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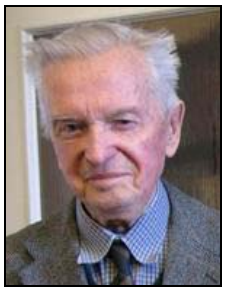

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GEOECOLOGICAL FEATURES OF BELARUS LAKES – THE HABITATS OF RELICT SPECIES *ISOËTES LACUSTRIS* L.

Własow B. P. **Cechy geoekologiczne jezior Białorusi jako miejsc występowania reliktowego gatunku *Isoëtes lacustris* L.** Na obszarze Białorusi stwierdzono 16 jezior, w których występuje reliktowy gatunek ryblin jeziorny *Isoëtes lacustris* L. Jeziora badano w latach 1972–2011. Populacje gatunku *Isoëtes lacustris* L. W jeziorach różnią się morfologią roślin, obfitością, częstością występowania, pokryciem projekcyjnym. Rozwój populacji gatunku ograniczają morfometryczne wskaźniki mis jeziornych, hydrofizyczne i hydrochemiczne parametry środowiska. Ocena tolerancji gatunku w stosunku do środowiska występowania pozwala na określenie warunków środowiskowych: jako optymalne dla 4 jezior (Biełoje w rejonie łuninieckim; Briedno, Głubokoje, Czerbomysło), niesprzyjające – dla 3 (Biełoje w rejonie gorodeckim; Biełoje w rejonie miadziolskim; Świteź) oraz jako normalne – dla kolejnych 8 jezior. Istniejące zgrożenia dla gatunku i niesprzyjające warunki środowiskowe prowadzą do dewastacji i zaniku roślin. Najbardziej znaczącym zagrożeniem dla *Isoëtes lacustris* L. jest eutrofizacja jezior, alkalizacja wód oraz mechaniczne niszczenie (wydeptywanie) roślin.

Власов Б. П. **Геоэкологические особенности озер Беларуси – мест обитания реликтового вида *Isoetes lacustris* L.** В Беларуси зарегистрировано 16 мест обитания реликтового вида. Озера изучали в период с 1972 по 2011 гг. Популяции вида *Isoëtes lacustris* L. в озерах различаются морфологией растений, обилием, частотой встречаемости, частным проективным покрытием. Развитие популяций вида ограничивают морфометрические показатели котловин, гидрофизические и гидрохимические параметры среды. Оценка толерантности вида к среде произрастания позволяет характеризовать условия среды озер как оптимальные для 4-х озер (Белое, Лунинецкий р-н; Бредно, Глубокое, Чербомысло), неблагоприятные – для 3 (Белое, Городокский р-н; Белое, Мядельский р-н; Свитязь) и как нормальные – еще для 8-ми озер. Существующие угрозы виду и неблагоприятные условия среды приводят к угнетению и гибели растений. Наиболее значимой угрозой произрастанию *Isoëtes lacustris* L. служат эвтрофикация озер, подщелачивание вод и механическое уничтожение (вытаптывание) растений.

Key words: lakes, *Isoëtes lacustris* L., isoetid lakes, environment parameters, anthropogenic impact

Abstract

In Belarus 16 habitats of relict species lake quillwort (*Isoëtes lacustris* L.) are registered. Lakes were studied in the period from 1972 to 2011. Populations of *Isoëtes lacustris* L. in the lakes differ with morphology of plants, abundance, frequency of occurrence, partial projected foliage cover. Development of populations of the species is limited by morphometric characteristics of lake hollow, hydrophysical and hydrochemical parameters of the environment. Evaluation of lake quillwort tolerance to environmental conditions allows us to characterize lakes' parameters as optimal for 4 lakes (Beloe, Luninets district; Bredno; Glubokoe; Cherbomyslo), non favorable, which has led to the oppression of the population and destruction of plants (Beloe, Gorodok district; Beloe, Myadel district; Svityaz') and normal for 8 lakes. The most significant threats to growth of *Isoëtes lacustris* L. are changes in the lakes' level, eutrophication of lakes, alkalizing of water, mechanical destruction of plants.

