ IEC 17025 – 2009, ISO/ IEC 17025 – 2005).

RESULTS AND DISCUSSION

During the study, ten species of macroscopic algae which can be classified on used scale as extremely rare, very rare and rare were found. Most of these have narrow ecological amplitude, limited areal and small population. They belong to four divisions: *Cyanoprokaryota* – 1 species, *Rhodophyta* – 3, *Chrysophyta* – 1, *Charophyta* – 5. The hydrochemical parameters of the water samples are listed in Table 1.

Nostoc pruniforme C. Agardh ex Bornet & Flahault is a rare colonial alga from *Cyanoprokaryota* (Fig. 2). Abundance score: rare.

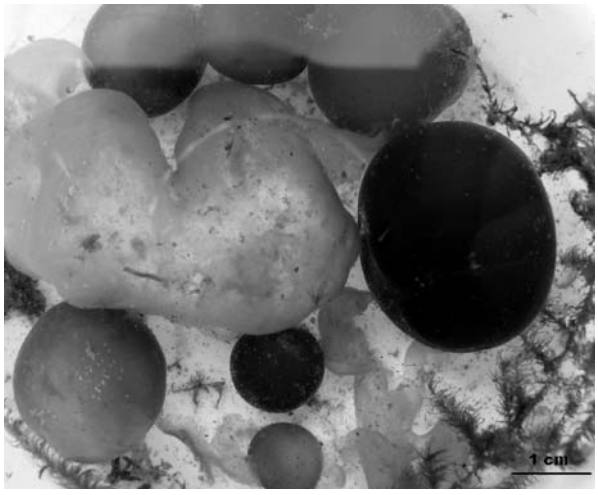

Fig. 2. Macroscopic colonies of *Nostoc pruniforme*

Table 1. Physical and chemical data on the sites where samples of rare algae-macrophytes were collected

Species / Parameters	*Nostoc pruniforme*	*Lemanea fluviatilis*	*Audouinella hermannii*	*Batrachospermum gelatinosum*	*Hydrurus foetidus*
Chromaticity°	4.8–46.0	9.0–17.0	15.6–26.3	4.8–46.0	5.0–36.0
pH	6.22–7.69	6.49–6.83	5.89–6.66	5.89–7.23	5.81–7.37
Conductivity, µS·cm^{-1}	10.0–176.4	33.9–51.6	9.7–22.4	1.6–176.4	6.4–208.4
Permanganate oxidizability, mg·l^{-1}	0.25–7.7	0.67–1.70	0.86–1.18	0.78–5.70	0.25–5.70
COD, mg·l^{-1}	0.2*–33.0	18.8–22.0	2.08*–4.06*	0.7*–33.0	0.2*–33.0
P_{min}, mg·l^{-1}	0.0005*–0.0190	0.004*–0.007*	0.008*–0.037	0.0005*–0.0370	0.0005*–0.0280
P_{total}, mg·l^{-1}	0.006*–0.150	0.024*–0.059	0.015*–0.042	0.015*–0.059	0.012*–0.059
NH_4^+, mg·l^{-1}	0.007*–1.340	0.009*–0.020*	0.110*–0.340*	0.009*–0.560	0.009*–1.340
NO_3^-, mg·l^{-1}	0.001–0.005	–	–	0.004–0.005	
N_{total}, mg·l^{-1}	0.05*–7.90	0.06–0.34	0.28–0.36	0.05*–0.45	0.05*–7.90
Si, mg·l^{-1}	0.2–11.9	3.10–3.70	1.90–2.50	0.42*–11.90	0.42*–11.90
Cl^-, mg·l^{-1}	0.086*–1.560	0.22*–0.38*	0.16–0.30	0.035*–0.520	0.086*–0.750
SO_4^{2-}, mg·l^{-1}	2.04–3.47	2.80–5.80	0.80*–0.89*	0.20*–9.80	0.20*–9.80
HCO_3^-, mg·l^{-1}	8.5–128.0	9.3*–16.7	5.6*–9.3*	4.4*–83.0	4.4*–83.0
Ca^{2+}, mg·l^{-1}	0.94–247.00	4.5–7.4	2.30–2.53	2.20–13.90	0.66–16.80
Mg^{2+}, mg·l^{-1}	0.18–26.40	0.30–0.50	0.14–0.17	0.140–6.700	0.037*–6.700
Na^+, mg·l^{-1}	0.40–6.30	0.60*–0.87*	0.46–0.50	0.46–0.69	0.21–0.83
K^+, mg·l^{-1}	0.18–0.61	–	0.21–0.26	0.21–0.27	0.043*–0.271
Fe_{total}, mg·l^{-1}	0.070–0.270	0.032–0.167	0.005*–0.035	0.005*–0.270	0.0011*–0.270
Mn, µg·l^{-1}	1.0–17.0	6.8–15.0	0.4*–3.5	0.4*–17.0	0.2*–17.0
Cu, µg·l^{-1}	0.14*–12.20	0.08*–0.60	0.1*–1.5	0.08*–12.20	0.13*–2.90
Zn, µg·l^{-1}	2.11*–330.00	2.11*–11.33*	0.5*–12.5	0.2*–330.0	0.16*–330.00

