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DIVERSITY OF DIATOMS IN PHYTOBENTHOS COMMUNITIES OF THE SHCHUGOR RIVER IN THE URALS (THE KOMI REPUBLIC, RUSSIA)

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Abstract

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The composition of diatom assemblages of epilithon, epiphython and epipelon in the Shchugor River was presented. Biofoulings of rocky substrates, macrophytes, filamentous algae and samples from the surface of bottom sediments were studied. The diatom assemblages had a diverse composition and included 218 species with varieties and forms from 60 genera, 27 families and 12 orders. The order Naviculales (56 taxa) and the family Fragilariaceae (39 taxa) played a major role. The genera *Gomphonema* (17 taxa), *Nitzschia* (16), *Navicula* (14), *Eunotia* (14) were dominant by the species abundance. The identified diatoms were mostly epiphytes, indifferent to salinity and alkaliphilous species, clean water indicators. The most common community in the river was epilithon, whereas epiphyton distinguished by the most diverse composition. The epipelon was poorly developed, having the lowest number of diatom taxa.
Dominant, subdominant, accompanying species of the diatoms were very similar in different phytobenthos groups, the Sørensen-Czekanowski coefficients varied from 0.70 to 0.81. The dominant species were *Achnanthidium minutissimum*, *Encyonema minutum*, *Fragilaria gracilis*, *Gomphonema exilissimum*, *G. ventricosum*, *Hannaea arcus*, *Meridion circulare*. The sub-dominant species were *Cocconeis placentula*, *Nitzschia fonticola*, *Ulnaria ulna* and *Staurosirella pinnata*. Based on the Berger-Parker and Simpson variety indices, the occurrence of taxa in the genera and families in the epiphyton was more uniform. The assessment of benthic diatoms demonstrated that the Shchugor River is a typical mid-mountain river. Diatom communities of epilithon, epiphython and epipelon can be used for the monitoring of ecological status of the river.

Keywords: diatoms, diversity, epilithon, epipelon, epiphyton, Shchugor River, Urals.

INTRODUCTION

The rivers of the Urals, the Pechora River tributaries, are highly important as qualitative freshwater sources and habitats for various water organisms, including valuable fish species such as *Salmo salar* Linné. The Shchugor is a typical river on the western slope of the Urals, the right Pechora tributary. It is 300 km long and flows on the territory of the Komi Republic in Yugyd va National Park. The main gas pipeline crosses the upper part of the river. Until the year 2000 there were no bridges there, and so the gas pipeline has made a negative impact on the zoobenthos and fish population (Šubina, 2006). The lower course of the river is experiencing anthropogenic influence because of the development of tourism. The available data on the river ecosystem are insufficient; this is especially true of the algal flora with significant bioindicative properties. The protected water ecosystem cannot be monitored without the knowledge on species composition and structure of diatoms, the most indicative group of algae.

To date, the previously obtained data on algal flora of the Shchugor River (Gecen, 1971; Šubina, 1986) have been completed by the studies on the composition of diatoms in epilithon (Stenina & Sterljagova, 2017), a short characterization of the communities of attached algae (Sterljagova & Stenina, 2018), and the annotated checklist of diatoms (Stenina, 2019). So far, nothing was known about benthic assemblages. The purpose of the present study was to assess the diatom composition in epilithon, epiphyton, and epipelon communities of the Shchugor River and to discuss the suitability of benthic diatom taxonomic structure for the monitoring of water quality of the rivers.

MATERIALS AND METHODS

The Shchugor River begins at the height of 720 m on the southern slope of the Jaruta Mountain in the Subpolar Urals (Roščevskij, 2000). The river bed is covered with large pebbles and boulders. The upper river is prominent through high flow rates; the mean stream is of small depth with shallow shoals. The river is nourished mainly with snow (55%), which explains a low concentration of principal ions and a neutral water medium reaction. The composition of the main ions is hydrocarbonate-calcium. The mineralization index is 33.8–50.2 mg dm^{-3}, the conductivity 47–58 µS cm^{-1}, and the pH 7.1–7.3.

