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RESEARCH PAPER

Microalgal diversity as bioindicators of gold and coal mining impacts on a river ecosystem in the permafrost zone (Chara River, Yakutia, Russia)

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ABSTRACT

The aim of this study was to assess the impact of gold and coal mining on aquatic ecosystems in the region using the bioindicator properties of planktonic algae. The work used previously widely tested methods of ecological mapping, JASP, and analysis of “species-environment" relationships. For the Chara River, 211 indicator species of algae and cyanobacteria with a predominance of diatoms were identified. An increase in the diversity and abundance of phytoplankton was observed towards the mouth of the river from 48 species to 94. Ecological mapping revealed not only sections of the river associated with existing gold and coal mining, but also the impact of potential developments where exploration is underway. A weak influence of organic pollution associated with subsoil mining was revealed, but it was established that natural self-purification processes take place in the studied river. The results obtained are suitable for assessing the level of anthropogenic impact on aquatic communities in permafrost conditions.

Keywords: phytoplankton, microalgae diversity, ecology, bioindicators, ecological mapping, gold mining, coal mining, permafrost, Eastern Siberia

РЕЗЮМЕ

Габышев В.А., Габышева О.И., Баринова С.С. Использование разнообразия микроводорослей для оценки влияния золотодобычи и угледобычи на речные экосистемы в условиях многолетней мерзлоты (на примере реки Чара, Якутия). Целью данного исследования – оценка воздействия золотодобычи и угледобычи на водные экосистемы Якутии с использованием биоиндикационных свойств планктонных водорослей. В работе применялись ранее апробированные методы экологического картирования, анализа в программе JASP и изучения связей «виды–среда». Для реки Чара было идентифицировано 211 индикаторных видов водорослей и цианобактерий с преобладанием диатомовых. Наблюдалось увеличение разнообразия и обилия фитопланктона по направлению к устью реки – с 48 до 94 видов. Экологическое картирование выявило не только участки реки, связанные с существующей добычей золота и угля, но и воздействие потенциальных разработок, где ведутся разведочные работы. Обнаружено слабое влияние органического загрязнения, связанного с недропользованием, однако установлено, что в исследуемой реке протекают процессы естественного самоочищения. Полученные результаты пригодны для оценки уровня антропогенного воздействия на водные сообщества в условиях вечной мерзлоты.

Ключевые слова: фитопланктон, разнообразие микроводорослей, экология, биоиндикаторы, экологическое картирование, золотодобыча, угледобыча, вечная мерзлота, Восточная Сибирь

Eastern Siberia is a region where industrial mining began in the 20th century and its scale is steadily increasing. Copper, iron ore, coal and gold deposits are being mined in the Chara River basin. The largest mining enterprises are located on three tributaries of the river: the Tokko, Zhuya and Apsat rivers. In the basin of the right tributary of the Tokko River, there is a large gold mining enterprise Taborny (2026), where up to a thousand workers are currently employed in production, and the annual extraction and processing of ore has reached 7.5 million tons. At the headwaters of the left tributary of the river – the Zhuya River, there is a gold-bearing deposit Sukhoi Log (2026) – the largest in the world in terms of gold ore reserves. The Apsat coal and gas deposit is estimated at 2.2 billion tons of coking coal and 55 billion cubic meters of methane (NedraDV 2026). Its development is carried out using an open-pit method, and deep well drilling was carried out to assess methane reserves.

Open-pit coal mining is associated with landscape transformation, disruption of water exchange, which can lead to disruption of aquatic ecosystems and large-scale impacts on a wide range of living organisms (Goswami 2015, Nikanorov et al. 2015). Placer gold mining is also associated with significant landscape transformation (Abdul-Wahab & Marikar 2012). The gold mining process requires large amounts of water for various activities, such as washing and processing of the mined ore (Laker 2023). This often leads to pollution of water sources with sediments, chemicals and heavy metals (Eisler 2004a,b). Hydrocarbon mining poses a major potential threat to biota due to the risk of film formation on the surface of water bodies, accumulation of toxic hydrocarbons (Mendelssohn et al. 2012). In addition to potential damage to aquatic flora and fauna, mining can lead to deterioration in the quality of drinking water available to the local population (Irfan et al. 2024). The negative impact of mining on biota is exacerbated in the conditions of the north and permafrost zone, which is due to the extremely low restoration potential of northern ecosystems.

In the last decade, residents of villages located at the mouth of the Chara River have regularly raised the issue of declining river water quality in the local press. Frequent complaints from local residents and environmental activists about the decline in water transparency and deterioration of its organoleptic properties have been the reason for the organization of multiple inspections of the activities of subsoil users in the region by local and federal authorities.

Numerous local and regional factors that can reflect the overall health of aquatic ecosystems and influence their structure and functions are closely related to the state of the phytoplankton community structure and any changes in it (Henson et al. 2021). In addition, the species composition of phytoplankton and the overall level of biodiversity of plankton communities is a reliable indicator of water quality in different types of freshwater ecosystems (Chandel et al. 2024). Therefore, it is critical to understand the influence of environmental factors on the composition and diversity of phytoplankton communities to assess the impacts of human activities on aquatic systems (Katsiapi et al. 2012).

The Chara River is located in a remote area and remains difficult to access for researchers so information about the aquatic ecosystem of its basin and, in particular, algae is scarce. Zhuldybina (2010) provided information on the content of the main ions, salinity level and pH in the Chara River. The study is based on the materials of hydrometeorological service, according to data from an observation point located in the Chara settlement (upper reaches of the river). The author notes the low mineralization of the river waters and its seasonal decrease in June, as well as an increase in the pH value with an increase in the stream discharge of the river; a correlation was found between the river runoff and fluctuations in the concentration of the main ions. Sudakova et al. (2020) studied the flora of soil algae of the Chara Depression in the vicinity of the village of Chara. The authors provided a list of 34 algae species belonging to 5 phyla: Cyanoprokaryota, Euglenozoa, Ochrophyta, Chlorophyta and Streptophyta. Comprehensive information on phytoplankton and the chemical composition of the Chara River waters was presented in 2012–2023 (Gabyshev & Gabysheva 2012, 2018, 2023).

This study continues our work in which we hypothesize that biodiversity and indicator properties of river phytoplankton species are suitable for reliably characterizing the anthropogenic impact of extractive industries on the aquatic ecosystem in the permafrost zone with severe climatic conditions.

The aim of this study was to spatially characterize the dynamics of biodiversity along the gold and coal mining basin of the Chara River, conduct an ecological analysis using indicator species, and identify the most important ecological factors influencing the diversity of this group of aquatic organisms in the studied river basin with statistical methods and ecological mapping.

MATERIAL AND METHODS

Site description

The Chara River is a large second-order tributary of the Lena River. The river is 851 km long and its basin area is 87.6 thousand km^2 (Chistyakov 1964). The Chara originates from Bolshoe Leprindo Lake, located on the southern slope of the Kodar Range, and flows into the Olekma River near its confluence with the Lena. The average annual water discharge at the river mouth is 850 sq. m s^{-1} (Sokolov 1952). The river basin is characterized by continuous permafrost; the permafrost thickness in the river valley reaches 200 m or more (Shepelev 2009). The climate is sharply continental, with maximum air temperatures in summer reaching +37°C and minimum temperatures in winter reaching -60°C (Gvozdetsky & Mikhailov 1978). The Chara basin is home to the Kodar Glacial Region, the only one in the south of Eastern Siberia. The river is fed by rain, snow and glaciers.

Field data were collected from June 8 to 13, 2011, along the river section from the settlement of Chara to its mouth (762 km) (Figs 1, 2, Table 1). For the first 110 km, in the upper part of the section we studied, the river flows through the Chara Depression. The valley here is wide, low and swampy. The riverbed forms meanders. The flow rate varies from 1.3 to 1.5 m s^{-1}. The river depth is small and is 1.5–2.5 m along the fairway. Water transparency is 1.1–1.2 m according to the Secchi disk, at the mouth of the tributary (the Apsat River) – 2.2 m. The banks of the river and the bottom of its channel are composed mainly of sand and a sandy-silty mixture.

On the next section, 241 km long, the river crosses the Kodar Range. The valley here is sharply narrowed; the river is a whitewater with a cascade of large rapids. The flow rate in some places reaches 5.5 m s^{-1}. Near the mouth of the Sen River, the valley of Chara widens, the river leaves the gorge and flows along the edge of the Olekma–Chara Plateau to the mouth of the Zhuya River. Here, underwater and above-water rocks are found in the riverbed, the flow rate decreases to 1.9–2.5 m s^{-1}. The depth is small – up to 2 m. Aufeises is common along the banks of the river.

In the section from the mouth of the Zhuya River to the mouth of the Chara, the river goes around the Olekma-Chara plateau, and before flowing into the Olekma River, it flows along the Prilenskoye plateau. The valley of the Chara River widens even more here. The banks and the bottom are mainly sandy and pebbly, silted in places. The depth of the channel varies from 2.7 to 9.5 m. The flow rate is less than in the previous section – 0.9–2.6 m s^{-1} and decreases towards the mouth of the river.

Sampling, water chemistry and algological analysis

A total of 20 water samples for hydrochemical analysis and 40 planktonic algological samples were collected and processed, including 20 samples for qualitative and the same number for quantitative analysis. Samples were collected near the river banks or along the fairway from the surface wa-

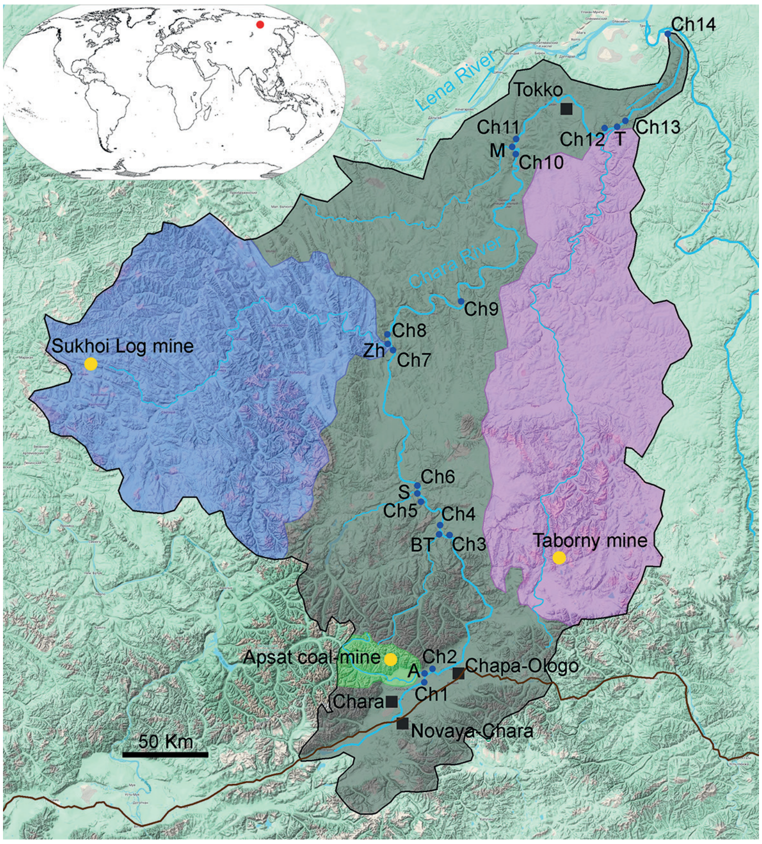

Figure 1 Sampling site on the Chara River. Blue dots as sampling points, yellow dots as mining facilities, black squares as settlements, brown line indicating Baikal-Amur Mainline, blue arrows show the course of the river, red dot on world maps indicating the geographical location of the study area. The Chara River basin is outlined in black. Partial basins tinted green (Apsat River basin), blue (Zhuya River basin) and pink (Tokko River basin)

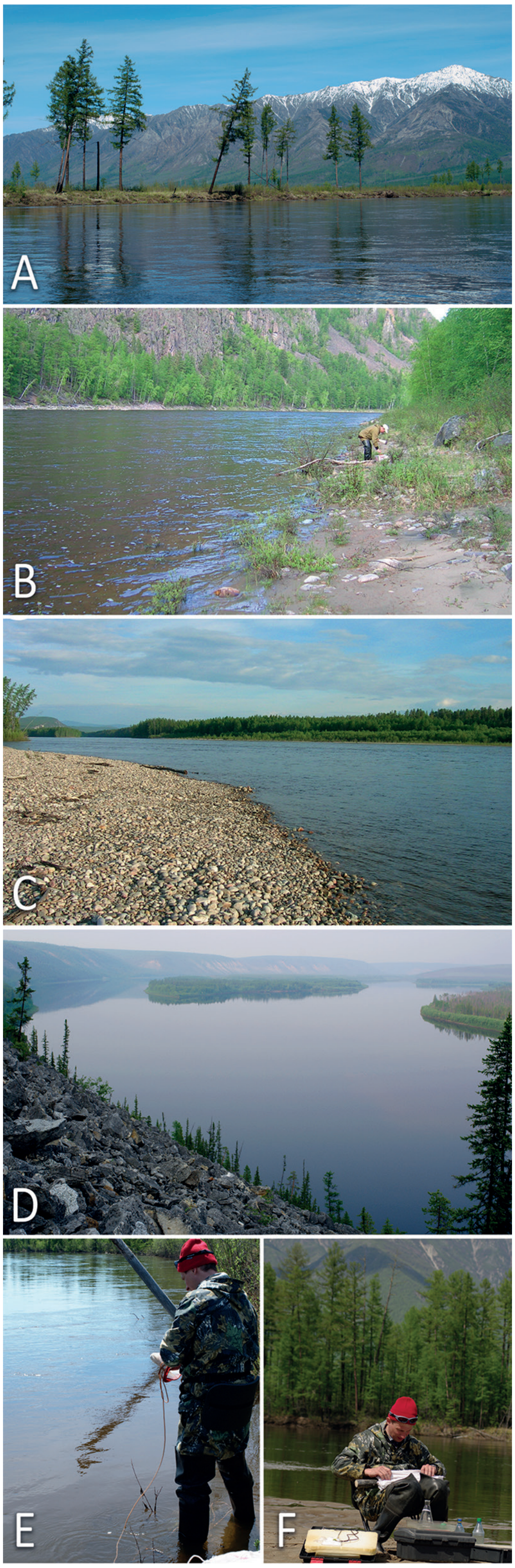

Figure 2 Sampling points: Chara River above the mouth of the Apsat River (A), Chara River above the mouth of the Bol'shaya Tora River (B), Chara River above the mouth of the Zhuya River (C), mouth of the Chara River (D), phytoplankton sampling on the Chara River below the mouth of the Apsat River (E), Chara River above the mouth of the Sen' River (F)