Species / Parameters	*Tolypella intricata*#	*Tolypella canadensis*	*Nitella opaca*	*Chara contraria*	*Chara globularis*
Chromaticity,°	10.0	4.0–50.0	4.8–46.0	8.2–23.0	5.0–26.0
pH	6.9–7.3	6.3–7.4	5.89–7.23	6.80–7.72	6.55–6.88
Conductivity, µS·cm^{-1}	–	24.0–28.0	17.9–159.0	153.0–1728.0	23.9–65.7
Permanganate oxidizability, mg·l^{-1}l	4.65	1.86–13.00	0.25–3.70	1.50–11.03	1.98–9.30
COD, mg·l^{-1}	–	6.0–36.6	0.2*–23.3	0.63–5.20	1.95
P_{min}, mg·l^{-1}	0.002	0.001–0.026	0.002*–0.037	–	0.015
P_{total}, mg·l^{-1}	–	–	0.007*–0.059	0.0015–0.1700	0.007–0.037
NH_4^+, mg·l^{-1}	0.09	0.01–0.44	0.009*–1.340	0.013–1.340	0.056
NO_3^-, mg·l^{-1}	0.001	–	–	–	–
N_{total}, mg·l^{-1}	–	0.20–0.28	0.06–7.90	0.038–1.742	0.203–0.488
Si, mg·l^{-1}	0.80	–	0.42*–3.70	3.3–10.1	0.41–0.86
Cl^-, mg·l^{-1}	2.84	0.6–8.1	0.086*–0.520	0.23–4.90	0.30–0.51
SO_4^{2-}, mg·l^{-1}	23.0	1.30–10.60	0.20*–9.80	82.0–197.0	0.096–2.700
HCO_3^-, mg·l^{-1}	13.4	10.2–30.5	5.6*–64.0	88.0–159.0	10.61–33.00
Ca^{2+}, mg·l^{-1}	3.00	2.2–8.2	2.20–13.90	11.0–298.0	2.91–8.00
Mg^{2+}, mg·l^{-1}	1.22	0.6–1.7	0.140–6.700	10.10–26.40	0.51–4.61
Na^+, mg·l^{-1}	–	0.66–8.50	0.46–0.50	3.20–6.90	0.77–0.98
K^+, mg·l^{-1}	–	0.29–0.45	0.210–0.259	0.19–0.61	0.03–0.20
Fe_{total}, mg·l^{-1}	0.14	0.04–2.10	0.0048*–0.2700	0.006–0.680	0.018–0.056
Mn, µg·l^{-1}	–	0.10–260.00	0.34*–17.00	0.44–3.10	3.62–5.00
Cu, µg·l^{-1}	–	0.12–9.00	0.14*–12.20	0.10–0.65	0.34–1.20
Zn, µg·l^{-1}	–	0.28–47.00	0.50*–33.00	0.8–3.1	1.2–2.7

Note: # – unpublished data of A.S. Stenina, — – data not available, * – the result could not be detected since it is lower than measurement limit value.