Qualitative samples of algae were collected from the middle part (125 m a.s.l.) and upstream (285 m a.s.l.) of the river from two sites in July 2015 and from one site in July 2016 (Fig. 1). These points occur at a distance of 56–108 km from the gas pipeline, where the river retains conditions to a greater extent close to natural.

Diatoms were sampled at each site from all types of habitats (epilithon, epiphyton, epipelon) if they were present and within the different places along the river bank. Epilitic diatoms were brushed from the whole upper surface of the several (4–5) stones (subsamples), preserved within 4% formalin and were placed into collecting vials. In order to sample epiphytic diatoms, the surface of the same 4–5 aquatic macrophyte (*Batrachium* spp., *Caltha palustris* L., *Carex* spp., *Equisetum* spp.) was washed off by hands. Mosses and macroalgae were taken as a whole. Diatom subsamples from different points of

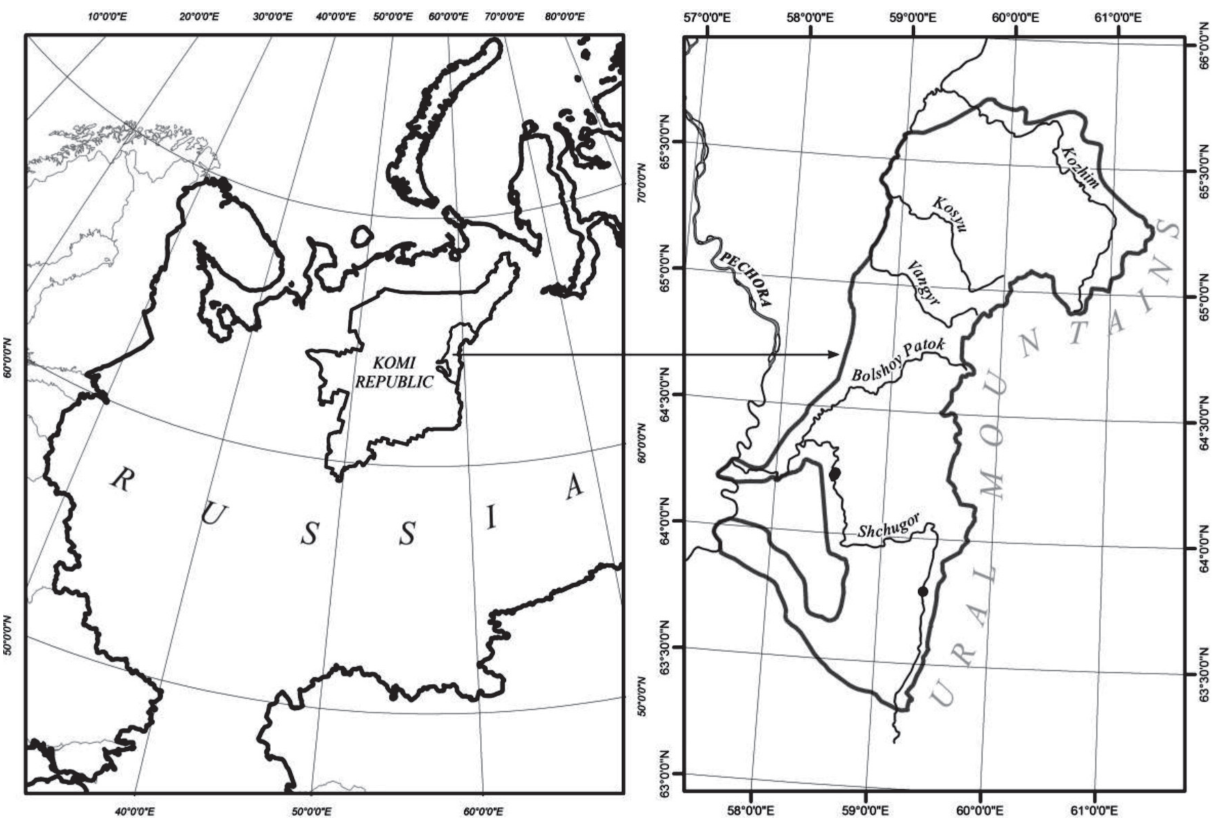


Fig. 1. Location of sampling sites on the studied river in the Ural Mountains. The boundaries of National Park "Yugyd va" are marked on the map

each site were pooled obtaining one combined sample for each substrate. We sampled epipelic forms present on the surface from the bottom at 40 cm depth, with a pipe, diameter of 1 cm. A total of 18 samples were collected (six samples from each site).

At the laboratory, the portions of each sample were boiled in concentrated sulphuric acid to eliminate organic matter and washed with distilled water. A small portion of the solution containing cleaned diatom frustules was dried on cover slips that were mounted in Elijashev mountant. Identifications were made using a light microscope Biolam–I with ×1500 magnification upon oil immersion.

Identification to a species level was done using recent identification books and floristic reports (Krammer & Lange-Bertalot, 1986, 1988, 1991a, 1991b; Krammer, 2000, 2003; Kulikovskij et al., 2016; Čudaev & Gololobova, 2016). The nomenclature changes were specified by Algaebase (Guiry & Guiry, 2018). The degree of similarity in the composition of diatoms was estimated by the Sørensen–Czekanowski coefficient (Magurran, 1992). The abundance was evaluated by semi-quantitative method in points from 1 to 6 in each slide: 1 – less than 10 valves in slide, very seldom; 2 – 10 valves in slide, seldom; 3 – 1–10 valves in a row, not seldom; 4 – 11–25 valves in a row, often; 5 – 26–50 valves in a row, very often; 6 – more than 50 valves in a row, in the mass.