INTRODUCTION

Isoëtes lacustris L. (photo 1) is rare boreal amfiatlantic relict species, which grows on limited areas in lakes of North America, North, Central and Eastern Europe, isolated populations are recorded in the Ural Mts and Western Siberia. In Belarus lake habitats of *Isoëtes lacustris* (photo 2) are located on the south-eastern boundary of the area of species distribution in the island locations. Protection category – 3, included in the Red List of Belarus (1981, 1993, 2005).

Photo 1. *Isoëtes lacustris* L. of Glubokoe lake, Polotsk district (phot. by B. P. Vlasov)
Fot. 1. Poryblin jeziorny *Isoëtes lacustris* L. z Jez. Głubokoje w rejonie połockim (fot. B. P. Własow)

Photo 2. Typical habitat of *Isoëtes lacustris* L. – Glubokoe lake (phot. by B. P. Vlasov)
Fot. 2. Typowe siedlisko *Isoëtes lacustris* L. – Jez. Głubokoje (fot. B. P. Własow)

Development of populations is determined by environmental factors and first of all by such as pH, transparency of water, mineralization, nutrient (nitrogen and phosphorus) and organic matter content. As a result of anthropogenic impact – eutrophication of lakes and alkalizing of water, mechanical destruction of plants (trampling) and other threats, distribution of *Isoëtes lacustris* L. populations during recent decades has been decreased dramatically. As a result of eutrophication the number of lakes habitat of Lake Quillwort has declined in Germany and Netherlands by more than 87%, in Poland by 11%, by 50% for the last 100 years in Denmark. Less rate of extinction of isoetid lakes is observed in Scandinavia, Great Britain and Ireland (VÖGE, 2002; 2004; FREE *et al*., 2009; ARTS GHP, 2002).

The current threat of extinction of species requires objective information on the ecological state of its habitats: environment parameters of lakes and existing risks to populations (types, exposure sources and concentrations of pollutants). Effective measure for the species conservation can be development of the protection strategy, including of lake habitats in the list of protected areas and monitoring of populations, which is part of the governmental policy in the field of nature conservation and environmental protection. Goals and objectives of *Isoëtes lacustris* populations monitoring as well as their habitats meet the overall objectives of the integrated monitoring of the environment, which includes observation, evaluation and prediction of anthropogenic changes in the state of ecosystem, and its responses to these changes.

MATERIALS AND METHODS

Study area

Studies have been conducted in the area between 52° and 56° φ N and between 25° and 30° λ E. The climate of Belarus is moderately continental with cold, wet winters and warm summers. Annual precipitation is 650–750 mm, the average January temperature in the range from -4°C to -8°C, in July: +17÷+19°C. Average growing season is within range 184–208 days. The study of lakes and aquatic vegetation were carried out during growing season annually from 1973 to 2010. Sixteen lakes for which occurrence of *Isoëtes lacustris* L. was reliably proofed by herbarium specimens were studied. In Lake Beloe (Belozersk district) habitation of the species was not confirmed since 1970. List and characteristics of lake habitats of known populations of *Isoëtes lacustris* in Belarus are presented in fig. 1 and table 1.

Lake characteristics

Research of the following parameters of lakes – habitats of *Isoetes lacustris*, was conducted: morphometry and structure of the lake hollows, catchment area and structure, the chemical composition of the water (the content of major ions and nutrients) and bottom sediments. Water transparency was measured by Secchi disk, color of water was assessed by chromium-cobalt scale. Depth maps and distribution of sediments in all studied lakes were plotted.

Study subject

The study of *Isoetes lacustris* L. was conducted at the highest water vegetation survey according to the method (VLASOV, GIGEVICH, GRISHENKOVA, 2011). It were assessed species composition of macrophytes, width and depth of growth, biomass of plants (dry weight), layering, occurrence of species (1–7 points), the abun-