Colonies are spherical or sometimes ellipsoidal, solid or with a hollow in the centre, filled with mucilage, 1–4 cm in diameter, wet weight 1–12 g. Periderm is thick (up to 1–2 mm), from green-brown to olive-green (sometimes black) in colour, solid or semitransparent. Alga dwells in stagnant fresh water bodies. It can only be found in clean, not affected by anthropogenic impact waters with neutral or slightly alkaline reaction, or in soils with high calcium content (Vitėnaitė, 2001). The alga reaches high numbers in well-warmed littoral zone waters. After hormogonium formation, an air camera is formed within a colony, and alga floats towards the surface. Normally, the alga is formed in great numbers (10–20 colonies per dm^2 at the bottom) by the end of the growing season (mid August – early September). The findings are rare, the species was recorded in 60–70s in Syktyvkar and Vorkuta surroundings; however, its populations have disappeared from the waters of these industrial centres by now (Getzen, 1978; Patova & Demina, 2008). In the study area, populations of the species were recorded in little-inhabited and remote places of Polar and Subpolar Urals in the basins of the Kara (2 lakes), Usa (2 lakes), Kožym (1 lake), Bol'šoj and Malyj Patok Rivers (3 lakes) and Ukhta River (1 lake) (Patova, 2004; Patova & Demina, 2008; Sterlyagova & Patova, 2008). The population survival is based on habitat, which is located in protected areas such as Yugyd Va National Park (Subpolar Ural) and Paras′kiny Lakes in the basin of the Ukhta River. The species populations are vulnerable due to short life cycle, severe environmental conditions, narrow ecological niche, disturbance, pollution and eutrophication of the lakes they dwell in. The species is in the list of rare species and included in the new edition of the Red List of Komi Republic (2009), and is also recommended to be included into the Red List of NAD. The proposed status is 3rd category of protection that includes species (subspecies, populations) with naturally low numbers distributed in a limited area or sporadically occurring over large areas (Degteva, 2009). The species is also included in the Red Data Books of Tatarstan (Šepovskix, 1995), Kirov (Dobrinskij, Korytin, 2001) and Vologda regions (Konečnaja & Suslova, 2004), Republic of Belarus (Paškov, 2006) as well as Komi Republic (Degteva, 2009). In the Red Data Book of Leningrad region, it was marked as probably extinct (Cvelev, 2000).

In the studied region, among few freshwater species belonging to *Rhodophyta*, three species can be classified as rare.

The first is ***Lemanea fluviatilis*** (L.) C. Agardh (Fig. 3). Abundance score: very rare. Its thallus is 5–15 cm long, sparsely branched, rarely simple, distinctly thinner in the base or often with a well-formed thin leg. Algae are well pigmented dark purple or dark brown in colour. In the area of the research, only four findings of the species population were recorded: in the streams of the upper and middle flow of Kara (Patova & Demina, 2008) (Polar Ural), and in the basin of Schugor River (Subpolar Ural) (Shubina, 1986). Alga dwells only in clean, fresh, fast streams, rivers or flowing lakes (Kostkevičienė & Laučiūtė, 2009). The usual habitats are large boulders and pebbles covered with water mosses in rapids of mountain streams. The alga is epilitic; it is attached to the substrate by the lower end of the thallus. It can be found up to 880 m above sea level, at pH 6.7–7.8, temperature 6.8–12.3°C, depth 2–15 cm; the species is very demanding for water transparency. In the studied territory, the species abundance and population dynamics have not been studied, the findings are unique. Population density is low. The vulnerability of the species is conditioned by the weak competitiveness of the species. It is pressed by water epilithic mosses and algae. The limiting factor is narrow ecological amplitude; the species dwells only in streams with clean water. The alga is highly sensitive to water pollution and increasing water turbidity. Exploration works, building of oil and gas transportation constructions and development of mineral mines result in the habitat violation. The species is protected on the territory of Yugyd Va National Park. The algae habitats (the upper and middle flow of the Kara) should be included into the lists of specially protected water bodies. The species is included in the Red Data Book of NAD region (Lavrinenko & Lavrinenko, 2006). The species is included into the Red Data Book of Komi Republic, where is ascribed to the 3rd category.