Dominant were the species with the abundance value of six (6) points, sub-dominant ones with the abundance value of 4–5 points, and accompanying species with the abundance value of 3 points. Taxa belonging to the groups of 3–6 points by abundance represent the dominant community of diatoms (DC). The structural taxonomic diversity measures were the Shannon (H), the Simpson (S) indices, the Berger-Parker dominant index (B–P), the equitability (E), and the Pielou (P) index (Magurran, 1992) calculated using the information about the relative abundance of species and intraspecific taxa. We used Student's *t*-test in the work to compare the composition of diatoms in assemblages (Pesenko, 1982).

Algal samples are deposited at the Herbarium of the Institute of Biology of the Komi Scientific Centre of the Ural Branch of the Russian Academy of Sciences (SYKOA).

RESULTS AND DISCUSSION

Taxonomic composition of the phytobenthos

As the investigated phytoplankton was underdeveloped in the river bed and included single algae from other communities, we considered to study only benthic diatom flora. According to the results of the study on epilithon, epiphyton and epipelon, the Shchugor River contained 218 taxa from 60 genera, 27 families and 12 orders. There were six main orders, which included over 10 taxa below genus in each: Naviculales (56 taxa), Cymbellales (39), Fragilariales (39), Achnanthales (30), Bacillariales (17), Eunotiales (14). There were eight main families such as Fragilariaceae Round (39), Achnanthidiaceae D.G. Mann (25), Gomphonemataceae Kützing (23), Naviculaceae Kützing (21), Bacillariaceae Ehrenberg (17), Pinnulariaceae D.G. Mann (16), Cymbellaceae Gréville (15), Eunotiaceae Kützing (14 taxa). Six genera dominated by taxa diversity, i.e. *Gomphonema* Ehrenberg (17 taxa), *Nitzschia* Hassal (16), *Navicula* Bory de St.-Vincent (14), *Eunotia* Ehrenberg (14), *Fragilaria* Lingbye (11) and *Pinnularia* Ehrenberg (11).