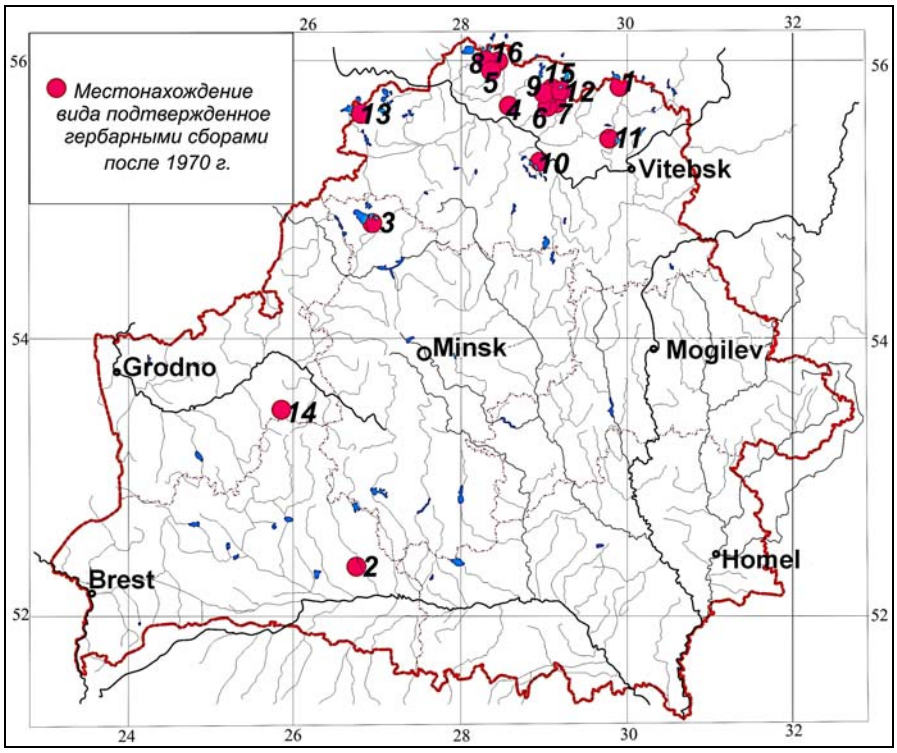

Fig. 1. Location of lakes, habitats of *Isoëtes lacustris* L. in Belarus
Rys. 1. Lokalizacja jezior, w których występuje *Isoëtes lacustris* L. na obszarze Białorusi

Table 1. List of known populations of *Isoëtes lacustris* L. on the territory of Belarus
Tabela 1. Lokalizacja i charakterystyka znanych populacji *Isoëtes lacustris* L. na obszarze Białorusi

Number	Lake, district	Location		Lake area, km²	Lake depth, m	Characteristics of populations				Measures of protection, monitoring of populations*
		N	E			AD	PFPC	O	B	
1	Beloe, Gorodok	55°49'29"	29°53'10"	2.5	8.9	2	10	10	0.024	Nature reserve "Surimno"is planned to organize (1)
2	Beloe, Luninets	52°22'59"	26°38'35"	0.2	17	5	50	90	0.360	Biological reserve "Luninsky" (1, 2)
3	Beloe, Miadel	54°07'82"	26°24'52"	1.9	8.1	1	10	10		NP "Narachansky" (1, 2)
4	Beloe, Polotsk	55°37'20"	28°37'49"			3	30	20		Establishment of protection regime of the area is required
5	Beloe, Rosson	55°59'34"	28°27'52"	1.2	6.6	3	30	30	0.062	LR "Krasny Bor", status IBA (1, 2)
6	Beloe B., Polotsk	55°40'43"	29°33'21"	1.5	10	3	30	10		Establishment of protection regime of the area is required
7	Beloe M., Polotsk	55°40'25"	29°32'4"	0.9	11	3	30	30		Establishment of protection regime of the area is required
8	Bredno, Rosson	55°59'54"	28°28'55"	0.3	4.7	5	30	100	0.124	LR "Krasny Bor", status IBA (1, 2)
9	Glubokoye, Polotsk	55°41'42"	29°27'5"	0.4	12	3	40	50		SNR "Glubokoe- Velikoe Ostrovito" (1)
10	Krivoe, Ushachi	55°9'56"	29°1'54"	4.5	32	3	20	30	0.10	SNR "Krivoe" (1, 2)
11	Losvido, Gorodok	55°22'45"	30°1'50"	11.4	20	3	30	20		Establishment of protection regime of the area is required, (1)
12	Ostrovito V., Polotsk	55°41'35"	29°31'50"	0.5	6	3	40	30		SNR "Glubokoe-Velikoe Ostrovito"
13	Richi, Braslav	55°41'42"	26°41'50"	12.9	52	3	50	20	0.132	SNR "Richi" (1)
14	Svitiaz, Novogrudok	53°25'59"	25°54'58"	2.2	15	2	10	10		LR "Svitiaziansky" (1)
15	Cherbomyslo, Polotsk	55°41'45"	29°28'31"	0.5	6.9	5	80	90		SNR "Glubokoe- Velikoe Ostrovito"
16	Okunevets, Rosson	56°01'34"	28°32'53"	0.2	-	-	-	-	-	LR "Krasny Bor", status IBA (1, 2)