Another poorly studied freshwater species is ***Audouinella hermannii*** (Roth) Duby. Abundance score: very rare. Thallus is branched, to 20 mm long. Thalli colour varies, from dark red to black. Branching is versatile, lateral branches are thinner than the basis thread. The species has narrow ecological

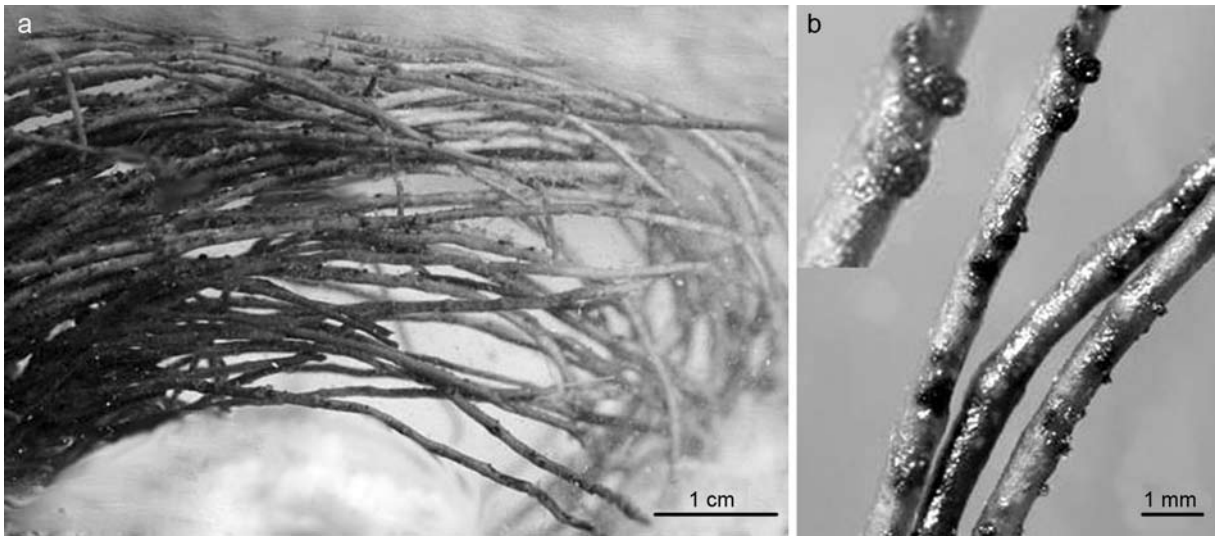

Fig. 3. *Lemanea fluviatilis.* a – thallus; b – thallus with spermatangial papillae

niche, its distribution on the researched area as well as its biology is studied poorly: only one finding was recorded in Lake Bol′šoj Balbanty (basin of Balbanyu, Subpolar Ural) (Sterlyagova & Patova, 2008). The alga inhabits lakes and streams of slow flow, it can be found among thickets of the aquatic mosses and usually together with other red algae species (Kostkevičienė & Vitonytė, 2008) and also *Charales* algae. The density and population dynamics is not studied. The species is under the threat as it has limited distribution and small populations. Limiting factors are disturbed habitats and water pollution, which comes from mining and exploration of minerals. The species was found on the territory of the special protected area Yugyd Va National Park. Monitoring of the state of the population as well as searching of new locations (where species can be possibly found) are needed. In a new addition of the Red Data Book of Komi Republic, the species is included as one that requires biological control.