Diatom species of different ecological groups

In general, the diatom composition of the Shchugor River was dominated by epiphytes (88 taxa; or 41%), species indifferent to water salinity (111; 51%), halophobous (79; 36%) or alkaliphilous with alkalibiontic (92; 42%), clear water indicators (97; 44%).

Epilythic diatoms

Epilithon was the most common assemblage in the Shchugor River, because the river bottom was covered with stone grounds by 90% (Šubina, 2006). It was covered with mosses or macroalgae to different extent. The pebbly-boulder grounds without moss fouling especially on riffles provide habitation place for abundant diatoms, which form a brownish film. The dominant species were typical rheophils such as *Hannaea arcus* (Ehrenberg) Patrick var. *arcus*, *Meridion circulare* (Gréville) C. Agardh, *Fragilaria gracilis* Oestrup, and epiphytes such as *Achnanthidium minutissimum* (Kützing) Czarnecki, *Encyonema minutum* (Hilse) Mann, *Gomphonema ventricosum* Gregory and *G. exilissimum* (Grunow) Lange-Bertalot et Reichardt. The subdominant species were the epiphytic-littoral species *Ulnaria ulna* (Nitzsch) Compère and benthic species *Nitzschia fonticola* (Grunow) Grunow and *Staurosirella pinnata* (Ehrenberg) Williams et Round. The accompanying diatoms included 25 taxa. They were epiphytes *Cocconeis placentula* Ehrenberg, *Planothidium lanceolatum* (Brébisson ex Kützing) Lange-Bertalot, *Rossithidium linearis* (W. Smith) Round et Bukhtiyarova, *Encyonopsis microcephala* (Grunow) Krammer, benthic species *Fragilaria vaucheriae* (Kützing) Petersen, *Diatoma mesodon* (Ehrenberg) Kützing, *Navicula radiosa* Kützing and *Tryblionella angustata* W. Smith. In the parts of the river influenced by peatland waters, *Tabellaria flocculosa* (Roth) Kützingis was observed. Under high flow rate conditions, *Epithemia sorex* Kützing, *Reimeria sinuata* (Gregory) Kociolek et Stoermer and other reophilous diatoms were present. Lake water can be a source of planktonic species such as *Asterionella formosa* Hassall, *Aulacoseira alpigena* (Grunow) Krammer, and *Ulnaria danica* (Kützing) Compère et Bukhtiyarova to the river.

Stones overgrown with mosses had abundant diatoms with no particular species occurring in mass quantities. Fifty present of diatom species on stones overgrown with moss communities were similar as in non-overgrown ones, representing mainly the taxa with the abundance value of 3–6 points; the Sørensen-Czekanowski coefficient equals 0.51–0.52, correspondingly. Among twenty diatom species found there frequently, 14 taxa were also common dominant or accompanying diatoms in the communities on the stones not covered with mosses. Epiphytic species such as *Epithemia adnata* (Kützing) Brébisson with varieties, *E. turgida* (Ehrenberg) Kützing, *Gomphonema truncatum* Ehrenberg and especially *Cymbella cistula* (Ehrenberg) Kirchner, were predominant on the rocky substrates with and without mosses.