**Note: AD – Abundance Drude, in balls; PFPC – Partial foliage projective cover; O – Occurrence,%; B - Biomass, kg/m²; NP – National Park; LR - Landscape reserve; SNR – State Nature Reserve; 1–Index plot of water plants monitoring of the National System of monitoring of Environment (IP WPM); 2 – survey points of integrated monitoring of the National System of monitoring of Environment (SP IM)*

dance (1–6 points), partial foliage projective cover (1–100%). Tolerance of species to the environment was evaluated with respect the above-mentioned indicators as following: “Optimum" (coenotic and environmental) correspond to the maximum values, "Oppression" – the minimum values, "Extinction" – the presence of individual plants. Maps showing the distribution of water vegetation and weediness in the locality of *Isoetes lacustris* growth were plotted.

RESULTS

Lake parameters

According to typification of lakes by the species composition of vegetation, the character and extent of growth of aquatic vegetation (GIGEVICH, VLASOV, VYNAEV, 2001), the lakes – places of the of *Isoëtes lacustris* L. growth are belong to the isoetid type, often called also as Lobelia lakes, which possess a number of specific characteristics and allow to select them as individual group. Almost all isoetid lakes in Belarus are of glacial origin, only some are karst (Lakes Svityaz', Beloe, Luninets district). All lakes are shallow and not great by area. Hollows have a simple structure: a round or oval by shape, slightly sinuous coastline, funneled shape structure of the bottom. Littoral (1.0–1.5 meters depth) is narrow, flat, occupies usually 10–20% of the water area, composed of sands and silted sands. Sublittoral slope is not wide, steep, composed of sandy silt. Lake bed is flat, composed of detrital sapropel. The coasts are usually steep, formed by sand and peat, covered with wetland vegetation. The floodplain is not expressed. The slopes of the hollow are of 5–10 meters height, steep, with some slope areas, composed of sands, mostly covered by forest, rarely occupied by areas of mixed grassy meadows. Watersheds have a small area, mainly composed of sand, covered with pine trees. Catchment area of majority of lakes has small spot of upland bogs adjacent to the aquatorium. By hydrological indicators most lakes are weakly running, evaporation or drain reservoirs. Lake Richi, Losvido and Krivoe have inflow of surface water from the catchment area. The main parameters of lakes are presented in table 2.

Table 2. Diapason of variation and the mean values of morphometric parameters of isoetid lakes in Belarus
Tabela 2. Zakres zmian średnich wartości parametrów morfometrycznych jezior Białorusi, w których występuje *Isoëtes lacustris* L.

Indices	min – max	Mean ±SD
Mirror area, km²	0,23–12,89	2,80±3,96
Maximum depth, m	4,70–51,90	,28±12,37
Medium depth, m	1,90–10,20	5,40±2,60
Length, km	2,58–7,08	2,58±2,11
Maximum width, km	1,4 –4,88	1,41±1,24
Medium width, km	0,71–2,06	0,71±0,52
Coastline length, km	1,70–33,44	9,05±9,58
Water-shed area, km²	0,31–123,00	21,65±41,44
Under forest, %	17,00–100,00	75,88±27,92
Under wetland, %	0,00–13,00	1,98±4,44