One more species belonging to freshwater red algae is ***Batrachospermum gelatinosum*** (Linnaeus) De Candolle (Fig. 4). Abundance score: rare. Thallus reaches the length of 2–10 cm; it is covered with mucous; green or olive-gray in colour, sometimes brownish, more or less branched. To the distribution of the species on the investigated area: in tundra, alga dwells in the streams and lakes of Bolšezemelskaja tundra, in the upper flows of Kara, Usa, Kolva Rivers; in taiga, the species can be found in the basins of Svetlyj Vuktyl, Malyj Patok, Schugor, Balbanyu, Kozhym Rivers (Getzen, 1978; Getzen et al., 1994; Sterlyagova & Patova, 2008). The algae inhabits fast streams and springs as well as lakes: it attaches to the rocks and aquatic plants. The species prefers to settle in clean cold water at stable temperature conditions. Changing of environmental conditions has a strong influence on morphological features of the thallus. The species can be found sporadically. The population is low. The species is limited by changes in hydrological conditions, anthropogenic pollution of the water by side effects of oil and gas extracting. The alga is protected on the territory of Yugyd Va, Pechora-Ilych Nature Reserve and other reserves. It is included in many regional Red Data Books of Endangered Species (Konečnaja & Suslova, 2004; Paškov, 2006), including the Red Data Book of NAD (Lavrinenko & Lavrinenko, 2006). As for the Red Data Book of Komi Republic, the species is recommended to be under ecological control.

Among the interesting findings, ***Hydrurus foetidus*** (Villars) Trevisan should be noted (Fig. 5). Abundance score: often. Alga belongs to *Chrysophyta*, which is not common on the studied territory. The alga forms macroscopic colonies in a form of long mucous highly branched bushes with apical growth. The species prefers to settle in low-mineralized, very clean, cold streams with a fast flow. On the studied area, the algae was observed mainly in various mountain streams of the Ural mountain ridge, especially in mountain streams during the periods, when the water temperature raised above 10–14°C. In Polar and Sub-