Epiphytic diatoms

Epiphyton was the most rich in diatom species. In the littoral areas of the river, abundant diatoms such as *Achnanthidium minutissimum* and *Encyonema minutum* on moss, *Equisetum* spp. and *Caltha palustris* were the same as in epilithon. Fouling on the *Batrachium* spp. dominated by often observed species *Cocconeis placentula* (four-point group by abundance). *Carex* spp. did not have dominant species of diatoms. Biofoulings of macroscopic colonial and filamentous algae (*Ulothrix zonata* (F.Weber & Mohr) Kützing, *Tetraspora cylindrica* (Wahlenberg) C.Agardh, *Tribonema* spp.) included few diatom species. In contrast to the other plant substrates, *Adlafia minuscula* (Grunow) Lange-Bertalot, *Nitzschia fonticola* and *N. microcephala* Grunow were recorded there. The accompanying component of dominant community included species of 31 genera, which were mainly the same as in epilithon. Among these, *Cymbella cistula*, *Gomphonema truncatum*, *Epithemia adnata* var. *adnata*, *Rhopalodia gibba* (Ehrenberg) Müller, *Meridion circulare*, *Fragilaria gracilis*, *Ulnaria ulna*, *Hannaea arcus*, *Ulnaria danica*, *Tabellaria flocculosa*, *Navicula radiosa* were numerous in the upper and mean courses of the river. *Epithemia adnata* var. *porcellus*, *Reimeria sinuata* and *Staurosira venter* (Ehrenberg) Kobayasi were often found only in moss fouling. Among common species of the studied plants, the epiphytes of the *Achnanthidium*, *Cymbella*, *Gomphonema* and *Rhopalodia* genera were highly abundant, attached to the substrate with cells or gelatinous structures. The diatoms from *Caltha palustris* foulings were least similar to diatoms from *Batrachium* spp., *Carex* spp., *Equisetum* spp., and macroalgae (Table 1). Apparently, araphid diatom species cannot hold on rounded and smooth *Caltha palustris* stems and leaves. On the *Batrachium* spp., in addition to typical epiphytes (*Cocconeis*, *Planothidium*, *Encyonema*), araphid colonial and one-cell

Table 1. The Sørensen-Czekanowski similarity coefficient of diatom composition (above diagonal) and the number of common taxa for plants (under diagonal) in epiphyton of the Shchugor River

	Moss	*Batrachium* spp.	*Equisetum* spp.	*Caltha palustris*	*Carex* spp.	Macroalgae
Moss	–	0.38	0.40	0.40	0.40	0.40
Batrachium spp.	21	–	0.41	0.28	0.48	0.44
Equisetum spp.	21	13	–	0.35	0.41	0.46
Caltha palustris	24	11	13	–	0.35	0.31
Carex spp.	22	16	13	14	–	0.41
Macroalgae	24	17	17	14	16	–

diatoms of the *Fragilaria*, *Ulnaria*, *Tabellaria* genera also developed. They occur in the multi-divided leaves of plant (Komulajnen, 2004).

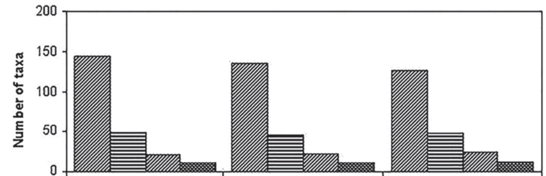
The diatom assemblages on stones and plants (pooled samples for each substrate) were largely alike; the similarity coefficients were above the mean value for the whole list of species (0.65) and especially for species with the abundance of 3–6 points (0.81).

Epipelic diatoms

Epipelon in the river was underdeveloped as the silty-sandy deposits were poor. Under conditions of a fast river flow rate and relatively shallow water (0.3–2.0 m on sand-banks), diatoms from other phytobenthos communities inhabited epipelon. Therefore, a high similarity of epipelon composition and its dominant communities with epiphyton (0.62; DC – 0.66) and epilithon (0.58; DC – 0.70) was determined. Besides, there were no dominants in this benthic group; 26 taxa were characterized as “not seldom” by abundance. In contrast to other benthic algae communities, the epipelon assemblage was inhabited by low-abundance species *Caloneis bacillum* (Grunow) Cleve, *C. branderii* (Hustedt) Krammer, *C. undulata* (Gregory) Krammer, *Neidium ampliatum* (Ehrenberg) Krammer, *N. iridis* (Ehrenberg) Cleve, *Pinnularia complexa* var. *minor* Krammer, *P. divergens* W. Smith, *P. microstauron* (Ehrenberg) Cleve, *P. stomatophora* (Grunow) Cleve, *Placoneis elginensis* (Gregory) Cox, *P. explanata* (Hustedt) Lange-Bertalot and others that were not found in epilithon and epiphyton communities.