Hydrochemical parameters of water body of lakes are influenced by the nature of water supply and shape of the basin. Water body is clearly stratified, temperature and dissolved gases are reduces, and the concentration of major ions increases from the surface to the bottom. The surface layers of water in the summer are warmed up well (19–21°C) and saturated with oxygen (81–113%), the content of free carbon dioxide is 0.9–6.6 mg/l. Water clarity is high – 2.0–9.5 m, colour of water is low (5–40 grad. by Cr–Co scale). Active reaction of water changes ranges from acidic (pH value of pH 4.5) to alkaline (pH 8.2) (table 3). In the chemical composition of water the lakes belongs to the hydrocarbonate class of calcium group. The structure of the ion composition can be presented as:
$HCO_3^- > SO_4^{2-} > Ca^{2+} > Cl^- > Mg^{2+} > Na^+ > K^+$

Mineralization of water in the lakes is 23–230 mg/l. The ratio of lakes with salt content up to 50 mg/l is 44%, with a mineralization over 200 mg/l – 18% of the isoetid lakes. For the content of chemical elements in the water stratification is also stated: at depth increasing the content of all core elements of mineralization is growing. The content of nutrients during growing season is low (total nitrogen 0.01–0.8 mg/l, phosphate is about 0.01–0.02 mg/l). The amount of organic matter as minor: permanganate oxidation is 0.7–9.8 mg O_2/l, bichromate – 4,7–47,2 mg O_2/l.

Isoëtes lacustris characters

In of the studied lakes *Isoëtes lacustris* L. is the main cenosis creating species, which form the lower layer of the aquatic plants. Species grows mainly in lakes in areas of shallow littoral zone at a depth of 60 to 150 cm. In the two lakes (Cherbomyslo; Beloe, Luninets district) it grows in the littoral and on a flat bed on the depth of 4.0–5.0 m, where it forms underwater meadows. As a rule species forms pure or mixed associations. *Lobelia dortmanna* L. is an accompanying cenosis creator (Svityaz'; Bredno; Beloe, Luninets district). Species prefers ecotopes with sandy silt and silty detrital soils.

In the lakes with favorable environmental conditions species density varies from 4 (on the periphery of the association) to 6 points (under optimal conditions for the growth; table 1). Partial foliage projective cover is 30–100%. In the lakes with

Table 3. The range of variation and the mean values of hydrochemical parameters of the water body of the lakes, habitats of Lake Quillwort (*Isoëtes lacustris* L.)
Tabela 3. Zakres zmian średnich wartości parametrów hydrochemicznych wód jeziornych, w których występuje poryblin jeziorny (*Isoëtes lacustris* L.)

Parameters	min – max	Mean ±SD
Transparency, m	1,90–9,50	4,57±1,70
Water color index, Cr - Co	5,00–20,50	14,37±4,62
pH	4,85–8,51	7,20±1,00
HCO_3, mg/l	5,80 –140,02	45,64±43,14
Ca, mg/l	2,27–37,29	11,65±11,51
Mg, mg/l	0,24–11,41	2,94±3,19
Cl, mg/l	1,25–10,63	3,51±2,71
SO_4, mg/l	1,00–12,60	6,27±3,60
Fe, mg/l	0,00–0,23	0,10±0,07
Si, mg/l	0,00–1,12	0,37±0,37
Na+K, mg/l	0,51–6,00	2,77±1,82
Nitrite nitrogen, NO_2, mg/l	0,01–0,20	0,05±0,08
Nitrate nitrogen, NO_3, mg/l	0,01–0,23	0,09±0,07
NH_4, mg/l	0,06–1,40	0,35±0,40
PO_4, mg/l	0,00–0,08	0,02±0,02
P_{tot}, mg/l	0,00–0,06	0,02±0,02
Mineralization, mg/l	16,60–215,45	70,87±66,38
Permanganate oxidizability, mgO_2/l	0,72–7,65	4,71±2,00
Bichromate oxidizability, mgO_2/l	3,20–47,20	21,91±15,05

the most optimal conditions for the growth (Glubokoe, Cherbomyslo, Bredno) for 1 m^2 of the bottom there are 20–30 plants, plant height ranges from 9–11 cm, rarely up to 13 cm. Occurrence of species in the lakes varies significantly: 4 lakes has the occurrence from 50 to 100%, 4 lakes – 30%, 6 lakes has less than 30% of species occurrence (table 1).