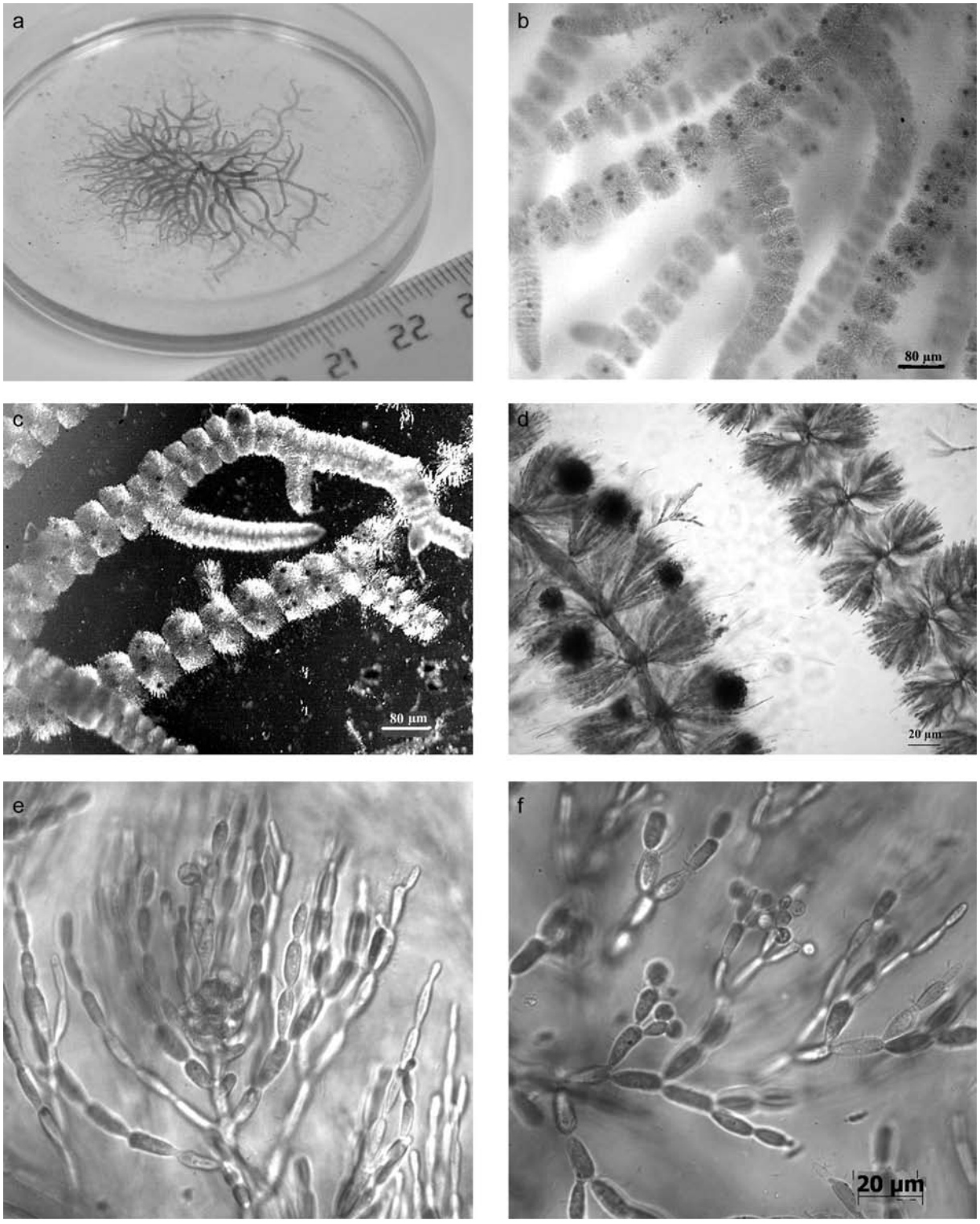

Fig. 4. *Batrachospermum gelatinosum.* a, b, c, d – whorls with carposporophytes; e – trichogina; f – anteridia

polar Urals, the massive development of the alga was registered in the basins of the Kara, Usa, Kožym, Malyj and Bol'šoj Patok Rivers. The colonies sometimes reach the length of more than ten cm and cover the entire mountain stream channel. The species is sensitive to changes in the environmental conditions as it has

narrow ecological amplitude. Limiting factors include disturbance of natural habitat, changes in hydrological conditions, and industrial pollution of water bodies as a result of mineral exploration as well as developing of infrastructure for transportation of hydrocarbons. Due to the wide distribution and high rates of reproduction in mountain streams of the studied area, the species does not need special protection, however, the species population can be recommended to be studied and controlled within its habitat.