Comparison of the diversity of benthic diatom assemblages

The studied phytobenthos assemblages were different by the level of taxonomic diversity of diatoms (Fig. 2). The number of taxa being below the genus (species, varieties, and forms) varied from 126 (epipelon) to 143 (epiphyton), epilithon was between them (135); the number of genera, families, and orders was almost the same. The identified diversity could be considered quite high compared to some other rivers of the Urals. For the diatom assemblages of the Kožym River in the Subpolar Urals, the value is 71 (Stenina & Sterljagova, 2010), and for the mountain parts of the rivers in the Polar Urals, it is



	Epiphyton	Epilithon	Epipelon
Species, varieties, forms	143	135	126
Genera	49	46	47
Families	21	22	23
Orders	11	10	12

Fig. 2. The taxonomic diversity of diatoms in the Shchugor River communities

64 taxa (Jarušina, 2004). For the pre-mountain Sylva River in the Middle Urals, the number of taxa below genus attains 108 species with varieties and forms in epiphyton, 102 – in epilithon (Beljaeva, 2014).

By the taxonomic structure, the Fragilariales order dominated in substrate-attached groups (22–23% of diatom number), and the Fragilariaceae family prevailed in all assemblages (18–22%). Among genera, the *Gomphonema* took a significant position in epiphyton (8%) and epilithon (10%). Epipelon was prominent through domination of the Naviculales order (29%) and the *Nitzschia* genus (9%).

The biofoulings of stony and plant substrates were similar as dominated by epiphyte species (47 and 46%, correspondingly). In epipelon, epiphytic species percent equalled that for benthic diatoms (36% each). The species being equally widespread in any community were well-represented with the abundance of 3–6 points (11 taxa), but *Achnanthidium minutissimum* and *Encyonema minutum* occurred in mass only in epiphyton and epilithon.

All assemblages contained 64 taxa that were common, 16 of these had the abundance index of 3–6 points. In epiphyton, only up to 33 taxa were found, and it was the same for epilithon. Among these, *Ulnaria delicatissima* W. Smith var. *angustissima* (Grunow) Aboal et Silva had the abundance value of three points in the first mentioned algocenosis, and *Nitzschia vermicularis* (Kützing) Hantzsch – in the second one. Epilithon included 30 species with varieties and forms that did not appear in other assemblages, but had the abundance value only of 1–2 points; 24 taxa characteristic of substrate-attached groups was not found in epipelon.

There are numerous studies on the importance of substrate and the environmental physico-chemical properties in formation of composition and development of algae (Komulajnen, 2004; Beljaeva, 2011; Karosienė & Kasperovičienė, 2012; Rusanov et al., 2012). The differences identified often relate to the "architecture", morphological properties of macrophytes, which play a particular role in formation of composition and structure of epiphyton (Townsend & Gell, 2005; Karosienė & Kasperovičienė, 2012; Beljaeva, 2014; Kahlert & Rašic, 2015; Rojas & Hassan, 2017). But the species found only on one substrate in low abundance cannot be considered as substrate specific, because they can be also found on other substrates (Townsend & Gell, 2005). In rivers, cells get removed from one substrate and recolonized in the other. Invertebrates can feed on algae or algae can vertically move to bottom deposits, etc. (Fischer et al., 1977; Komulajnen, 2004; Townsend & Gell, 2005). The river algal flora is also enriched with algae from tributaries and neighbouring water bodies in flood season.

The structure of taxonomic diversity of different diatom assemblages was analysed using diversity indices. Evaluation of the similarity degree among total spectra of the genera by Student's criterion did not reveal true differences between epiphyton and epilithon with epipelon though the floristic richness of epiphyton was higher. The same picture was observed for families.