Table 1. Sampling station points on the Chara River with geographical coordinates and abbreviated names

Station name	Abbr.	Latitude N	Longitude E
Chara River above the Apsat River mouth	**Ch1**	57°02'14"	118°30'16"
Apsat River mouth	**A**	57°02'23"	118°30'31"
Chara River below the Apsat River mouth	**Ch2**	57°02'17"	118°30'52"
Chara River above Bol. Tora River mouth	**Ch3**	57°46'51"	118°40'20"
Bol'shaya Tora River mouth	**BT**	57°46'51"	118°40'10"
Chara River below Bol. Tora River mouth	**Ch4**	57°47'13"	118°39'54"
Chara River above the Sen' River mouth	**Ch5**	57°59'21"	118°26'11"
Sen' River mouth	**S**	57°59'35"	118°25'53"
Chara River below the Sen' River mouth	**Ch6**	58°00'06"	118°25'57"
Chara River above the Zhuya River mouth	**Ch7**	58°45'25"	118°10'29"
Zhuya River mouth	**Zh**	58°45'43"	118°09'15"
Chara River below the Zhuya River mouth	**Ch8**	58°46'25"	118°08'45"
Chara River fairway	**Ch9**	58°57'57"	118°52'17"
Chara River above the Molbo River	**Ch10**	59°45'08"	119°22'12"
Molbo River mouth	**M**	59°45'26"	119°22'06"
Chara River below the Molbo River mouth	**Ch11**	59°45'51"	119°22'42"
Chara River above the Tokko River mouth	**Ch12**	59°50'58"	120°21'02"
Tokko River mouth	**T**	59°50'23"	120°21'57"
Chara River below the Tokko River mouth	**Ch13**	59°51'18"	120°24'09"
Chara River mouth	**Ch14**	60°18'45"	120°53'26"

ter horizon (0–0.3 m). Samples for studying the qualitative composition of phytoplankton were collected using an Apstein net (SEFAR NITEX fabric, mesh size 15 μm). Hydrochemical samples, as well as quantitative phytoplankton samples, were collected by simply scooping up 1.5 l of water. Planktonic samples for quantitative analysis were sedimented in situ under pressure on filters (Sartorius AG, Göttingen, Germany). All algological samples were fixed by adding 3 % neutral formaldehyde. Chemical analysis of water samples was performed using generally accepted methods (Semenov 1977). Unified methods were used in processing and analyzing the phytoplankton material (Vasser et al. 1989). Species identification of phytoplankton was carried out using an Olympus BH-2 light microscope (Olympus Corporation, Tokyo, Japan). The taxonomic affiliation of species was clarified in accordance with data from the algaebase.org portal (Guiry & Guiry 2024).

Bioindication

Bioindicator analysis was performed according to Barinova (2017a) with species-specific ecological preferences of revealed indicator taxa (Barinova et al. 2019). Water Ecosystem State Index (WESI) (Barinova 2017b, 2025) was calculated to assess the toxic pollution influence on the aquatic ecosystems using equation:

$$WESI = Rank\ Index\ S/Rank\ N\text{-}NO_3$$

The index values vary from 0 to 5. If the index values are less than one, then the ecosystem is exposed to toxic pollution, which inhibits photosynthesis.

The BioDiversity Pro 2.0 program was used for similarity calculation (McAleece et al. 1997). Pearson coefficients calculation was done in (Wessa 2017).

Ecological analysis

Ecological maps constructed on the basinal basis as recommended in Barinova (2017c) and Krupa et al. (2019) for the major variables of water quality. The network analysis in JASP (Jeffreys's Amazing Statistics Program), significant only, was doing on the botnet package in R Statistica package of Love et al. (2019).

Canonical Correspondence analysis (CCA) was done with CANOCO program for calculation of biological dominated variables and environment variables relationships (Ter Braak & Šmilauer 2002).

RESULTS

Chemical data

The water of the Chara River was slightly warmed up during sampling, which is due to the glacial feeding of the river and the presence of many icings along the banks. The water temperature increased from headwaters to mouth (Appendix Table A1, Fig. 3). The flow rate is high and in the mountainous area it reached 2.5 m s^{-1}. A decrease in transparency was noted around the mouth of the Zhuya River and downstream of the Chara up to the mouth of the Molbo River. River water pH is close to slightly alkaline. The oxygen regime is within normal limits. The carbon dioxide content is low and relatively stable in all areas.

According to the component composition of the main ions, the waters belong to the sulfate class (21–40 % eq.), calcium group (21–34 % eq.), type III. Hydrocarbonates account for 12–21 % eq. of the total amount of cations and anions, magnesium accounts for 10–19 % eq., chlorides for 4–10 % eq., sodium for 3–7 % eq., and potassium for 1–2 % eq. The percentage ratio of elements in different sections of the river does not change significantly. The waters of the Chara River are fresh, low-saline, and very low hardness (Appendix Table A1).

The waters of the Chara River are poor in nutrients and organic matter (Appendix Table A1). Low levels of nitrite and nitrate nitrogen, as well as silicon, are noted. The concentration of phosphorus compounds (phosphates and total phosphorus) and ammonium nitrogen is low. The complex of easily oxidizable organic substances (according to BOD5), phenols, oil products and detergents also characterized by low values. No features in the spatial distribution of nutrients and organic matter along the river were noted but the main ions fluctuated sufficiently. So, concentration of calcium, magnesia, hydrocarbonates, sulfates, COD, TDS, and watercolor were suddenly increased in the Molbo tributary. Fig. 3 shows by the trend lines decreasing CO_2 concentration, increasing water temperature and stabile values of oxygen with the altitude of the river stations.

Phytoplankton data

Altogether 211 species and intraspecies of algae and cyanobacteria from seven phyla were revealed in 40 phytoplankton samples from the Chara River sampling stations in 2011 (Appendix Table A2). Diatoms were noticeably dominant with 126 species. The dynamics of species richness at the river stations is shown in Fig. 4. It is evident that the total species richness at each station is 90 % diatoms. However, the fluctuation in the number of species in the divisions was almost synchronous with the increase (according to the trend lines) towards the mouth of the river.

A comparison of the species composition at the river stations shows that there is virtually no division into clusters (Fig. 5), that is, the representation of species in the communities is quite uniform.

Only a few diatom species were found in significant numbers at most stations (*Achnanthidium nodosum* (Cleve) Tseplik & Chudaev, *Encyonema silesiacum* (Bleisch) D.G. Mann, *Hannaea arcus* (Ehrenberg) R.M. Patrick, *Tabellaria flocculosa* (Roth) Kützing), which characterizes the main core of the communities of the studied river. However, in the overall abundance of communities, it is shown (Appendix Table A2) that there is a slight division into clusters in Fig. 6. The community of station 1 is separated from the entire compared community richness. The rest are difficult to separate into indistinct clusters, uniting around the communities of the tributaries.

Bioindicators

Among the identified diversity of algae and cyanobacteria, indicator species turned out to be up to 99 % in each analyzed community (Appendix Table A3). Bioindicators were distributed among 9 systems of environmental parameter assessment according to the ecological preferences of species (Appendix Table A4). Figures 7, 8 and 9 show the distribution of the percentage composition of indicator species by stations of the Chara River. Species richness in each phylum was also used as an indicator, allowing us to identify the response of diversity to environmental conditions at each specific station (Fig. 7). It is evident that diatoms were prevalent at all stations of the river and tributaries (Fig. 7a). However, the enrichment of communities with species of other phyla occurred starting from station M, a lower left tributary of the river and below. The indicators show that throughout the river, benthic and planktonic-benthic habitats were preferred for them (Fig. 7b). The indicators of moderate temperature waters (Fig. 7c) and moderate oxygen saturation (Fig. 7d) predominated.

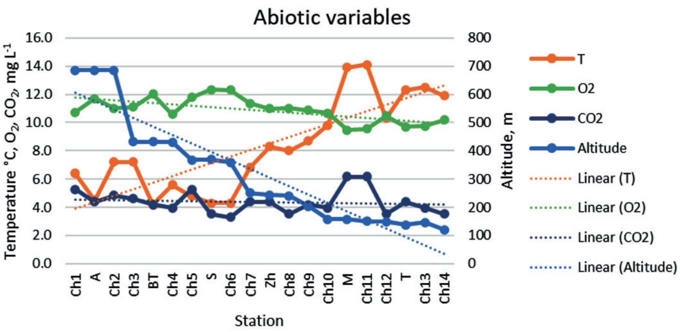

Figure 3 Dynamics of the main environmental variables at the Chara River stations according to Appendix Table A1

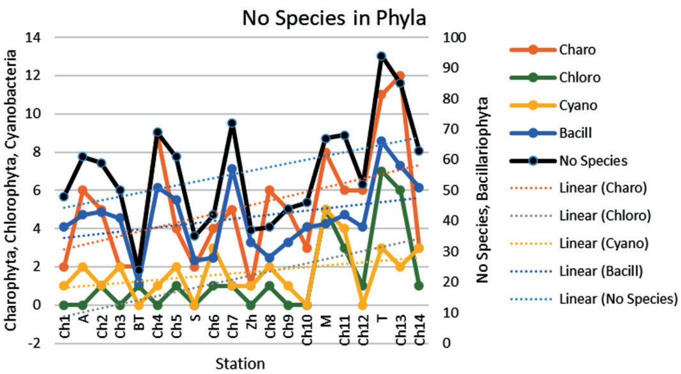

Figure 4 Phytoplankton species richness dynamic in the Chara River stations according to Appendix Table A2

Fresh neutral water indicators prevailed throughout the river (Fig. 8a, b), and only in the BT tributary was slight desalination and acidification observed, while in the M tributary subsalination and pH growth observed. Diatomaceous water indicators of organic pollution (Fig. 8c) show a small influx of organic matter from the A, BT, Zh, M and T tributaries, which is quickly consumed by the river ecosystem. The indication of the algae nutrition type indicates the predominance of autotrophs (Fig. 8d). However, in the middle reaches of the river mixotrophs also appear among the community, which indicates a negative impact on photosynthesis. The Fig. 8 also shows that the suppression of algae activity begins with the A tributary, then the activity is restored at the S tributary and falls again after the M tributary.

Water trophic state indicators show the dynamics of all groups with a predominance of oligotrophic and eutrophic species (Fig. 9a) with an increase in the proportion of eutrophic species towards the river mouth. Outbreaks of oligotrophic species were observed at stations Ch1 and BT, while a sharp increase in the proportion of eutrophic species was at the mouths of tributaries A and M. The number of indicator species of the second class of water quality, determined by the species-specific saprobity index S, prevailed along the entire length of the river (Fig. 9b). Up to 30 % of species also belonged to the third class and this ratio did not undergo significant changes.

Thus, the distribution of indicator species groups significantly complements the results of the analysis of chemical indicators and taxonomy of river communities. The comparison of the composition of indicator species by constructing a tree of similarities shows that the communities can already be differentiated into four clusters, uniting most of the stations of the upper and middle reaches together with tributaries A and M, as well as three others, where the communities of a few stations of the riverbed have similarities with the communities of tributaries S, T and BT (Fig. 10).

Correlation analysis of the indices linking community complexity and environmental assessment showed a high negative correlation of saprobity indices with

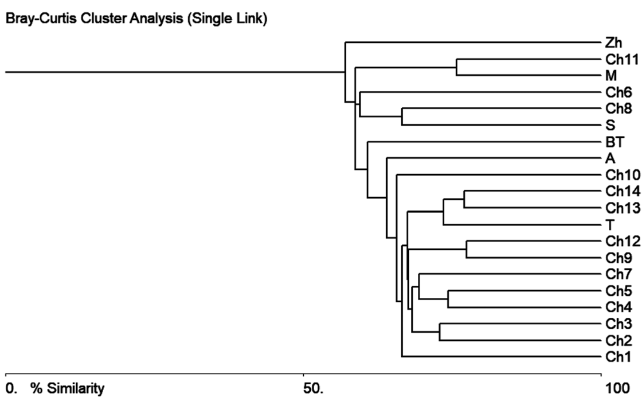

Figure 5 Tree of Bray-Curtis similarity for the phytoplankton species richness in the Chara River stations according to Appendix Table A2

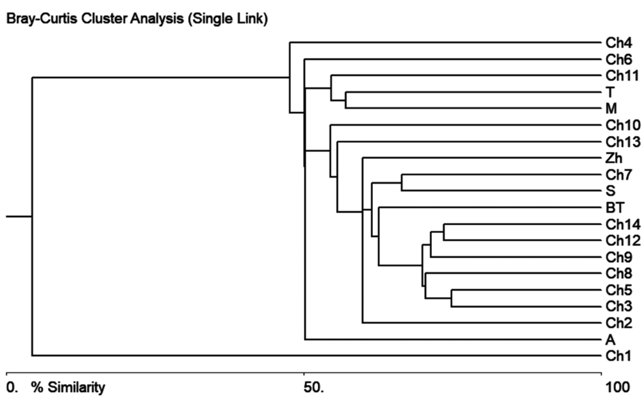

Figure 6 Tree of Bray-Curtis similarity for the phytoplankton abundance in the Chara River stations according to Appendix Table A2