Hydrophyton of aquatic plants by the degree of adaptation to the aquatic environment is presented by following species: water – *Lobelia dortmanna* L., *Menyanthes trifoliata* L., *Calla palustris* L., *Phragmites australis* (Cav.) Trin. ex Steud., *Schoenoplectus lacustris* (L.) Palla, *Equisetum fluviatile* L., *Sparganium gramineum*, *Eleocharis palustris* (L.) Roem. et Schult., *Juncus conglomeratus* L., *Carex omskiana* Meinsch, fully submerged in water plants – *Nuphar lutea* (L.) Smith, *Potamogeton natans* L., *Persicaria amphibia* (L.) S.F. *Gray f. aquatica)*, floating on the water surface with leaves and flowers – *Litorella uniflora* (L.) Aschers., *Nitella gracilis* (G. M. Smith) Ag., *Utricularia vulgaris* L., *Potamogeton lucens* L., *Potamogeton praelongus* Wulf., *Potamogeton perfoliatus* L., *Myriophyllum verticillatum* L., *Drepanocladus Sendtnen* Warnst.

DISCUSSION

Evaluating the role of limnological parameters as limiting factors of *Isoëtes lacustris* L. growth and development in reservoirs of Belarus the statistical data processing of integral natural observations was conducted. The correlation between morphometric and physicochemical parameters of the lakes during the growing season and value of species density (by scale of Drude), partial foliage projective cover and occurrence were estimated.

The results of the analysis showed that the environmental and climatic conditions – fluctuations of temperature and water level vary in the range of longstanding mean values and generally favorable

for the growth of species throughout the country, but lake habitats of *Isoëtes lacustris* L. possesses azonal features. Morphometric characteristics of lakes have a wide range of variability and are not limiting factors for the species growth. The exception is the area of shallow with a depth up to 2 meters, which in combination with the water transparency value limits the area of plant growth in the lake aquatorium. In spite of the seasonal variation physicochemical parameters for the selected isoetid lakes have similar values, for the others large scale of fluctuation limits was revealed.

Lakes that serve as habitats for *Isoëtes lacustris* have a number of specific features. According to the distribution dendrogram the lakes are combined into three clusters with similar characteristics of the populations and habitat conditions (fig. 2). The first group consists of mesotrophic lakes: Krivoe, Losvido, Richi. This lakes are characterized by large lake and catchment area (4–12.8 km^2 and 65–123 km^2, correspondingly), great depth (from 20 to 51 m), the presence of surface flow and low proportion of forests (17–32%). Hydrochemical parameters are characterized by high mineralization (140–240 mg/l), high acidity (range of summer pH values is 7.3–8.5), water color index is ≥ 20°, the concentration of total phosphorus lies in the diapason 0.02–0.03 mgP/l. The species composition of macrophytes at this lake group is rich (about 20 species). Populations of *Isoëtes lacustris* in this locations are characterized with medium to low values of abundance, occurrence and projective foliage cover of the species (table 1).

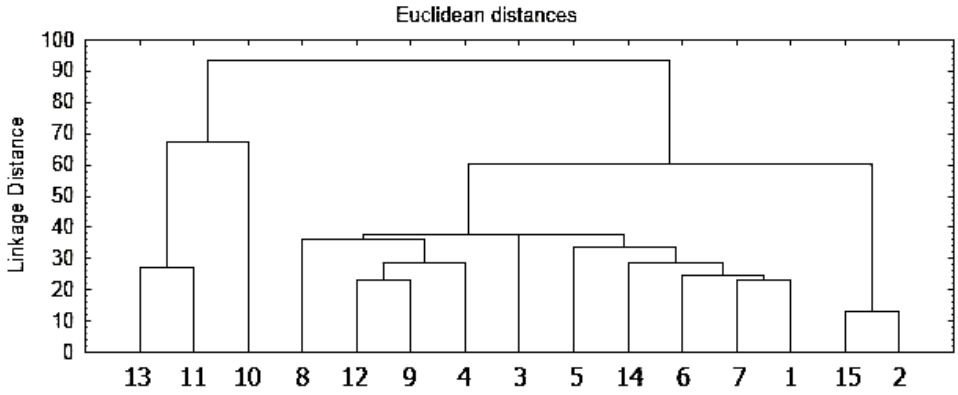

Fig. 2. Dendrogram of distribution of lakes by characteristics of *Isoëtes lacustris* populations and its habitats. Notes: Lakes are indicated by the numbers as in table 1.
Rys. 2. Dendrogram rozmieszczenia jezior na podstawie charakterystyki populacji *Isoëtes lacustris* i ich siedlisk. Uwaga: numery jezior jak w tab. 1.