The reason for this is that the diatom flora of the Shchugor River was dominated by low-abundance taxa (1–2 points). They variously took 74–76% of the diatom composition (in epilithon and epithyton, accordingly) and 79% (in epipelon). The taxa considered also dominated by sum abundance: in epilithon – 49%, epiphyton – 55%, epipelon – 60% of total abundance. In case when the genera with a single species was eliminated from the study, epiphyton and epilithon differed significantly at $p = 0.001$ by Student's criterion. Between epiphyton and epipelon, the difference was also significant at $p = 0.01$. There were no such differences between epilithon and epipelon, because they were in close relation.

The diversity indices show unequal degree of equality and dominant species number in the genera in various assemblages. Among indices, the Berger-Parker and the Simpson were highly impressive (Table 2; Fig. 3). More uniform the frequency of taxa occurrence in different genera was marked in epiphyton, which was evidenced by high index values. The similar situation was observed also for the families.

Table 2. The structural diversity indices in composition of genera for diatom complexes

Index	Assemblages		
	Epilithon	Epiphyton	Epipelon
Simpson	24.20 18.62	28.05 22.30	28.04 20.93
Berger-Parker	9.64 8.36	13.00 11.45	11. 45 9.73
Equitability	0.91 0.94	0.92 0.95	0.93 0.96
Pielou	0.96 0.95	0.96 0.96	0.96 0.95
Shannon	1.52 1.36	1.56 1.43	1.55 1.38

Note: above the line – Index values for all diatom genera; under the line – the Index when the genera containing one species were eliminated.

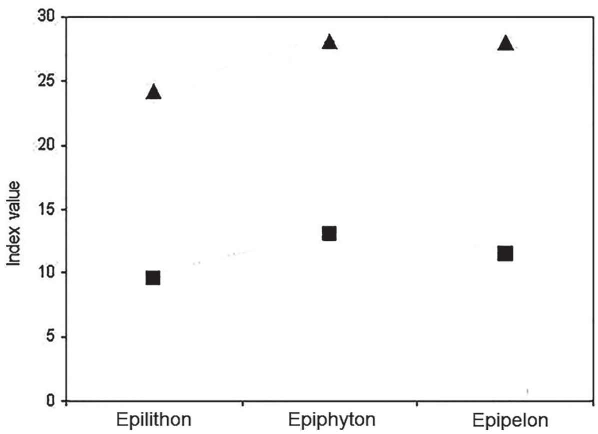


Fig. 3. The structural diversity indices of taxonomic composition for genera in phytobenthos communities of the Shchugor River (▲ – the Simpson index, ■ – the Berger-Parker index)

Communities of benthic diatoms characteristic of rivers in montane regions

The identified composition of diatoms in the Shchugor River was typical of similar non-disturbed pre-montane and montane streams. Almost every species found there is available in the Maly Patok, the Svetly Vuktyl, the Balbanyu and the Kožim Rivers in the Subpolar Urals and upper courses of the Pechora with tributaries in the Northern Urals (Stenina, 2004, 2005; Stenina & Sterljagova, 2010). These rivers are also prominent through well-represented species of the *Achnanthidium*, *Didymosphenia*, *Encyonema*, *Fragilaria*, *Gomphonema*, *Hannaea*, *Meridion* genera, some species of the *Nitzschia* genus. Most of them prefer low or medium salinity and neutral water, which was in the river during the observation period. The first data on diatoms for the Shchugor River are limited and do not allow detailed comparison with our data. However, diatoms "in large amounts" (Šubina, 1986) include many similar species from the above genera. The composition of dominant species of the Shchugor River is characteristic of numerous montane rivers and streams with lime bottom in different physical-geographical regions (Goma et al., 2005; Morales et al., 2007; Kim, 2008). Such species as *Diatoma mesodon*, *Hannaea arcus* and *Didymosphenia geminata* prefer fast-flow rivers with cold weakly-mineralized water. The Shchugor River includes few representatives of the *Eunotia*, *Tabellaria*, *Pinnularia* and *Frustulia* genera. These genera prefer rivers with high amount of humic substances, low conductivity and pH, where acidophilic and halophobous species dominate (Kwandrans, 1993; Soininen, 2004; Savateev & Medvedeva, 2005; Komulaynen, 2009). Being single by the abundance rate in the studied river, eutrophic water indicators such as *Melosira varians* C. Agardh, *Nitzschia acicularis* (Kützing) W. Smith, *Rhoicosphenia abbreviata* (C. Agardh) Lange-Bertalot, *Luticola mutica* (Kützing) Mann and *Surirella angusta* Kützing can be found in case of slow river or anthropogenic impact (Gecen, 1971; Jarušina et al., 2004; Martynenko, 2017; Komulajnen, 2018; Panahy Mirzahasanlou et al., 2018).