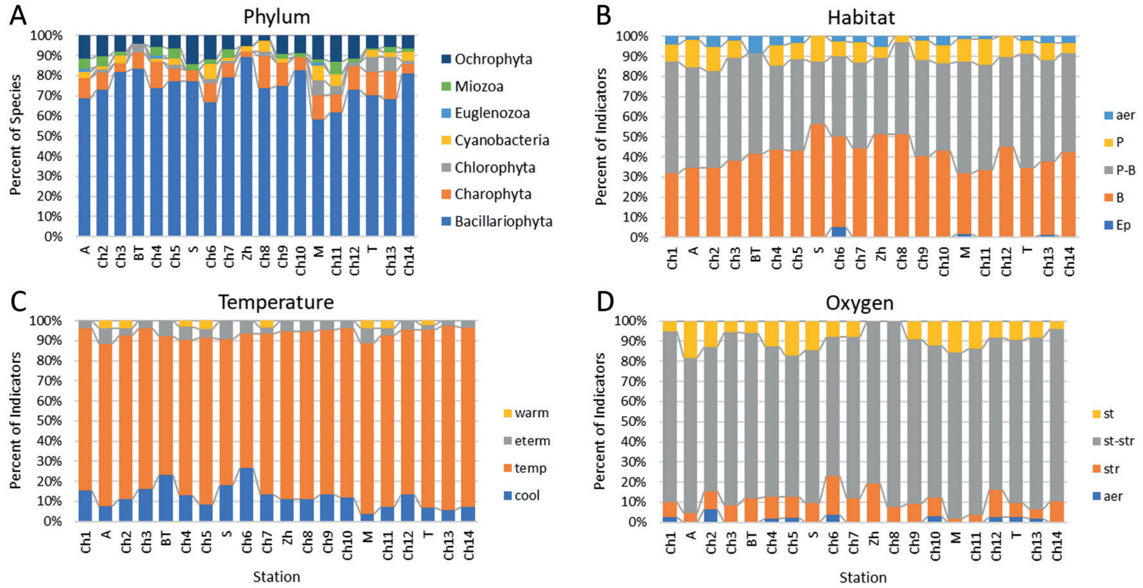

Figure 7 Distribution the phytoplankton species number in the taxonomic Division (a) and indicators of habitat (b), water temperature (c), and oxygen (d) in the Chara River stations according to Appendix Table A2 and Table A4. Abbreviations: Habitat: P – planktonic, P-B – plankto-benthic, B – benthic, Ep – epiphytes; aer – aerophytes; temperature preferences: cool – cool-water, temp – temperate, eterm – eurythermic, warm – warm-water; oxygenation and water moving aer – aerophiles, str – streaming water, st-str – low streaming water, st – standing

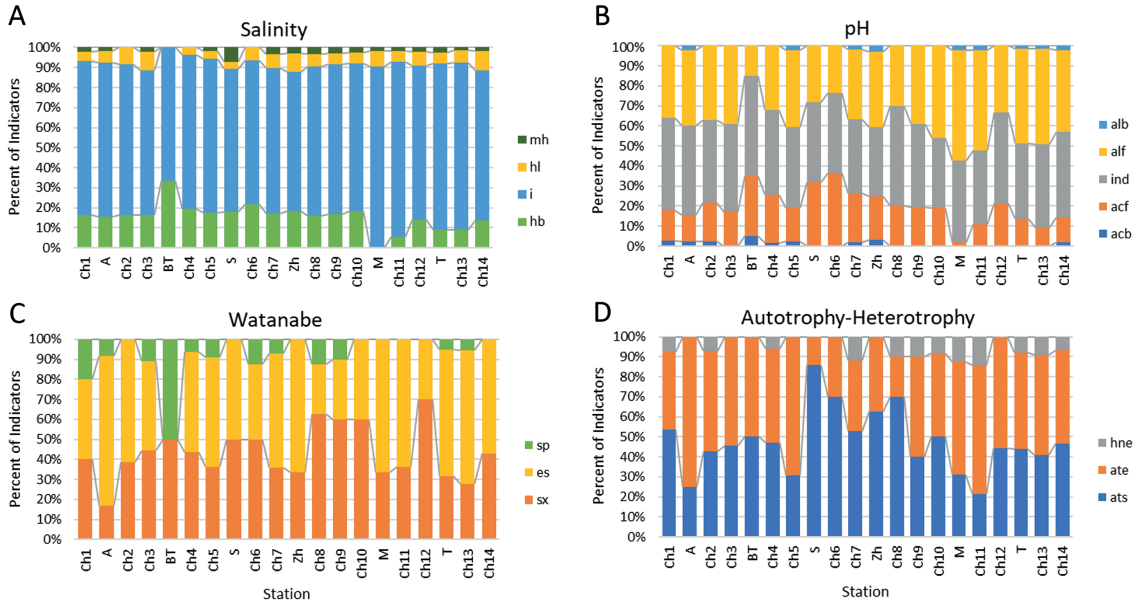

Figure 8 Distribution of the phytoplankton indicators of salinity (a), water pH (b), organic pollution by Watanabe (c), and nutrition type preferences (autotrophy-heterotrophy) (d) in the Chara River stations according to Appendix Table A4. Abbreviations: salinity ecological groups according to (Hustedt 1938–1939): hb – oligohalobes-halophobes, I – oligohalobes-indifferent, hl – halophiles, mh – mesohalobes, oh – oligohalobes; pH preferences groups according to (Hustedt 1957): alb – alkalibiontes, alf – alkaliphiles, ind – indifferent, acf – acidophiles, acb – acidobiontes; organic pollution indicators according to (Watanabe et al. 1986): sx – saproxenes, es – eurysaprobes, sp – saprophilesnitrogen uptake metabolism (Aut-Het) (Van Dam et al. 1994): ats – nitrogen-autotrophic taxa, tolerating very small concentrations of organically bound nitrogen, ate – nitrogen-autotrophic taxa, tolerating elevated concentrations of organically bound nitrogen, hne – facultative nitrogen-heterotrophic taxa, needing periodically elevated concentrations of organically bound nitrogen

Shannon structural indices (-0.660, $p < 0.0007$), as can be seen in Fig. 11. There was no significant correlation between the number of species and abundance (-0.324, $p < 0.08$). The remaining indices did not have clearly expressed values of correlation indices. Indices WESI, calculated for each station, show high capability to utilize organic pollutants because its value was above 1 (Appendix Table A4).

The tree of similarity constructed on the basis of all chemical, taxonomic and bioindication data showed the separation of the river source and tributaries A, BT, M into separate clusters, and the remaining stations were grouped together with tributaries S, T and Zh (Fig. 12). Thus, it was possible to identify the high habitat-forming role of the tributaries of the Chara River.

Based on the findings on the significant impact of tributaries on phytoplankton communities and water quality, a calculation of the similarity of bioindicator data was performed in the JASP program. It turned out that the bio-

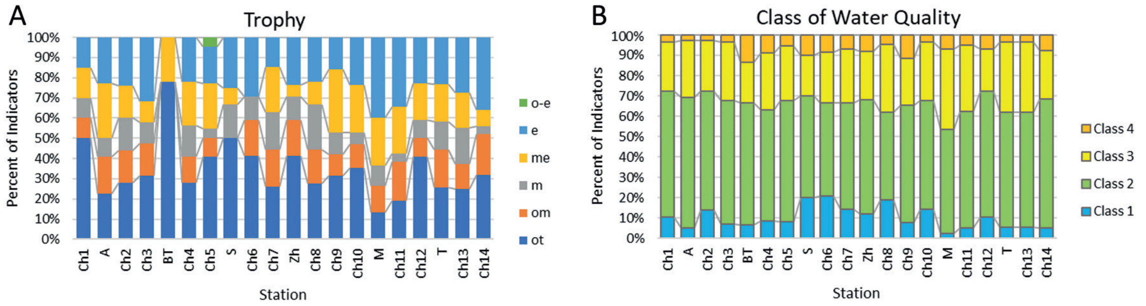

Figure 9 Distribution of the phytoplankton species indicators of trophic state (a) and class of water quality (b) in the Chara River stations according to Appendix Table A4. Abbreviations: trophic state indicators according to (Van Dam et al. 1994): ot – oligotraphentic, om – oligomesotraphentic, m – mesotraphentic, me – mesoeutraphentic, e – eutraphentic, o-e – oligo to hypereutraphentic. Class of water quality as averaged species-specific index saprobity S according to (Sládeček 1986)

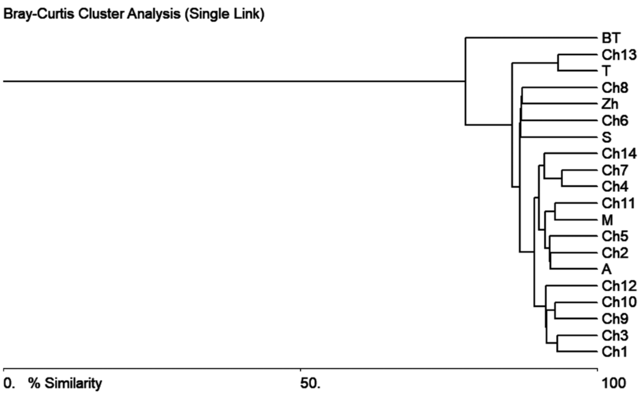

Figure 10 Tree of Bray-Curtis similarity for the phytoplankton species indicators in the Chara River stations according Appendix Table A4

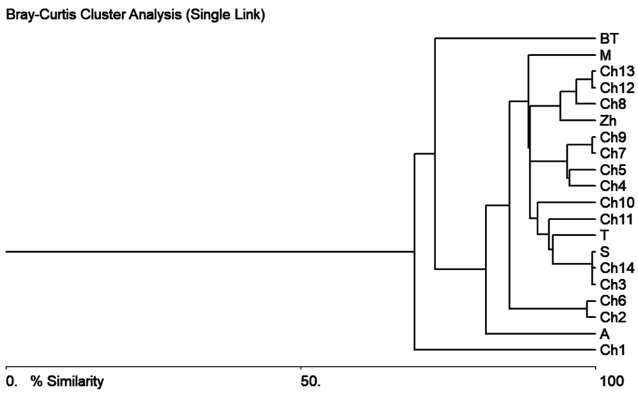

Figure 11 Tree of Bray-Curtis similarity for the phytoplankton species richness, bioindicators, indices, and main chemical variables in the Chara River stations according to Appendix Table A1, Table A2, and Table A4

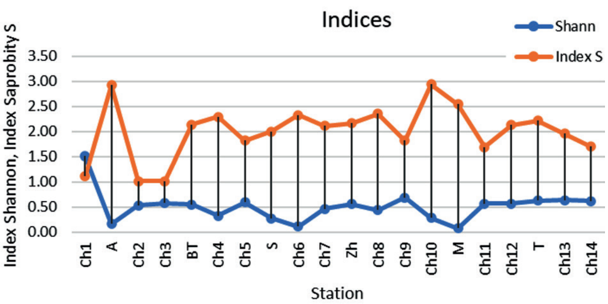

Figure 12 Diversity and saprobity indices dynamic in the Chara River stations

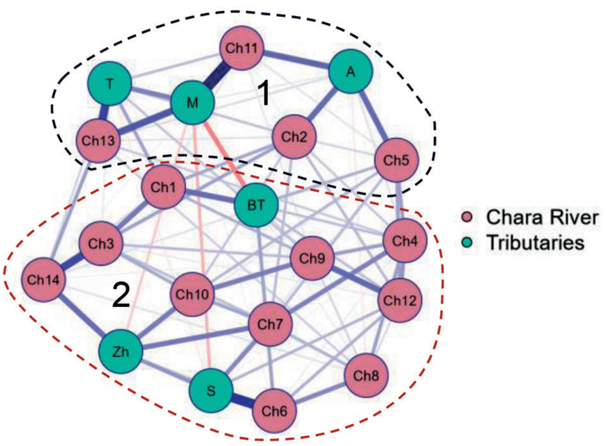

Figure 13 JASP plot for the phytoplankton species-indicators in the Chara River stations according to Appendix Table A4

indicators divide the stations into two clusters, the first of which is grouped with tributaries A, M and T, and the second is reliably separated from tributaries S, Zh and BT (Fig. 13). That is, the analysis shows that the commonality of the environment and biota in the Chara River basin has two continua.

Species-environment relationships

CCA biplot (Fig. 14) for the phytoplankton species richness and main environmental variables shows that the main environmental factors are divided into two bundles, among which the first is oxygen, and the second is pH, TDS, CO_2 and water transparency that influenced community of stations Ch 11 and M.

Figure 15 shows that the second bundle of environmental parameters stimulates the development of green algae and cyanobacteria, which is not hindered by a decrease in the oxygen concentration from the first bundle.