Of great interest are the second, the largest (more than 50% of the lakes) group, that includes acidotrophic (Bredno, Glubokoe, Bol'shoe Ostrovito) and mesotrophic (Beloe, Gorodok district; Beloe Maloe; Beloe Bol'shoe; Svityaz'; Beloe, Polotsk district) lakes. The lakes have a small water surface area (0.2–1.5 km^2) and catchment area (0.3–1.9 km^2), which is covered with forest and bogs (50–100%). Physicochemical parameters of the water body of this group are characterized by low mineralization (12–80 mg/l), summer acidity values at a range pH 4.8–7.2, color of water values about 10–20°, concentration of total phosphorus 0.01–0.03 mgP/l, high water transparency at diapason from 4 to 9.5 m.

Populations of *Isoëtes lacustris* L. of this habitats are basically characterized with values from average (acidotrophic lakes) to low (mesotrophic lake) of abundance, projective foliage cover and occurrence of the species.

In smallest third cluster were segregated two lakes – acidotrophic Cherbomyslo and mesotrophic Beloe (Luninets district), which are characterized with the maximum values of indicators of *Isoëtes lacustris* populations growth and development (abundance, the projective foliage cover and occurrence), in general indicating this lakes are optimal coenotic and environmental conditions for species habitat. Only in this lakes there were recorded most productive mats of *Isoëtes lacustris* L., which forms the "underwater meadows" at depths of 2–4 m. Individual plants of the species are characterized by specific morphological features as described (VÖGE, 2002).

For the evaluation of the contribution of specific environmental factors (hydrochemical parameters of aquatic habitat) for the state and development of