CONCLUSION

Epilithon, epiphyton, and epipelon in the Shchugor River included 218 species with varieties and forms of diatoms from 60 genera, 27 families and 12 orders. As phytoplankton was underdeveloped, benthic diatoms formed the river algal flora. Taxa from the Naviculales order made 26%, the Fragilariaceae family – 18% and the *Gomphonema*, *Nitzschia*, *Navicula*, *Eunotia*, *Fragilara*, *Pinnularia* genera altogether comprised up to 38% of phytobenthos diversity in the river. The floristic richness value varied from 126 (epipelon) to 143 taxa (epiphyton). The dominant species were *Achnanthidium minutissimum*, *Encyonema minutum*, *Fragilaria gracilis*, *Gomphonema exilissimum*, *G. ventricosum*, *Hannaea arcus*, *Meridion circulare*. The sub-dominants were *Cocconeis placentula*, *Nitzschia fonticola*, *Ulnaria ulna* and *Staurosirella pinnata*. The accompanying diatoms included 25–31 taxa in different phytobenthos communities; most diatoms were single or rare by abundance. The dominant taxa of stony and plant substrates as well as of epipelon (0.70–0.81) were very similar. Based on the Berger-Parker and Simpson variety indices, the occurrence of taxa in the genera and families in the epiphyton was more uniform. The diatoms of the Shchugor River are typical of non-disturbed pre-montane and montane water streams and can possibly serve as a clear river water benchmark for the monitoring purposes.

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TITNAGDUMBLIŲ ĮVAIROVĖ ŠČIUGORO UPĖS FITOBENTOSO BENDRIJOSE (URALAS, KOMI RESPUBLIKA, RUSIJA)

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Santrauka

Straipsnyje pateikiama Ščiugoro upės epilitono, epifitono ir epipelono titnagdumblių bendrijų struktūra. Dumblių apaugimai tirti ant akmenų, makrofitų, siūlinių dumblių ir dugno nuosėdose. Nustatyta didelė titnagdumblių bendrijos įvairovė. Iš viso aptikta 218 rūšių ir vidurūšinių taksonų, priklausančių 60 genčių, 27 šeimoms ir 12 eilių. Naviculales (56 taksonai) eilė ir Fragilariaceae (39 taksonai) šeima išsiskyrė didžiausia įvairove; tarp genčių gausiausios rūšimis – *Gomphonema* (17), *Nitzschia* (16), *Navicula* (14), *Eunotia* (14 taksonai). Dominavo epifitono dumbliai, švarių vandens telkinių indikatoriai, alkalifilinės ir indiferentinės druskingumo sąlygoms rūšys. Epilitono bendrijos buvo dažniausios, tuo tarpu epifitonas pasižymėjo didžiausia rūšių įvairove. Rūšių įvairovė epipelono bendrijose buvo mažiausia.