Ecological mapping

Ecological mapping was carried out using the saprobity index S. The index reflects not only the saturation of water with dissolved organic matter but is also an indicator of the state of the aquatic ecosystem. On the map (Fig. 16), sections of the river and tributaries are painted in EC colors corresponding to water quality classes. Thus, it is clear that tributary station A has waters of class 4 (orange), the riverbed below and above it is of class 2 (green). Further,

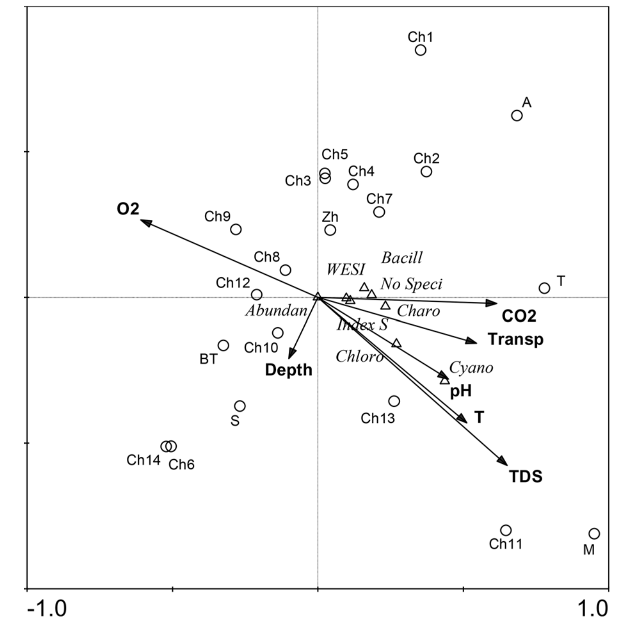

Figure 14 CCA biplot for the phytoplankton species richness and main environmental variables in the Chara River stations according to Appendix Table A1 and Table A2

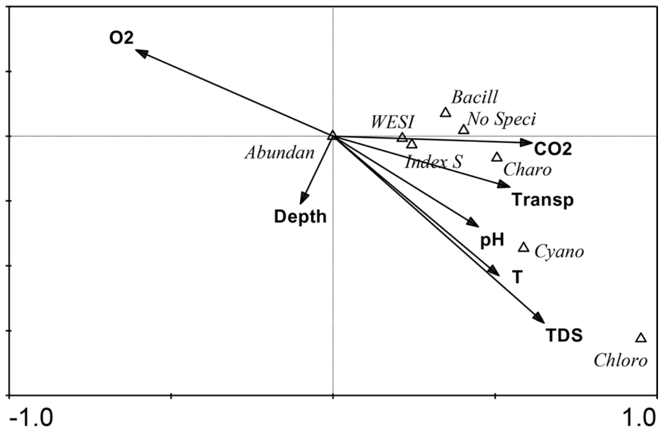

Figure 15 CCA biplot for the phytoplankton species in Taxonomic Divisions, abundance, indices saprobity S, and WESI, and main environmental variables in the Chara River stations according to Appendix Table A1 and Table A2

starting from the tributary BT and up to station Ch 9, the waters were of class 3 (yellow). However, below Ch 9 and up to the confluence of the river with the tributary M, the waters were of class 4. Below the tributary M, water quality class 3 is again noted, including the entire tributary T and up to the confluence of the Chara and Olekma.

Thus, the ecological mapping of the water quality of the Chara River basin shows the areas of significant influence of coal and gold mining enterprises. But it also reveals areas of potential impact, both in the upper section of the river (coal-bearing Apsat and gold mining in Sukhoi Log) and in the lower section (tributary T from the Taborny gold mining). The map also indicates the section of the middle course of the river in the area of the confluence of the tributary M, where we have no reliable data on mining operations, but exploration may be underway there.

DISCUSSION

The species composition of algae found in the plankton of the Chara River is quite diverse. The biodiversity of phytoplankton of the studied river increases from the source to the mouth. JASP analysis indicates a high habitat-forming role of the tributaries of the Chara River. This is due to the enrichment of the species composition due to the tributary system, as well as due to the increase in the number of biotopes in the riverbed itself. This fact is described as a phenomenon of "river continuum", expressed in the successive replacement of some groups of biotopes by others (Vannote et al. 1980).

In technogenic landscapes of placer gold mining, as a result of water erosion and discharge of industrial waters, the removal of suspended matter increases many times over, metal concentrations increase, and pollutants spread along watercourses far beyond the gold mining sites (Zamana & Vakhnina 2020).

The decrease in transparency we have noted in certain sections of the river is man-made in nature. One of the problems of gold mining at placer deposits is the increase in the concentration of suspended particles in river water due to the work of the dredge. The increase in turbidity makes it difficult for light to penetrate into the water column. In turbid water, the growth of algae and macrophytes is inhibited due to a decrease in photosynthesis and physical suppression of vegetation at the bottom of the reservoir. The number and diversity of benthic invertebrates decreases as a result of reduced vegetation, clogging of the food apparatus with small, suspended particles and the lack of suitable living conditions in the bottom layer (Radomskaya et al. 2021). In the community, those species that are better adapted to living in highly turbid waters gain an advantage.

The long-term nature and delayed type of impact of coal mining on aquatic ecosystems is shown in the study devoted to a legacy of underground and surface coal mining in the Canadian Rockies (Cooke et al. 2024). The data obtained by the authors in the analysis of dated cores from bottom sediments from Crowsnest Lake indicate an increase in the content of selenium, lead, carbon, nitrogen and polycyclic aromatic compounds, which are closely associated with past mining at now mothballed and reclaimed coal mines. And episodic penetration into surface water runs off from tailing dumps leads to a periodic (but short-term) increase in the content of iron, various metals, and suspended matters.

Studies in various regions on the impact of subsoil mining on aquatic ecosystems have revealed significant changes in water quality and biodiversity. For example, in the polar part of the Krasnoyarsk Territory on May 29, 2020, as a result of an omission in the design and construction of the pile foundation of the Norilsk Nickel oil storage tank, it was damaged and leaked with a volume of 21 thousand tons (Kirakosyan & Molchanova 2021). By October 2020, the main stages of the accident cleanup were completed at the accident site: 90 % of the spill was collected, and the removal of contaminated soils was completed. Nevertheless, an analysis of the consequences of this accident showed high concentrations of organic carbon in bottom sediments, and

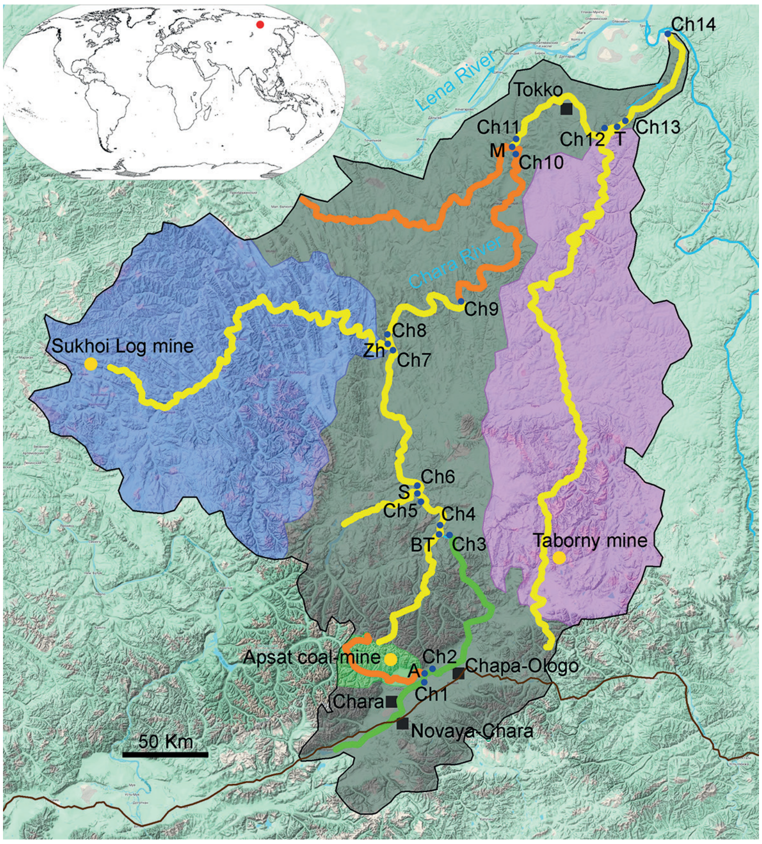

Figure 16 Ecological map of water quality in the Chara River basin according indices saprobity S. The line color as in the EC scale

Okrug – Yugra (KhMAO–Yugra) using bioindication and ecological mapping methods made it possible to identify the impact of salinization and organic pollution in oil-contaminated areas. The results on the distribution of indicator species showed a disturbance of oil-contaminated habitats and a deviation of indicators from those typical for the region's nature (Skorobogatova et al. 2019).

In addition to direct impacts, indirect threats from hydrocarbon exploration and production can also exacerbate negative impacts on ecosystem functioning and biodiversity loss regardless of continent or climate zone, as shown in Brazil and the Polar Urals (Esterhuyse et al. 2022, Anhalt et al. 2020). Oil and gas activities in the Mississippi River Basin have contributed significantly to the loss of wetlands in the river delta (Ko & Day 2004). The impact is associated not only with the toxicity of spilled oil, but also with secondary and indirect consequences, such as changes in hydrology. Impacts on plant communities include disruption of plant-water relationships, direct effects on plant metabolism, toxicity to living cells, and a decrease in oxygen exchange between the atmosphere and water. Impacts include growth retardation, reduced productivity, altered metabolic systems and biomagnification of hydrocarbon compounds.

the content of polycyclic aromatic hydrocarbons reached 3764.4 ng g^{-1}. Lakes were most affected due to their slow water exchange. According to experts, the large polar lake Pyasino will probably never be restored to its original state. It should be added that some of the oil products entered the marine ecosystem of the Kara Sea.

For northern water bodies affected by mining, a number of authors note a tendency towards a decrease in the biodiversity of algal communities (Nikolaeva & Kopyrina 2023, Systerova 2023).

The impact of stressors on freshwater ecosystems is often complex and has a synergistic effect, leading to irreversible or complex consequences, the counteraction of which is expensive in many situations (Bănăduc et al. 2024). The taxonomic composition in flow-through systems exhibits stochastic distributions due to physical disturbances, in contrast to stagnant aquatic ecosystems (MacArthur & Wilson 1967).

Research conducted using statistical mapping methods on water bodies in Western Yakutia in the zone of influence of oil and gas production and diamond deposit development made it possible to determine the main abiotic factors affecting the vegetation of diatom communities, among which the researchers named chlorides (in the diamond mining area) and copper (in the oil and gas production area) (Barinova et al. 2024).

A study of the diversity of algae in the Ershovskoye oil field swamps of the Khanty-Mansiysk Autonomous

The features of phytoplankton reorganization in response to anthropogenic factors (eutrophication, heavy metal pollution, acidification, thermofication) were demonstrated using the example of northern lakes in the North-West of European Russia affected by subsoil development activities (Sharov 2021). It has been proven that in northern water bodies, the complex effect of heavy metals and biogenic elements leads to the suppression of phytoplankton, and the effect of acidification in combination with heavy metals enhances the toxic effect of the latter. A feature of the response to acidification is an increase in the variability of phytoplankton biomass dynamics. The main limiting factor in the development of phytoplankton in cold-water lakes is temperature and the content of nutrients in the water. The influx of biogenic and organic substances with domestic wastewater leads to eutrophication, characterized by an increase in the total biomass of phytoplankton to 20 mg l^{-1} and a restructuring of the dominant phytoplankton complexes – an increase in the proportion of cryptophytes to 30 % and green volvocine algae to 60 %. Under the influence of low pH and heavy metals, there is a decrease in species diversity and an increase in the variability of phytoplankton biomass.

The results of the bioindication analysis show a small influx of organic matter not only from the tributaries of the Chara River, where gold and coal mining enterprises are already operating, but also the influence of potential developments, where exploration work is being carried out. However, the identified organic pollution is quickly absorbed by the river ecosystem. Our data confirms the high capacity of the Chara River to utilize organic pollution.

CONCLUSION

Thus, 211 species and varieties of algae were found in the plankton of the Chara River in Eastern Siberia according to the results obtained in June 2011 at a 762 km stretch of the river. Diatoms were distinguished by the highest diversity species. The biodiversity of the river phytoplankton increases towards its mouth, which is obviously due to the high habitat-forming role of the tributaries of the Chara River. Our data indicates a decrease in the transparency of river waters, which is of a technogenic nature and is noted in sections of the river that are under the influence of gold mining. The results of the bioindication method point to organic pollution associated with subsoil mining in the river basin. At this stage, the river ecosystem has a high capacity for self-purification and can recycle organic runoff, as shown by ecological maps of water quality in the Chara River basin. The significant impact of coal and gold mining operations reduced water quality to Class 4 in the tributaries. However, the river ecosystem subsequently recovered from the organic runoff, and water quality increased to Class 3 in the lower reaches of the river. The number of species in the communities also showed a significant increase downstream, demonstrating the ecosystem's biotic activity.. The Chara River basin is a unique area for research. It combines, on the one hand, technogenic factors of gold mining operations and coal and gas deposit development. On the other hand, the risks of global climate change affecting this region as a zone of continuous permafrost distribution may have an unexpected effect. This study has shown the relevance of monitoring studies of aquatic ecosystems in northern regions where intensive development of subsoil extraction industries is underway. In addition, further development of bioindication methods adapted to specific pollutants and types of ecosystems will increase the accuracy and applicability of monitoring and risk assessment programs.

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APPENDIX

Appendix Table A1. Table of averaged data of environmental variables in the sampling stations of the Chara River basin, 2011.