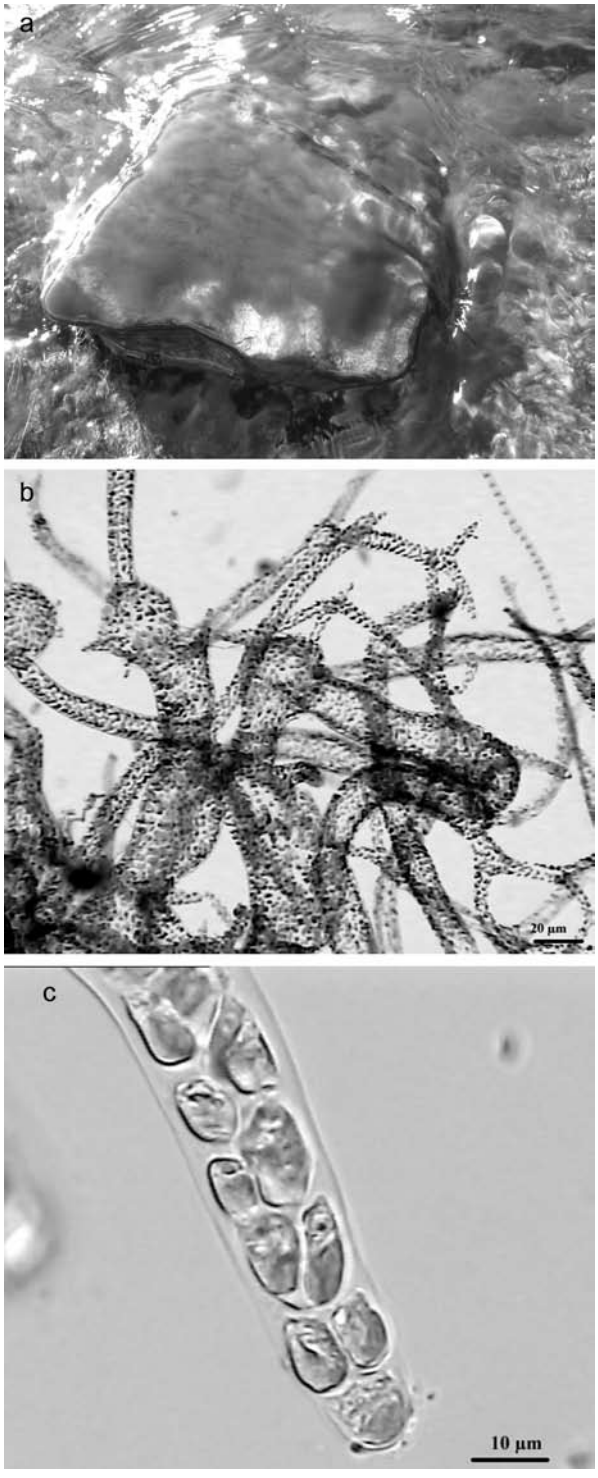

Fig. 5. *Hydrurus foetidus.* a – macroscopic colony; b, c – thalli (microscopic view)

Among the identified algal macrophytes, five belong to *Charophyta* department. The rare freshwater alga is ***Tolypella intricata*** (Trentepohl ex Roth) H von Leonhardi. Abundance score: very rare. The plant is monoecious, usually quite strong, 15–25 cm in height, spreading; green, often with brownish and greyish undertones due to lime encrustation. The alga dwells in stagnant water bodies, mainly in small lakes. On the research area, the species was noted only in NAD region, in Lake Ambarty (basin of the Korotaikha River) (Getsen, 1985; Getsen et al., 1994). Population density in NAD region is very low. Population dynamics was not studied. The main limiting factor is the reduction of growing season in cold years, which shortens fructification period. The factor that narrows distribution of the species is anthropogenic pollution of water bodies. Protection of the species requires a systematic monitoring of its habitats in the lakes of the Korotaikha River basins. Further research is needed to identify new findings of the algae. The species is ascribed to 4th category (a rare species of uncertain status) of the Red Data Book of NAD.

According to literature sources, the ***Tolypella canadensis*** Sawa was found in Russia only on the territory of Bolschezemelskaja tundra (NAD and Komi Republic) (Zhakova, 1995; Langangen & Zhakova, 2002). Abundance score: very rare. The species was found in water bodies of the Bol'šaja Rogovaja River basin, Lake Bol'šoe Harbeito. The alga grows at the bottom (at a depth of 1 to 6 m) of tundra lakes with low salinity, low calcium and high phosphorus content, on pebble-clay, clay-sand, silt-clay soils. The ecology and biology of the species is barely studied. The species is included in the Red Data Book of Komi Republic (3rd category).

In the water bodies of the region, ***Nitella opaca*** (C. Agardh ex Bruzelius) C. Agardh was found. Abundance score: moderately frequent. The plant is dioecious, usually 10–30 cm in height, rather firm; dirty-green or sometimes black in colour, not limed. On the investigated area, few populations of the spe-

cies were found in lakes of Bolschezemelskaja Tundra (Bol'šoe Harbeito), in some glacial and mountain-valley lakes in Polar Urals (Kara River basin, Bol'šaja and Malaja Usa) and in Subpolar Urals (Malyj and Bol'šoj Patok, Schugor, Balbanyu, Kozhim River basins), in the Vychegda River basin. The algae mainly inhabit freshwater stagnant water bodies as well as rivers with muddy, rock-silt, silt-sand bottom. In tundra lakes, under favourable conditions, the species was recorded at a depth of 1–6 m. The findings of the species in Komi Republic are rare. The population density on the territory of the research is low. Species dynamics was not studied. Due to the short lifespan and narrow ecological niche, the species is endangered. The limiting factors are pollution of water (which leads to low water transparency) due to the influence of mining, oil and gas industry and wastewater utility sector. The species is protected in Yugyd Va National Park. The activities leading to habitat disturbance (pollution, littering, etc.) should be banned in the areas of *N. opaca* distribution. Protection of the species also requires monitoring of its populations as well as identification and further protection of new habitats. The species is included in the List of Endangered Species of Tatarstan Republic (Šepovskix, 1995), NAD (Lavrinenko & Lavrinenko, 2006) and Komi Republic as the species that needs biological supervision.