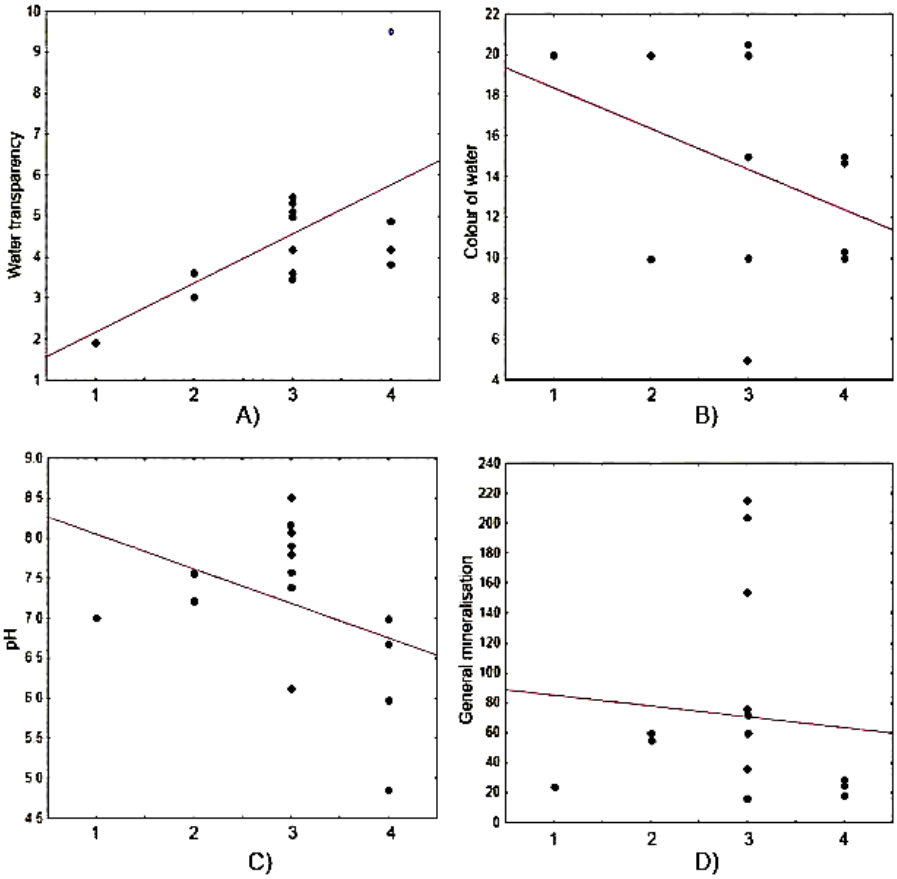

Fig. 3. The distribution pattern of indicators of *Isoëtes lacustris* L. populations' cenotical characteristics (tolerance), depending on the limiting environmental factors: water transparency (A), colour of water (B), acidity pH (C), general mineralisation (D). Note: X – axis: 1 – " Extinction", 2 – "Oppressed", 3 – "Norma", 4 – "Optimum".
Rys. 3. Rozmieszczenie wskaźników charakterystyki cenotycznej populacji *Isoëtes lacustris* L. W zależności od czynników środowiskowych: przezroczystości wody (A), koloru wody (B), kwasowości pH (C), mineralizacji ogólnej (D).
Примечание: na osi X: 1 – „wymieranie", 2 – „dewastacja", 3 – „norma", 4 – „optimum"

Isoëtes lacustris population in Belarusian lakes it was assessed the correlation between hydrophysical parameters and population's cenotical status. It was revealed that the most significant influence has pH value, transparency, colour of water, in less extent mineralization, and the balance of optimal values of these parameters for the development of the species was estimated (fig. 3).

Environmental threats for the *Isoëtes lacustris* populations

Almost all lake habitats of *Isoëtes lacustris* L. are organized for the protection within national hydrological and landscape reserves (table 1). Anthropogenic impact on protected areas is governed by the guidelines and protection regimes. The shore lands and watersheds of the lakes, except Krivoe, Losvido and Richi have no settlements and agricultural land, however, the lakes with scenic coastline are extensively used for recreation and tourism, amateur fishing. It is possible to mention the main threats to *Isoëtes lacustris* habitats in Belarus: change in chemical composition of water and eutrophication of lakes in the result of intensive recreational use of aquatoria and coasts (Svityaz', Beloe, Myadel district). Eutrophication is manifested as increasing of the concentration of nitrogen and phosphorus, hydrogen index (pH), reducing transparency. Mechanical damage and trampling of plants by swimmers, damage by fishing tools (nets, anchors) are also pose a threat to the species populations (VLASOV, 2012).

Effective measure to preserve the species *Isoëtes lacustris* is the use of designed procedure of evaluation of populations and their habitats, based on integrated ecological and genetic monitoring, aimed at the evaluation of the genetic diversity parameters of the populations through the use of DNA markers (SCHWARTZ, 2007; VLASAVA *et al.*, 2011). According to obtained data (Vlasava N. B. – personal communication), population-genetic parameters for the 4 studied localities (Beloe, Lininets district; Svityaz', Glubokoe, Cherbomyslo) on the basis of designed

for *Isoëtes lacustris* L. RAPD-and ISSR-markers were identified; extremely vulnerable populations with low adaptive genetic potential were revealed (Svityaz' and Beloe) among studied. Based on the habitat monitoring data of *Isoëtes lacustris* L. and quantitative characteristics of genetic resource of the species evidence-based recommendations for the conservation of gene pools of the species according to the level of intra- and interpopulation genetic diversity were proposed (VLASAVA, VLASOV, DZHUS, 2012).

CONCLUSIONS

As a result it is possible to conclude, that on the territory of Belarus there is a very limited number of lakes favorable for the habitat of *Isoëtes lacustris* L. According to limnological characteristics and the type ranking investigated lakes have azonal character. Population differences indicate that only about 2/3 of the total number of lakes possesses favorable conditions for sustainable growth of the species. Based on long-term monitoring data it is possible to assume physical and chemical parameters of the environment (transparency, pH, color, total mineral waters) as a main limiting factor of *Isoëtes lacustris*. distribution. In the wake of the widespread process of lakes' eutrophication there is a risk of deterioration of water quality and the extinction of relict species *Isoëtes lacustris* L. Effective measure to preserve the species from the danger of extinction includes the organization of the monitoring, creation of nature reserves, strict observation of conservation regime, restriction for the use of the territories − habitats of the endangered species.

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