Variable	Ch1	A	Ch2	Ch3	BT	Ch4	Ch5	S	Ch6	Ch7	Zh	Ch8	Ch9	Ch10	M	Ch11	Ch12	T	Ch13	Ch14
Altitude, m a.s.l.	685	685	685	432	432	430	367	368	359	251	244	241	203	158	158	151	149	137	146	120
Velocity	1.5	0.5	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.9	1.9	2.2	2.5	1.9	0.7	1.1	1.4	0.6	1.4	0.9
T °C	6.4	4.5	7.2	7.2	4.2	5.6	4.8	4.3	4.3	6.8	8.3	8.0	8.7	9.8	13.9	14.1	10.3	12.3	12.5	11.9
Transparency, m	1.1	2.2	1.4	1.3	1.2	1.7	1.8	1.4	1.4	1.9	0.6	0.5	0.6	0.8	1.7	1.1	0.9	3.0	3.3	1.1
Depth, m	2.0	1.5	1.5	2.0	1.5	1.8	3.0	1.7	5.0	5.0	5.0	5.0	9.0	5.1	2.7	5.0	9.5	3.0	9.5	9.5
pH	7.32	7.36	7.45	7.30	6.84	7.02	7.01	7.00	7.04	7.52	7.75	7.72	7.82	7.77	8.25	8.33	8.05	8.00	8.04	7.93
O_2, mg l^{-1}	10.73	11.70	11.01	11.11	12.03	10.58	11.79	12.34	12.30	11.36	10.97	11.02	10.86	10.67	9.45	9.55	10.48	9.70	9.74	10.19
CO_2, mg l^{-1}	5.28	4.40	4.84	4.62	4.18	3.96	5.28	3.52	3.30	4.40	4.40	3.52	4.18	3.96	6.16	6.16	3.52	4.40	3.96	3.52
TDS, mg l^{-1}	37.61	44.11	51.75	27.34	24.05	25.94	22.13	32.07	31.69	46.09	61.98	54.11	50.43	63.82	179.31	173.81	63.38	87.69	83.66	66.27
N-NH_4, mg l^{-1}	0.37	0.15	0.37	0.45	0.35	0.30	0.23	0.17	0.17	0.29	0.40	0.49	0.30	0.35	0.49	0.45	0.35	0.09	0.09	0.26
N-NO_2, mg l^{-1}	0.004	0.003	0.004	0.004	0.005	0.003	0.004	0.002	0.004	0.004	0.007	0.007	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
N-NO_3, mg l^{-1}	0.07	0.07	0.12	0.07	0.12	0.06	0.05	0.04	0.08	0.08	0.16	0.16	0.09	0.09	0.09	0.10	0.08	0.04	0.03	0.06
P-PO_4, mg l^{-1}	0.02	0.00	0.00	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.08	0.07	0.03	0.03	0.00	0.00	0.02	0.00	0.01	0.02
Ptot, mg l^{-1}	0.02	0.04	0.07	0.12	0.32	0.12	0.02	0.06	0.04	0.02	0.32	0.27	0.16	0.10	0.02	0.04	0.12	0.04	0.02	0.06
Si, mg l^{-1}	1.44	1.24	1.24	1.28	0.94	1.34	1.14	1.24	1.04	1.20	1.44	1.48	1.24	0.94	1.24	1.24	0.84	1.12	1.24	0.88
BOD_5, mgO l^{-1}	1.39	1.74	1.88	1.19	2.01	0.57	1.57	2.22	2.18	1.23	1.46	1.64	1.42	1.32	0.80	1.05	1.48	1.30	1.11	1.48
Fetot, mg l^{-1}	0.37	0.27	0.27	0.20	0.52	0.20	0.16	0.07	0.04	0.16	0.87	0.70	0.37	0.37	0.07	0.07	0.20	0.04	0.04	0.20
TSS, mg l^{-1}	14.8	14.8	14.8	14.0	14.0	14.0	16.0	16.4	16.0	14.0	14.0	14.0	12.4	15.2	15.2	15.2	16.0	16.0	16.0	12.4
Color, Pt/Co°	24	9	31	20	18	24	29	16	13	25	29	32	23	26	38	39	24	24	27	32
O_2%	95	99	99	98	98	89	96	100	100	97	97	97	96	97	95	96	96	94	94	98
Hardness, mg l^{-1}	0.48	0.52	0.62	0.32	0.28	0.32	0.28	0.42	0.40	0.58	0.8	0.68	0.62	0.76	2.24	2.14	0.82	1.10	1.14	0.84
Ca, mg l^{-1}	3.61	7.21	8.42	4.01	2.81	4.01	4.01	6.81	4.81	6.81	10.42	10.42	8.82	10.82	34.07	30.86	12.02	14.83	13.63	10.82
Mg, mg l^{-1}	3.65	1.94	2.43	1.46	1.7	1.46	0.97	0.97	1.94	2.92	3.4	1.94	2.19	2.67	6.56	7.29	2.67	4.37	5.59	3.65
Na, mg l^{-1}	1.9	2.3	2.6	1.9	1.6	1.3	1.0	1.2	1.6	1.5	1.6	1.6	1.6	3.9	5.4	5.9	1.9	3.7	3.4	2.5
K, mg l^{-1}	0.5	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.5	0.3	0.3	0.3	0.4
HCO_3, mg l^{-1}	10.98	9.76	17.09	3.66	3.66	4.88	3.66	2.44	2.44	17.09	21.97	18.31	21.97	18.31	82.99	81.77	20.75	31.73	8.54	21.97
Cl, mg l^{-1}	4.96	2.13	3.9	2.84	1.77	2.84	2.48	2.48	1.77	2.48	2.48	2.13	2.48	8.51	10.99	10.99	4.61	9.22	9.93	5.32
SO_4, mg l^{-1}	12.01	20.17	16.81	12.97	12.01	11.05	9.61	17.77	18.73	14.89	21.61	19.21	12.97	19.21	38.9	36.5	21.13	23.54	42.27	21.61
COD, mgO l^{-1}	18	10	12	12	10	10	10	10	10	17	10	10	17	18	28	20	10	10	10	10
Phenols, mg l^{-1}	0.30	0.30	0.30	0.30	0.30	0.30	0.26	0.26	0.26	0.26	0.26	0.26	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Detergents, mg l^{-1}	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.02
Oil, mg l^{-1}	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.001	0.002

Appendix Table A2. Average abundance (cells per litre) of algae and cyanobacteria species from 20 sampling stations of the Chara River basin in 2011. Abbreviated station names as in Table 1.

Taxa	**Ch1**	**A**	**Ch2**	**Ch3**	**BT**	**Ch4**	**Ch5**	**S**	**Ch6**	**Ch7**	**Zh**	**Ch8**	**Ch9**	**Ch1·**	**M**	**Ch11**	**Ch12**	**T**	**Ch13**	**Ch14**
Bacillariophyta																				
Achnanthes flexella (Kützing) Brun	·	·	·	·	·	·	4	4	4	4	4	3173	·	4	·	·	4	4	·	4
Achnanthidium nodosum (Cleve) Tseplik & Chudaev	4	4	3173	4	28560	4	9520	9520	3173	9520	12693	9520	6347	4	·	4	9520	4	6347	6347
Amphora ovalis (Kützing) Kützing	4	4	4	4	·	3173	4	·	4	·	·	·	4	4	4	4	4	4	4	4
Aneumastus tusculus (Ehrenberg) D.G.Mann & A.J.Stickle	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·
Asterionella formosa Hassall	4	4	4	4	·	4	4	·	·	4	·	·	4	4	4	4	4	4	4	4
Aulacoseira alpigena (Grunow) Krammer	4	4	·	4	4	4	4	·	·	·	·	4	4	·	·	·	·	4	4	·
Aulacoseira distans (Ehrenberg) Simonsen	4	·	·	·	·	·	·	·	4	4	·	·	·	·	·	·	·	·	·	·
Aulacoseira granulata (Ehrenberg) Simonsen	·	4	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	4	4
Aulacoseira granulata var. *angustissima* (O.Müller) Simonsen	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Aulacoseira subarctica (O.Müller) E.Y.Haworth	4	·	4	4	·	3173	4	·	4	4	4	·	·	·	·	·	·	4	4	·
Cocconeis placentula Ehrenberg	·	4	4	4	·	4	4	·	·	4	·	·	4	4	4	3173	4	3173	6347	4
Cymatopleura elliptica (Brébisson) W.Smith	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	4	·	·
Cymatopleura solea var. *gracilis* Grunow	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	4	·
Cymbella aspera (Ehrenberg) Cleve	·	4	4	4	·	4	·	4	·	4	·	4	·	·	·	·	·	·	4	4
Cymbella cistula (Ehrenberg) O.Kirchner	4	·	4	4	·	4	4	4	·	4	4	4	4	4	4	4	4	4	4	4
Cymbella cymbiformis C.Agardh	·	·	·	·	·	4	·	·	4	4	·	4	·	4	·	·	·	·	·	·
Cymbella lanceolata C.Agardh	·	·	4	4	·	4	4	·	4	·	4	·	·	·	4	4	4	4	4	4
Cymbella parva (W.Smith) Kirchner	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cymbella stuxbergii (Cleve) Cleve	·	·	4	·	·	·	4	4	4	4	4	4	·	4	·	·	4	4	4	4
Cymbella tumida (Brébisson) Van Heurck	4	·	·	·	4	4	4	4	·	4	·	4	4	4	·	·	4	4	4	·
Cymbopleura amphicephala (Nägeli ex Kützing) Krammer	·	·	·	·	·	4	4	·	4	4	·	·	·	·	·	·	·	·	·	4
Cymbopleura cuspidata (Kützing) Krammer	·	4	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·
Cymbopleura inaequalis (Ehrenberg) Krammer	4	4	4	4	·	4	4	·	·	4	·	·	·	·	4	·	·	·	4	4
Cymbopleura subcuspidata (Krammer) Krammer	·	·	4	4	·	4	·	·	4	4	·	·	·	·	·	·	4	4	·	4
Diatoma elongata (Lyngbye) C.Agardh	·	·	·	4	·	4	4	4	·	4	12693	·	4	·	·	·	4	4	4	4
Diatoma tenuis C.Agardh	·	·	4	4	·	·	·	·	·	4	4	4	3173	4	6347	9520	9520	6347	15867	6347
Didymosphenia geminata (Lyngbye) Mart.Schmidt	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Diploneis smithii (Brébisson) Cleve	·	·	·	·	·	·	·	4	·	4	·	·	·	·	·	·	·	·	·	·
Encyonema silesiacum (Bleisch) D.G.Mann	4	3173	3173	6347	6347	4	6347	3173	4	4	6347	4	3173	4	·	4	4	4	3173	4
Entomoneis paludosa (W.Smith) Reimer	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Epithemia adnata (Kützing) Brébisson	·	4	·	·	·	·	·	·	·	4	4	·	·	·	4	3173	·	4	4	4
Epithemia sorex Kützing	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Epithemia turgida (Ehrenberg) Kützing	·	·	·	·	·	4	·	·	·	·	4	·	·	·	4	4	4	4	4	4
Eunotia arcus Ehrenberg	·	·	·	·	·	·	·	4	4	·	4	4	3173	4	·	3173	4	·	·	·
Eunotia bidens Ehrenberg	4	·	·	4	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Eunotia bigibba Kützing	·	·	4	·	·	4	4	·	·	·	4	·	·	·	·	·	4	·	·	·
Eunotia diodon Ehrenberg	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Eunotia exigua (Brébisson ex Kützing) Rabenhorst	4	4	4	·	1589	4	4	·	·	4	4	·	·	·	·	·	·	·	·	4
Eunotia flexuosa (Brébisson ex Kützing) Kützing	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·
Eunotia lunaris (Ehrenberg) Grunow	·	4	·	4	·	·	4	4	4	4	·	·	·	·	·	·	·	·	·	·
Eunotia major (W.Smith) Rabenhorst	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·
Eunotia monodon Ehrenberg	4	·	4	·	·	·	·	4	4	4	4	·	·	·	·	·	·	4	·	·
Eunotia papilio (Ehrenberg) Grunow	·	4	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·
Eunotia pectinalis var. *ventricosa* (Ehrenberg) Grunow	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·
Eunotia polydentula Hustedt	·	4	·	4	·	4	4	·	·	·	·	·	·	·	·	·	·	·	·	·
Eunotia praerupta Ehrenberg	·	·	4	4	4	4	·	4	4	4	·	·	4	4	·	4	4	·	·	·
Eunotia robusta Ralfs	·	·	·	·	4	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·
Eunotia valida Hustedt	·	·	·	·	4	·	·	·	·	·	4	·	4	4	·	·	4	·	·	4
Fragilaria crotonensis Kitton	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	4	·	·
Fragilaria montana (Krasske ex Hustedt) Lange-Bertalot	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·
Frustulia rhomboides (Ehrenberg) De Toni	·	4	4	·	·	4	4	·	·	4	·	·	·	4	·	·	·	4	4	4
Gomphonema longiceps Ehrenberg var. *montanum* (Schumann) Cleve f. *suecicum* Grunow	4	·	4	4	·	·	·	·	·	·	4	·	·	4	·	·	·	·	4	4
Gomphonema acuminatum Ehrenberg	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·
Gomphonema constrictum Ehrenberg	·	4	4	·	·	·	·	·	·	·	·	·	·	·	4	4	·	4	4	·
Gomphonema coronatum Ehrenberg	·	·	·	·	·	·	4	·	·	·	·	·	·	·	4	4	·	·	·	·
Gomphonema intricatum Kützing	4	·	·	4	·	4	4	4	4	3173	·	4	4	·	·	4	4	4	4	4
Gomphonema longiceps var. *subclavatum* Grunow	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	·	·	·

Appendix Table A2. Continued.