Chara contraria A. Braun is a very rare species on the studied territory. The plant is monoecious, medium-sized, 15–20 (50) cm in height, merely brushed highly incrusted with lime, greyish or brownish-green. On the territory of Komi Republic, the species was found in three karst lakes of Paras′kiny Lake complex (Ukhta basin), natural monument of Komi Republic. The species is a freshwater alga, which dwells in water bodies with high Ca content. The alga grows mainly in coastal zone of small water bodies with clean, clear water. It forms thickets at the bottom of lakes and river backwaters with oozy bottom (Kostkevičienė & Sinkevičienė, 2008). The optimal pH 7.45–8.4 is close to neutral or slightly alkaline. The water of the lakes belongs to the sulfate-bicarbonate-calcium type. Morphological signs of algae vary and depend on the environmental conditions in which the algae grow. Population density and dynamics was not studied. The species is vulnerable due to limited distribution, small population and narrow ecological amplitude. The natural limiting factor is the reduction of growing season in cold years. The decline of population is caused by the decrease of water transparency and anthropogenic pollution of water bodies. The alga is protected in Paras′kiny Lakes. The alga is included in the List of Endangered Species of NAD (Lavrinenko & Lavrinenko, 2006) and in the Red Data Book of Komi Republic (4th category) (Degteva, 2009).

Among the very rare species, ***Chara globularis*** J.L. Thuiller should be noted. The plant is monoecious, mainly medium-sized (15–20 and more cm long), merely brushed, thallium at the base can be encrusted with lime or encrusted, green or brownish-green in colour. The species inhabits small freshwater stagnant water bodies. On the territory of Komi Republic, three findings of the species were noted: in Malyj Patok River basin, in karst lake of the upper stream of the Vychegda River and sapropel Lake Pioneer (Middle Timan). Vulnerable due to small populations and narrow ecological niche. The limiting factor is the reduction of water transparency as a result of mining. The alga was found on the territory of Yugyd Va National Park. The species is in the List of Endangered Species of Moscow (Samojlov & Morozova, 2004) and Belarus (Paškov, 2006), and in Komi Republic as the species that needs biological supervision.

CONCLUSIONS

As a result of the investigation carried out in the north-eastern part of European Russia, ten rare species of algae macrophytes were found and included in the regional Red Data Books of Endangered Species. The main limiting factor for algae development is water pollution, which results from exploration and production of oil, gas and solid mineral deposits and building of infrastructure for hydrocarbon transportation. Further study of the species distribution, monitoring of the identified populations as well as development of actions for species protection are needed.

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RETOS MAKROSKOPINIŲ DUMBLIŲ RŪŠYS PEČIOROS IR VYČEGDOS UPIŲ BASEINUOSE (EUROPINĖS RUSIJOS DALIES ŠIAURĖS-RYTAI)

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Santrauka

Dešimt retų rūšių buvo aptikta gėluose vandens telkiniuose, priklausančiuose Pečioros ir Vyčegdos upių baseinams. Rūšys priskiriamos keturiems dumblių skyriams: *Cyanoprokaryota* – 1, *Rhodophyta* – 3, *Chrysophyta* – 1, *Charophyta* – 5 rūšys. Šios rūšys yra įtrauktos arba rekomenduotos įtraukti į Neneto autonominės srities ir Komijos Respublikos raudonąsias knygas. Straipsnyje pateikiami retų rūšių paplitimo arealai, jų augaviečių charakteristikos ir vystymąsi limituojantys veiksniai.