Taxa	**Ch1**	**A**	**Ch2**	**Ch3**	**BT**	**Ch4**	**Ch5**	**S**	**Ch6**	**Ch7**	**Zh**	**Ch8**	**Ch9**	**Ch1·**	**M**	**Ch11**	**Ch12**	**T**	**Ch13**	**Ch14**
Gomphonema montanum (Schumann) Grunow	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Gomphonema productum (Grunow) Lange-Bertalot & E.Reichardt	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·
Gomphonema pumilum (Grunow) E.Reichardt & Lange-Bertalot	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Gomphonema ventricosum W.Gregory	4	4	4	3173	6347	4	4	4	4	3173	4	4	4	4	4	4	4	4	4	4
Gomphonema vibrio Ehrenberg	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	4	4	4
Gyrosigma acuminatum (Kützing) Rabenhorst	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Gyrosigma attenuatum (Kützing) Rabenhorst	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	4	4	·
Hannaea arcus (Ehrenberg) R.M.Patrick	4	4	3173	9520	9520	22213	9520	4	4	4	3173	12693	6347	9520	·	4	15867	3173	3173	6347
Hannaea inaequidentata (Lagerstedt) Genkal & Kharitonov	·	·	4	4	4	4	4	·	4	4	4	4	4	4	·	·	4	4	4	4
Hantzschia amphioxys (Ehrenberg) Grunow	·	·	·	·	4	4	·	·	·	4	4	·	4	·	4	·	·	·	·	·
Hantzschia amphioxys var. *major* Grunow	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·
Hantzschia elongata (Hantzsch) Grunow	4	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Iconella biseriata (Brébisson) Ruck & Nakov	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Iconella hibernica (Ehrenberg) Ruck & Nakov	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	4	·
Iconella tenera (W.Gregory) Ruck & Nakov	·	4	4	·	·	·	4	·	4	·	·	·	·	4	4	·	·	4	4	·
Lindavia costata (Loginova, Lupikina & Khursevich) Nakov, Guillory, Julius, Theriot & Alverson	4	4	4	4	·	4	4	4	4	4	·	·	4	4	·	4	·	·	4	4
Melosira varians C.Agardh	4	4	4	4	·	4	4	·	·	4	·	·	·	4	4	4	4	4	4	4
Meridion circulare (Greville) C.Agardh	4	4	4	4	·	·	4	4	4	4	·	4	4	3173	4	4	4	4	4	4
Meridion constrictum Ralfs	4	·	4	4	·	4	4	·	·	4	·	·	·	·	·	·	·	·	·	·
Navicula radiosa Kützing	·	·	4	·	·	4	·	·	·	·	·	·	4	·	4	·	4	·	4	4
Navicula reinhardtii (Grunow) Grunow	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	4	·	·
Navicula viridula (Kützing) Ehrenberg	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4
Neidium amphigomphus (Ehrenberg) Pfitzer	·	4	·	·	·	4	·	·	·	4	·	·	·	·	·	·	·	·	·	4
Neidium dubium (Ehenberg) Cleve	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·
Neidium iridis (Ehrenberg) Cleve	4	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·
Neidium productum (W.Smith) Cleve	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Nitzschia acicularis (Kützing) W.Smith	·	4	·	·	·	·	·	·	·	·	·	·	4	·	4	4	·	4	4	4
Nitzschia flexa Schumann	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	·	·	·
Nitzschia flexoides Geitler	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4
Nitzschia linearis W.Smith	·	4	4	4	·	4	4	·	·	4	·	·	4	4	4	4	4	4	4	4
Nitzschia recta Hantzsch ex Rabenhorst	·	·	·	·	·	·	·	·	·	4	4	·	·	4	4	·	·	·	·	·
Nitzschia sigmoidea (Nitzsch) W.Smith	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	4	4	4
Nitzschia vermicularis (Kützing) Hantzsch	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	4	·	·
Odontidium hyemale (Roth) Kützing	4	4	4	3173	4	4	3173	·	4	4	4	4	4	4	·	·	3173	4	4	3173
Pantocsekiella kuetzingiana (Thwaites) K.T.Kiss & E.Ács	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Peronia fibula (Brébisson ex Kützing) R.Ross	·	·	·	·	·	4	4	·	4	4	·	·	4	·	·	·	4	·	·	4
Pinnularia abaujensis var. *linearis* (Hustedt) R.M.Patrick	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Pinnularia divergens W.Smith	·	4	·	·	·	4	4	·	·	·	·	·	·	4	·	4	·	·	·	·
Pinnularia interrupta W.Smith	·	4	·	·	·	·	·	·	·	4	·	·	·	·	·	·	4	·	·	·
Pinnularia lata (Brébisson) W.Smith	·	·	·	·	·	4	4	·	·	4	·	·	·	·	·	·	·	·	·	·
Pinnularia macilenta Ehrenberg	·	4	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·
Pinnularia major (Kützing) Rabenhorst	4	·	·	4	·	4	·	4	·	4	4	4	·	·	·	·	·	4	4	4
Pinnularia mesolepta (Ehrenberg) W.Smith	4	·	4	4	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	·
Pinnularia microstauron (Ehrenberg) Cleve	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Pinnularia stauroptera (Grunow) Rabenhorst	·	4	4	4	4	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·
Pinnularia viridis (Nitzsch) Ehrenberg	4	4	·	4	4	·	4	·	·	4	·	·	4	·	·	·	4	4	4	4
Pseudostaurosira parasitica (W.Smith) E.Morales	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·
Pseudostaurosira subconstricta (Grunow) Kulikovskiy & Genkal	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·
Reimeria sinuata (W.Gregory) Kociolek & Stoermer	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	4	·	3173	4	4
Rhoicosphenia abbreviata (C.Agardh) Lange-Bertalot	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·
Rhopalodia gibba (Ehrenberg) O.Müller	4	4	4	·	·	4	4	·	·	4	4	·	·	·	4	4	·	4	4	4
Stauroneis acuta W.Smith	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Stauroneis anceps Ehrenberg	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	4	·	4
Stauroneis phoenicenteron (Nitzsch) Ehrenberg	4	4	4	4	4	4	4	4	·	4	4	4	4	4	4	4	4	4	4	4
Staurosira leptostauron (Ehrenberg) Kulikovskiy & Genkal	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Surirella angusta Kützing	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	·	·	·
Surirella hibernica (W.Smith) D.Kapustin & O.Kryvosheia	4	·	4	·	·	·	4	·	·	·	·	·	·	·	·	·	4	4	4	·
Surirella librile (Ehrenberg) Ehrenberg	4	·	4	·	·	4	·	·	·	4	·	4	4	4	4	4	·	4	4	4
Tabellaria fenestrata (Lyngbye) Kützing	4	4	4	4	4	4	3173	4	4	4	4	4	3173	4	4	4	·	4	4	4

Appendix Table A2. Continued.

Taxa	Ch1	A	Ch2	Ch3	BT	Ch4	Ch5	S	Ch6	Ch7	Zh	Ch8	Ch9	Ch1·	M	Ch11	Ch12	T	Ch13	Ch14
Tabellaria flocculosa (Roth) Kützing	4	3173	4	4	47600	6347	6347	952·	6347	15867	15867	19040	6347	3173	3173	4	9520	4	4	4
Tabularia tabulata (C.Agardh) Snoeijs	4	4	·	4	·	·	4	4	·	4	4	4	4	4	4	4	4	4	3173	4
Tetracyclus glans (Ehrenberg) F.W.Mills	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	4	4	·
Ulnaria acus (Kützing) Aboal	·	4	4	·	·	4	4	·	·	4	·	·	·	·	4	4	·	4	·	·
Ulnaria amphirhynchus (Ehrenberg) Compère & Bukhtiyarova	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	4	3173	·
Ulnaria capitata (Ehrenberg) Compère	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·
Ulnaria contracta (Østrup) E.A.Morales & M.L.Vis	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·
Ulnaria oxyrhynchus (Kützing) Aboal	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Ulnaria ulna (Nitzsch) Compère	4	4	4	4	·	4	4	4	4	4	6347	3173	4	4	3173	4	4	9520	6347	4
Actinotaenium truncatum (Brébisson ex Ralfs) Teiling	·	·	·	·	·	·	·	·	·	·	4	4	·	·	·	·	·	·	·	·
Charophyta																				
Closterium ehrenbergii Meneghini ex Ralfs	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·
Closterium gracile Brébisson ex Ralfs	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Closterium intermedium Ralfs	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Closterium kuetzingii Brébisson	·	4	·	4	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Closterium leibleinii Kützing ex Ralfs	·	·	·	·	·	4	·	·	·	·	·	·	·	·	4	4	·	4	4	4
Closterium littorale f. *minus* L.E.Komarenko	·	·	·	·	4	·	·	·	·	4	·	4	4	4	4	4	4	4	4	4
Closterium littorale F.Gay	·	·	4	4	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Closterium moniliferum Ehrenberg ex Ralfs	4	4	·	·	·	·	·	·	·	·	·	·	4	·	4	4	·	4	·	·
Closterium peracerosum F.Gay	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·
Closterium pritchardianum W.Archer	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	4	·
Closterium ralfsii var. *hybridum* Rabenhorst	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·
Closterium rostratum Ehrenberg ex Ralfs	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·
Closterium rostratum var. *brevirostratum* West	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Closterium strigosum Brébisson	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	4	·
Closterium subulatum (Kützing) Brébisson	·	4	4	·	·	4	·	·	·	·	·	4	4	4	·	·	4	·	·	·
Cosmarium anceps P.Lundell	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·
Cosmarium botrytis Meneghini ex Ralfs	·	4	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·
Cosmarium formosulum Hoff	·	·	·	·	·	4	4	·	·	4	·	·	·	·	4	4	·	4	4	·
Cosmarium humile var. *substriatum* (Nordstedt) Schmidle	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·
Cosmarium pokornyanum (Grunow) West & G.S.West	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cosmarium punctulatum Brébisson	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·
Cosmarium pygmaeum W.Archer	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·
Cosmarium quadratum var. *willei* (Schmidle) Willi Krieger & Gerloff	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cosmarium reniforme (Ralfs) W.Archer	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cosmarium speciosum var. *simplex* Nordstedt	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·
Cosmarium subcrenatum Hantzsch	·	·	4	·	·	·	·	·	·	·	·	·	·	4	·	·	·	4	4	·
Cosmarium turpinii Brébisson	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·
Gonatozygon kinahanii (W.Archer) Rabenhorst	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Hyalotheca dissiliens Brébisson ex Ralfs	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·
Staurastrum avicula Brébisson	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Staurastrum avicula var. *lunatum* (Ralfs) Coesel & Meesters	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	4	·	·	·
Staurastrum basidentatum Borge	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·
Staurastrum dilatatum Ehrenberg ex Ralfs	·	·	·	·	·	4	·	·	·	·	·	4	4	·	·	·	·	·	4	·
Staurastrum polytrichum (Perty) Rabenhorst	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·
Staurastrum punctulatum Brébisson	4	·	·	·	·	4	4	·	·	·	·	·	·	·	4	4	4	4	4	4
Staurastrum ralfsii (West & G.S.West) Coesel & Meesters	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·
Staurodesmus glaber (Ralfs) Teiling	·	·	·	·	4	·	·	4	·	·	·	·	·	·	·	·	4	·	·	·
Staurodesmus megacanthus var. *scoticus* (West & G.S West) S.Lillieroth	·	·	·	·	·	·	·	4	4	4	·	·	4	·	·	·	·	·	·	·
Chlorophyta																				
Actinastrum hantzschii Lagerheim	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·
Ankistrodesmus arcuatus Korshikov	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	4	·	4	·	·
Colemanosphaera charkowiensis (Korshikov) H.Nozaki, T.K.Yamada, F.Takahashi, R.Matsuzaki & T.Nakada	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·
Desmodesmus armatus (Chodat) E.H.Hegewald	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·
Messastrum gracile (Reinsch) T.S.Garcia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	4	·	·
Monoraphidium contortum (Thuret) Komárková-Legnerová	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Monoraphidium griffithii (Berkeley) Komárková-Legnerová	·	·	·	·	·	·	·	·	·	·	·	3173	·	·	4	4	·	4	4	4

Appendix Table A2. Continued.

Taxa	**Ch1**	**A**	**Ch2**	**Ch3**	**BT**	**Ch4**	**Ch5**	**S**	**Ch6**	**Ch7**	**Zh**	**Ch8**	**Ch9**	**Ch1·**	**M**	**Ch11**	**Ch12**	**T**	**Ch13**	**Ch14**
Neglectella solitaria (Wittrock) Stenclová & Kastovsky	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·
Pandorina morum (O.F.Müller) Bory	·	·	4	·	·	·	·	·	·	4	·	·	·	·	4	4	4	4	4	·
Penium spirostriolatum J.Barker	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·
Pseudopediastrum boryanum (Turpin) E.Hegewald	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·	·
Pseudopediastrum boryanum var. *longicorne* (Reinsch) P.M.Tsarenko	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·
Cyanobacteria																				
Anabaena oscillarioides Bory ex Bornet & Flahault	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	4	·	4
Chamaesiphon confervicola A.Braun	·	·	·	·	·	4	·	·	4	·	·	4	4	·	4	4	·	·	·	4
Merismopedia tenuissima Lemmermann	·	·	·	·	·	·	·	·	4	4	4	·	·	·	·	·	·	·	·	·
Nostoc caeruleum Lyngbye ex Bornet & Flahault	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	4	·
Oscillatoria limosa C.Agardh ex Gomont	·	4	4	4	·	·	·	·	·	·	·	·	·	·	4	4	·	4	4	·
Oscillatoria tenuis C.Agardh ex Gomont	4	4	·	·	·	·	·	·	4	·	·	4	·	·	4	·	·	·	·	4
Tolypothrix distorta Kützing ex Bornet & Flahault	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Tolypothrix tenuis Kützing ex Bornet & Flahault	·	·	·	·	·	·	4	·	·	·	·	·	·	·	4	4	·	4	·	·
Euglenozoa																				
Lepocinclis acus (O.F.Müller) B.Marin & Melkonian	·	4	·	·	·	4	·	·	·	·	·	·	·	·	4	·	·	·	·	·
Miozoa																				
Ceratium hirundinella (O.F.Müller) Dujardin	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	·	·	·
Naiadinium polonicum (Wołoszyńska) Carty	4	4	4	4	·	4	4	4	4	4	·	·	4	4	·	4	4	4	4	4
Peridinium bipes F.Stein	·	4	4	·	·	4	4	·	·	4	·	·	·	·	·	4	·	·	·	·
Peridinium cinctum (O.F.Müller) Ehrenberg	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·	4	·
Peridinium willei Huitfeldt-Kaas	·	4	4	·	·	4	4	·	·	4	·	·	·	·	·	·	·	·	·	·
Ochrophyta																				
Dinobryon bavaricum Imhof	4	4	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Dinobryon borgei Lemmermann	3173	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Dinobryon cylindricum O.E.Imhof	·	4	4	·	·	4	·	4	4	4	·	·	·	·	·	·	·	·	·	·
Dinobryon divergens O.E.Imhof	4	4	4	4	·	4	4	·	·	4	·	·	4	·	4	4	4	4	4	4
Dinobryon divergens var. *schauinslandii* (Lemmermann) Brunnthaler	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	4	·	·	·	·
Dinobryon sertularia Ehrenberg	4	4	4	4	·	4	4	4	4	4	4	4	4	4	·	4	4	4	4	4
Dinobryon sociale (Ehrenberg) Ehrenberg	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	·	·
Dinobryon sociale var. *americanum* (Brunnthaler) Bachmann	·	·	·	·	·	·	·	4	4	4	4	·	4	4	·	·	4	·	·	4
Dinobryon stipitatum Stein	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	4	·	4	·
Dinobryon suecicum Lemmermann	·	4	·	4	·	·	·	·	·	·	·	·	·	·	·	4	·	·	·	·
Ducellieria chodatii (Ducellier) Teiling	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	·	·	·
Epipyxis ramosa (Lauterborn) Hilliard & Asmund	·	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·
Epipyxis tabellariae (Lemmermann) G.M.Smith	·	·	·	·	·	·	·	·	4	·	·	·	·	·	4	·	·	·	4	·
Isthmochloron trispinatum (West & G.S.West) Skuja	·	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·
Mallomonas coronata Bolochonzew	·	4	4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Synura uvella Ehrenberg	4	4	4	·	·	4	4	4	·	4	·	·	4	4	4	4	4	4	·	·
Tribonema pyrenigerum Pascher	4	·	·	4	·	·	·	·	·	·	·	·	·	·	4	4	·	4	·	4
Tribonema subtilissimum Pascher	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4	4	·	4	·	·
Tribonema viride Pascher	·	·	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	·	·
Tribonema vulgare Pascher	·	·	·	·	4	·	·	·	·	·	·	·	·	·	·	·	4	·	4	·

Appendix Table A3. Ecological preferences of algae and cyanobacteria species from 20 sampling stations of the Chara River basin in 2011.

Taxa	Hab	T	OXY	HAL	pH	D	AUT-HET	TRO	Index S
Bacillariophyta									
Achnanthes flexella	-	-	-	-	-	-	-	-	-
Achnanthidium nodosum	B	-	-	hb	acf	-	-	ot	1.00
Amphora ovalis	B	temp	st-str	i	alf	sx	ate	e	1.50
Aneumastus tusculus	P-B	-	st	i	alb	-	ate	o-e	0.90
Asterionella formosa	P	temp	st-str	i	alf	sx	ate	me	1.35
Aulacoseira alpigena	P-B	temp	st-str	i	alf	sp	ate	ot	0.80
Aulacoseira distans	P-B	cool	str	i	acf	sp	ats	ot	0.40
Aulacoseira granulata	P-B	temp	st-str	i	alf	es	ate	e	2.00
Aulacoseira granulata var. *angustissima*	P	temp	st-str	i	alf	es	ate	e	2.10
Aulacoseira subarctica	P	temp	st-str	i	alf	-	ats	om	1.70
Cocconeis placentula	P-B	temp	st-str	i	alf	es	ate	me	1.35
Cymatopleura elliptica	P-B	temp	st-str	i	alf	-	ate	e	1.40
Cymatopleura solea var. *gracilis*	B	-	-	i	alf	-	-	-	-
Cymbella aspera	B	-	st-str	i	neu	es	ats	e	0.30
Cymbella cistula	B	-	st-str	i	alf	sx	ats	e	1.20
Cymbella cymbiformis	B	temp	st-str	i	alf	sx	ats	om	2.00
Cymbella lanceolata	B	temp	st-str	i	alf	es	ate	e	2.50
Cymbella parva	B	-	-	i	ind	-	-	om	2.00
Cymbella stuxbergii	B	-	-	i	neu	-	-	ot	1.00
Cymbella tumida	B	temp	st-str	i	alf	sx	ats	me	2.20
Cymbopleura amphicephala	B	-	st-str	i	ind	-	-	-	-
Cymbopleura cuspidata	P-B	temp	st-str	i	alf	-	-	-	-
Cymbopleura inaequalis	B	-	st-str	i	alf	-	-	-	1.10
Cymbopleura subcuspidata	P-B	-	str	i	acf	sx	ats	om	1.00
Diatoma elongata	P-B	-	st-str	hl	alf	-	-	-	-
Diatoma tenuis	P-B	temp	st-str	hl	alf	-	-	om	2.40
Didymosphenia geminata	B	-	st-str	i	ind	-	-	-	2.00
Diploneis smithii	B	-	-	mh	alf	-	-	-	-
Encyonema silesiacum	B	temp	st-str	i	ind	-	-	-	-
Entomoneis paludosa	P-B	-	-	mh	alf	-	-	-	-
Epithemia adnata	B	temp	st-str	i	alb	-	-	-	1.20
Epithemia sorex	B	temp	st-str	i	alf	-	-	-	-
Epithemia turgida	B	temp	st-str	i	alf	-	-	-	1.10
Eunotia arcus	B	temp	st-str	i	acf	sx	ats	ot	0.40
Eunotia bidens	P-B, aer	cool	st-str	hb	acf	-	-	ot	1.00
Eunotia bigibba	B	-	str	i	acf	-	-	ot	0.40
Eunotia diodon	B	cool	st-str	i	acf	-	-	-	-
Eunotia exigua	P-B, aer	temp	st-str	hb	acb	-	-	ot	1.00
Eunotia flexuosa	B	temp	st-str	i	acf	-	-	-	0.40
Eunotia lunaris	B	-	-	-	-	-	-	-	-
Eunotia major	B	-	st-str	hb	acf	-	-	-	1.00
Eunotia monodon	B	-	st-str	hb	acf	es	ats	ot	0.40
Eunotia papilio	B	-	-	i	acf	-	-	-	-
Eunotia pectinalis var. *ventricosa*	B	-	st-str	i	acf	-	ate	ot	0.20
Eunotia polydentula	B	-	-	hb	acf	-	-	-	-
Eunotia praerupta	P-B	cool	st-str	hb	acf	-	-	-	0.30
Eunotia robusta	B	-	st	hb	acf	-	-	ot	1.00
Eunotia valida	P-B	-	-	hb	acf	-	-	ot	1.00
Fragilaria crotonensis	P-B	temp	st-str	i	alf	-	-	-	-
Fragilaria montana	aer	-	-	-	-	es	ate	-	-
Frustulia rhomboides	B	temp	st-str	hb	acf	es	-	-	1.00
Gomphonema longiceps var. *montanum* f. *suecicum*	-	-	-	-	-	-	-	-	-
Gomphonema acuminatum	B	temp	st-str	i	ind	-	-	-	0.80
Gomphonema constrictum	-	-	-	-	-	-	-	-	-
Gomphonema coronatum	B	-	st	i	ind	-	-	-	-
Gomphonema intricatum	B	-	st-str	i	ind	-	-	-	-
Gomphonema longiceps var. *subclavatum*	-	-	-	-	-	-	-	-	-
Gomphonema montanum	B	-	str	i	ind	-	ate	-	-
Gomphonema productum	B	-	str	i	ind	-	-	-	1.00
Gomphonema pumilum	B	temp	-	i	alf	-	-	-	-
Gomphonema ventricosum	B	cool	str	i	ind	-	-	-	1.00
Gomphonema vibrio	B	-	str	i	alf	-	ats	ot	0.30
Gyrosigma acuminatum	B	temp	st-str	i	alf	-	-	-	-
Gyrosigma attenuatum	P-B	temp	st-str	i	alf	-	-	-	-
Hannaea arcus	B	temp	str	i	alf	-	-	-	-
Hannaea inaequidentata	P-B	-	-	hb	neu	-	-	-	-
Hantzschia amphioxys	B, aer	temp	st-str	i	ind	-	-	me	3.00
Hantzschia amphioxys var. *major*	B	-	st-str	i	ind	-	-	-	-
Hantzschia elongata	B	-	aer	i	acf	-	-	-	-
Iconella biseriata	P-B	temp	st-str	i	alf	es	-	m	1.00
Iconella hibernica	B	-	st	i	ind	es	ats	ot	2.00
Iconella tenera	P-B	temp	st	i	alf	-	ats	ot	0.20
Lindavia costata	-	-	-	-	-	-	-	-	-
Melosira varians	P-B	temp	st-str	hl	ind	-	-	-	2.40
Meridion circulare	P-B	temp	st-str	i	ind	-	-	-	-
Meridion constrictum	P-B	temp	st-str	hb	ind	-	-	-	-
Navicula radiosa	B	temp	st-str	i	ind	sx	-	-	-
Navicula reinhardtii	-	-	-	-	-	-	-	-	-
Navicula viridula	B	-	st-str	hl	alf	-	-	-	-
Neidium amphigomphus	-	-	-	-	-	-	-	-	-
Neidium dubium	B	-	str	i	alf	-	-	-	-
Neidium iridis	B	temp	st-str	hb	ind	-	-	-	-
Neidium productum	P-B	temp	st-str	i	ind	-	-	-	-
Nitzschia acicularis	P-B	temp	st	i	alf	es	ats	om	1.40
Nitzschia flexa	B	-	-	oh	alf	-	ate	me	1.50
Nitzschia flexoides	B	-	-	-	-	-	-	-	1.50
Nitzschia linearis	B	temp	st-str	i	alf	-	-	-	-

Appendix Table A3. Continued.

Taxa	Hab	T	OXY	HAL	pH	D	AUT-HET	TRO	Index S
Nitzschia recta	B	temp	st-str	i	alf	-	-	-	1.00
Nitzschia sigmoidea	P-B	-	st-str	i	alf	-	-	-	-
Nitzschia vermicularis	P-B	temp	st-str	i	alf	-	-	-	-
Odontidium hyemale	P-B	cool	st-str	hb	ind	-	-	-	-
Pantocsekiella kuetzingiana	P-B	temp	st	I	ind	-	-	-	-
Peronia fibula	B	-	str	hb	acf	-	-	-	3.00
Pinnularia abaujensis var. *linearis*	B	temp	st-str	i	ind	-	-	-	-
Pinnularia divergens	B	-	st	hb	ind	-	-	-	-
Pinnularia interrupta	B	-	st-str	i	ind	-	-	-	-
Pinnularia lata	P-B	-	str	i	acf	-	-	-	0.30
Pinnularia macilenta	B	-	-	-	-	-	-	-	0.90
Pinnularia major	B	temp	st-str	i	ind	-	ats	m	1.00
Pinnularia mesolepta	P-B	temp	st-str	i	ind	-	-	ot	-
Pinnularia microstauron	P-B	temp	st-str	i	ind	-	ats	ot	0.30
Pinnularia stauroptera	-	-	-	-	-	-	-	-	-
Pinnularia viridis	P-B	temp	st-str	i	ind	-	-	ot	0.90
Pseudostaurosira parasitica	P-B	temp	st-str	i	alf	-	ate	ot	1.00
Pseudostaurosira subconstricta	P-B, Ep	-	st-str	i	alf	-	-	-	-
Reimeria sinuata	P-B, aer	temp	st-str	i	ind	-	-	-	-
Rhoicosphenia abbreviata	B	temp	st-str	i	alf	es	ate	me	1.90
Rhopalodia gibba	P-B	temp	st-str	i	alf	es	ate	om	1.40
Stauroneis acuta	B	-	st-str	i	alf	-	-	m	-
Stauroneis anceps	P-B	temp	st-str	i	ind	sx	ats	om	1.30
Stauroneis phoenicenteron	P-B	temp	st-str	i	ind	-	-	-	-
Staurosira leptostauron	P-B	temp	st-str	i	alf	-	-	-	1.30
Surirella angusta	P-B	temp	st-str	i	alf	-	-	-	-
Surirella hibernica	P-B	-	st-str	i	alf	-	-	-	-
Surirella librile	P-B	temp	st-str	i	alf	-	hne	-	-
Tabellaria fenestrata	P-B	-	st-str	i	ind	-	-	-	1.90
Tabellaria fenestrata var. *geniculata*	P	-	-	hb	-	-	-	-	2.80
Tabellaria flocculosa	P-B	eterm	st-str	i	acf	-	-	-	3.00
Tabularia tabulata	B	-	-	mh	alf	-	-	-	-
Tetracyclus glans	P-B	temp	-	i	acf	-	-	ot	1.00
Ulnaria acus	P-B	warm	st-str	i	alf	es	ate	me	1.85
Ulnaria amphirhynchus	P-B	-	-	i	alf	es	hne	om	2.00
Ulnaria capitata	P-B	-	st-str	i	alf	es	ats	e	2.00
Ulnaria contracta	B	-	-	i	alf	es	hne	-	2.40
Ulnaria oxyrhynchus	P-B	-	st-str	i	alf	es	ats	e	2.40
Ulnaria ulna	P-B	temp	st-str	i	alf	es	ate	e	2.40
Charophyta									
Actinotaenium truncatum	P-B	-	-	-	acf	-	-	m	-
Closterium ehrenbergii	P-B	-	st-str	hb	ind	-	-	me	1.50
Closterium gracile	P-B	-	st-str	hb	ind	-	-	om	1.50
Closterium intermedium	P-B	-	st	-	acf	-	-	om	0.80
Closterium kuetzingii	P-B	-	st	i	acf	-	-	m	0.70
Closterium leibleinii	P-B	-	st-str	-	ind	-	-	e	2.60
Closterium littorale f. *minus*	-	-	-	-	-	-	-	-	-
Closterium littorale	P-B	-	-	-	ind	-	-	e	2.40
Closterium moniliferum	P-B	-	st-str	i	ind	-	-	me	2.10
Closterium peracerosum	-	-	-	-	-	-	-	-	-
Closterium pritchardianum	P-B	-	-	-	ind	-	-	m	-
Closterium ralfsii var. *hybridum*	P-B	-	-	hb	acf	-	-	m	0.50
Closterium rostratum	B	-	aer	-	ind	-	-	m	0.70
Closterium rostratum var. *brevirostratum*	B	-	-	-	ind	-	-	m	0.70
Closterium strigosum	P-B	-	st-str	-	ind	-	-	e	1.90
Closterium subulatum	B	-	-	-	ind	-	-	me	-
Cosmarium anceps	B, aer	-	aer	-	acf	-	-	m	-
Cosmarium botrytis	P-B	-	st-str	i	ind	-	-	m	1.90
Cosmarium formosulum	P-B	-	-	-	ind	-	-	me	1.80
Cosmarium humile var. *substriatum*	P-B	-	-	-	ind	-	-	m	-
Cosmarium pokornyanum	B, aer	-	aer	hl	acf	-	-	m	-
Cosmarium punctulatum	P-B	-	-	hb	ind	-	-	m	1.30
Cosmarium pygmaeum	P-B	-	st-str	-	acf	-	-	om	-
Cosmarium quadratum var. *willei*	-	-	-	-	ind	-	-	m	0.80
Cosmarium reniforme	P-B	-	st-str	hb	ind	-	-	me	1.00
Cosmarium speciosum var. *simplex*	B, aer	-	aer	-	acf	-	-	m	-
Cosmarium subcrenatum	B, aer	-	aer	-	acf	-	-	m	1.10
Cosmarium turpinii	P-B	-	-	i	ind	-	-	me	0.70
Gonatozygon kinahanii	B	-	st-str	-	acf	-	-	-	1.10
Hyalotheca dissiliens	P-B	-	-	hb	ind	-	-	-	-
Staurastrum avicula	P-B	-	-	-	ind	-	-	m	-
Staurastrum avicula var. *lunatum*	P-B	-	-	i	ind	-	-	e	-
Staurastrum basidentatum	-	-	-	-	-	-	-	-	-
Staurastrum dilatatum	P	-	-	-	-	-	-	m	-
Staurastrum polytrichum	B	-	-	-	acf	-	-	m	-
Staurastrum punctulatum	P-B	-	st-str	i	ind	-	-	ot	-
Staurastrum ralfsii	B	-	-	-	acf	-	-	m	-
Staurodesmus glaber	B	-	-	-	acf	-	-	ot	-
Staurodesmus megacanthus var. *scoticus*	-	-	-	-	acf	-	-	m	-
Chlorophyta									
Actinastrum hantzschii	P-B	-	st-str	i	-	-	-	-	2.30
Ankistrodesmus arcuatus	P-B	-	st-str	i	-	-	-	-	2.10
Colemanosphaera charkowiensis	P	-	st-str	-	-	-	-	-	2.20
Desmodesmus armatus	P-B	-	st-str	-	-	-	-	e	1.90
Messastrum gracile	P-B	-	st-str	-	-	-	-	-	-
Monoraphidium contortum	P-B	-	st-str	i	-	-	-	-	-
Monoraphidium griffithii	P-B	-	st-str	i	-	-	-	e	2.50
Neglectella solitaria	P	-	st	i	ind	-	ats	-	0.80
Pandorina morum	P	-	st	i	-	-	-	m	-

Appendix Table A3. Continued.

Taxa	Hab	T	OXY	HAL	pH	D	AUT-HET	TRO	Index S
Penium spirostriolatum	B	-	-	-	acf	-	-	-	-
Pseudopediastrum boryanum	P-B	-	st-str	i	ind	-	-	e	2.10
Pseudopediastrum boryanum var. *longicorne*	P-B	-	st-str	-	-	-	-	e	2.10
Cyanobacteria									
Anabaena oscillarioides	P-B	-	-	-	-	-	-	e	2.00
Chamaesiphon confervicola	B	-	st-str	-	-	-	-	ot	1.10
Merismopedia tenuissima	P-B	-	-	hl	-	-	-	e	-
Nostoc caeruleum	B	-	-	i	-	-	-	-	1.40
Oscillatoria limosa	P-B	-	st-str	hl	alf	-	-	-	-
Oscillatoria tenuis	P-B, S	-	st-str	hl	-	-	-	-	-
Tolypothrix distorta	B, S	-	-	-	-	-	-	ot	0.95
Tolypothrix tenuis	B, S	-	st	i	-	-	-	ot	1.00
Euglenozoa									
Lepocinclis acus	P	eterm	st	i	ind	-	-	-	2.40
Miozoa									
Ceratium hirundinella	P	-	st-str	i	-	-	-	e	1.30
Naiadinium polonicum	P	-	st	i	-	-	-	-	-
Peridinium bipes	P	-	st-str	oh	-	-	-	-	1.40
Peridinium cinctum	P-B	-	st-str	i	-	-	-	-	1.40
Peridinium willei	P	-	st	-	-	-	-	-	-
Ochrophyta									
Dinobryon bavaricum	P-B	-	-	i	-	-	-	-	1.20
Dinobryon borgei	P	-	-	-	-	-	-	-	1.10
Dinobryon cylindricum	P-B	-	-	i	-	-	-	-	1.20
Dinobryon divergens	P-B	-	st-str	i	ind	-	-	-	1.20
Dinobryon divergens var. *schauinslandii*	P	-	-	oh	-	-	-	-	1.20
Dinobryon sertularia	P-B	-	-	i	-	-	-	-	1.30
Dinobryon sociale	P	-	-	i	-	-	-	-	1.30
Dinobryon sociale var. *americanum*	P	-	-	-	-	-	-	-	1.30
Dinobryon stipitatum	P	-	-	-	-	-	-	-	1.20
Dinobryon suecicum	P	-	-	i	-	-	-	-	1.10
Ducellieria chodatii	-	-	-	-	-	-	-	-	-
Epipyxis ramosa	Ep	-	-	-	-	-	-	-	1.50
Epipyxis tabellariae	Ep	-	-	-	-	-	-	-	0.80
Isthmochloron trispinatum	P	-	-	oh	-	-	-	-	-
Mallomonas coronata	P	-	-	i	-	-	-	-	1.40
Synura uvella	P-B	-	st	-	-	-	-	-	1.10
Tribonema pyrenigerum	-	-	-	-	-	-	-	-	-
Tribonema subtilissimum	B	-	-	i	-	-	-	-	-
Tribonema viride	P-B	-	-	i	-	-	-	-	0.70
Tribonema vulgare	P-B	-	-	i	-	-	-	-	1.40

Note: "0", not found. Abbreviations: Habitat (Hab) (P – planktonic, P-B – plankto-benthic, B – benthic, Ep – epiphytes; aer – aerophytes); temperature (T) preferences (cool – cool-water, temp – temperate, eterm – eurythermic, warm – warm-water); oxygenation and water moving (Oxy) (aer – aerophiles, str – streaming water, st-str – low streaming water, st – standing); pH preferences groups (pH) (alb – alkalibiontes; alf – alkaliphiles, ind – indifferent; acf – acidophiles, acb – acidobiontes); salinity ecological groups (Sal) (hb – oligohalobes-halophobes, i – oligohalobes-indifferent, hl – halophiles; mh – mesohalobes; oh – oligohalobes); organic pollution indicators (D): sx – saproxenes; es – eurysaprobes; sp – saprophiles; nitrogen uptake metabolism (Aut-Het): ats – nitrogen-autotrophic taxa, tolerating very small concentrations of organically bound nitrogen; ate – nitrogen-autotrophic taxa, tolerating elevated concentrations of organically bound nitrogen; hne – facultative nitrogen-heterotrophic taxa, needing periodically elevated concentrations of organically bound nitrogen; Trophic state indicators (Tro): (ot – oligotraphentic; om – oligomesotraphentic; m – mesotraphentic; me – mesoeutraphentic; e – eutraphentic; o-e – oligo to hypereutraphentic); Index S, species-specific index saprobity.

Appendix Table A4. Taxa indicators of algae and cyanobacteria in 20 sampling stations of the Chara River basin in 2011. Abbreviated station names as in Table 1.

Variable	Ch1	A	Ch2	Ch3	BT	Ch4	Ch5	S	Ch6	Ch7	Zh	Ch8	Ch9	Ch10	M	Ch11	Ch12	T	Ch13	Ch14
Division																				
Bacillariophyta	38	42	43	41	20	51	47	27	28	57	33	28	33	38	39	42	38	66	58	51
Charophyta	2	6	5	2	2	9	4	2	4	5	1	6	5	3	8	6	6	11	12	3
Chlorophyta	0	0	1	0	1	0	1	0	1	1	0	1	0	0	5	3	1	7	6	1
Cyanobacteria	1	2	1	2	0	1	2	0	3	1	1	2	1	0	5	4	0	3	2	3
Euglenozoa	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Miozoa	1	3	3	1	0	3	3	1	1	3	0	0	1	1	1	4	1	1	2	1
Ochrophyta	6	7	6	4	1	4	4	5	5	5	2	1	4	4	8	9	6	6	5	4
Habitat																				
Ep	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	1	0
B	15	20	20	18	10	30	26	18	18	30	19	18	17	19	19	21	22	31	31	25
P-B	26	29	28	24	12	29	27	10	16	29	14	16	20	19	35	33	22	51	43	29
P	4	8	7	4	0	7	5	4	3	7	2	1	4	4	7	8	5	6	7	3
aer	2	1	3	1	2	3	2	0	1	2	2	0	1	2	1	1	0	2	3	2
Temperature																				
cool	4	2	3	4	3	4	2	2	4	4	2	2	3	3	1	2	3	3	2	2
temp	21	21	22	20	9	24	20	8	10	24	15	15	18	21	23	23	18	38	32	25
eterm	1	2	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	1	1	1
warm	0	1	1	0	0	1	1	0	0	1	0	0	0	0	1	1	0	1	0	0
Oxygen																				
aer	1	0	3	0	0	1	1	0	1	0	0	0	0	1	0	0	1	2	1	0
str	3	2	4	3	2	6	5	2	5	6	5	2	3	3	1	2	5	5	3	5
st-str	34	34	33	31	14	42	33	16	18	41	21	24	27	25	42	42	28	59	52	41
st	2	8	6	2	1	7	8	3	2	4	0	0	3	4	8	7	3	7	5	2
Salinity																				
hb	7	8	8	7	7	11	9	5	7	10	6	5	6	7	0	3	6	7	6	7
i	33	40	37	31	14	44	40	20	23	43	23	23	27	28	47	48	33	64	56	39
hl	2	3	4	4	0	2	2	1	2	4	3	2	2	2	4	3	3	4	4	5
mh	1	1	0	1	0	0	1	2	0	2	1	1	1	1	1	1	1	2	1	1
Water pH																				
acb	1	1	1	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1
acf	6	6	9	7	6	14	8	8	11	14	7	6	7	7	1	5	9	10	6	6
ind	18	20	19	18	10	25	19	10	12	21	11	15	15	13	20	17	19	28	27	21
alf	14	17	17	16	3	19	18	7	7	20	12	9	14	17	27	23	14	35	31	20
alb	0	1	0	0	0	0	1	0	0	1	1	0	0	0	1	1	0	1	1	1
Watanabe																				
sx	4	2	5	4	1	7	4	3	4	5	2	5	6	6	4	4	7	6	5	6
es	4	9	8	4	0	8	6	3	3	8	4	2	3	4	8	7	3	12	12	8
sp	2	1	0	1	1	1	1	0	1	1	0	1	1	0	0	0	0	1	1	0
Autotrophy-Heterotrophy																				
ats	7	3	6	5	1	8	4	6	7	9	5	7	4	6	5	3	4	11	9	7
ate	5	9	7	6	1	8	9	1	3	6	3	2	5	5	9	9	5	12	11	7
hne	1	0	1	0	0	1	0	0	0	2	0	1	1	1	2	2	0	2	2	1
Trophic state																				
ot	10	5	7	6	7	9	9	6	7	7	7	5	6	6	4	5	9	11	10	8
om	2	4	4	3	0	4	2	0	3	5	3	3	2	2	4	5	2	8	5	5
m	2	2	4	2	0	5	1	2	2	5	2	4	2	1	3	1	2	6	7	1
me	3	6	4	2	2	7	5	1	0	6	1	2	6	4	7	6	4	8	7	2
e	3	5	6	6	0	7	4	3	5	4	4	4	3	4	12	9	5	10	11	9
o-e	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Class of Water Quality																				
Class 1	3	2	5	2	1	4	3	4	5	6	3	4	2	4	1	2	3	3	3	2
Class 2	18	25	21	17	9	25	22	10	11	22	14	9	15	15	22	23	18	31	31	24
Class 3	7	11	9	8	3	13	10	4	6	11	6	7	6	8	17	13	6	19	19	9
Class 4	1	1	1	1	2	4	2	2	2	3	2	1	3	1	3	2	2	2	2	3
Index S	1.11	2.92	1.02	1.02	2.13	2.29	1.81	2.00	2.32	2.11	2.16	2.35	1.81	2.94	2.54	1.69	2.13	2.22	1.96	1.70
Abundabce, thous. cells l^{-1}	3.3	6.6	9.7	22.4	100.0	35.1	38.3	22.3	9.6	32.0	57.2	50.9	31.8	16.1	12.9	19.3	47.8	25.7	47.9	22.4
No of Species	48	61	59	50	24	69	61	35	42	72	37	38	44	46	67	68	52	94	85	63
Index Shannon H'	1.505	0.157	0.528	0.578	0.551	0.322	0.59	0.269	0.106	0.459	0.561	0.436	0.689	0.283	0.071	0.564	0.563	0.626	0.635	0.616
Index WESI	1.50	3.00	1.50	1.50	2.50	2.50	4.00	4.00	2.50	2.50	2.50	2.50	2.00	3.00	3.00	2.00	2.50	2.50	2.00	2.00

Note: "0", not found. Abbreviations: Habitat (Habitat) (P – planktonic, P-B – plankto-benthic, B – benthic, Ep – epiphytes; aer – aerophytes); temperature (Temperature) preferences (cool – cool-water, temp – temperate, eterm – eurythermic, warm – warm-water); oxygenation and water moving (Oxygen) (aer – aerophiles, str – streaming water, st-str – low streaming water, st – standing); pH preferences groups (pH) (alb – alkalibiontes; alf – alkaliphiles, ind – indifferent; acf – acidophiles, acb – acidobiontes); salinity ecological groups (Salinity) (hb – oligohalobes-halophobes, i – oligohalobes-indifferent, hl – halophiles; mh – mesohalobes); organic pollution indicators (D): sx – saproxenes; es – eurysaprobes; sp – saprophiles; nitrogen uptake metabolism (Autotrophy-Heterotrophy): ats – nitrogen-autotrophic taxa, tolerating very small concentrations of organically bound nitrogen; ate – nitrogen-autotrophic taxa, tolerating elevated concentrations of organically bound nitrogen; hne – facultative nitrogen-heterotrophic taxa, needing periodically elevated concentrations of organically bound nitrogen; Trophic state indicators (Trophic state): (ot – oligotraphentic; om – oligomesotraphentic; m – mesotraphentic; me – mesoeutraphentic; e – eutraphentic; o-e – oligo to hypereutraphentic); Index S, species-specific index saprobity.