

Taxonomic composition of phytoplankton in the Vakh River (Western Siberia)

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Abstract. This paper provides data on the hydrological and hydrochemical parameters of the Vakh River in the Middle Ob region. In 2005-2008 we have identified 404 taxonomic units represented by 463 species, types and forms of algae, belonging to 140 genera, 52 families, 13 classes and 7 divisions. 386 species were identified for the first time, 141 taxa were identified as rare and 22 taxa as new for Western Siberia. Leading divisions, *Bacillariophyta* and *Chlorophyta*, make up for 78.9% of total phytoplankton diversity. *Cyanobacteria*, *Chrysophyta* and *Euglenophyta* form a community of 88 taxonomic units having a rank lower than genus level, and represent 19.0% of the total number. The floral role of *Xanthophyta* and *Dinophyta* is insignificant (2.1%). The main structure-forming species are 14: vegetating throughout the year (*Aulacoseira italica*, *Asterionella formosa*), summer taxa (*Microcystis aeruginosa*, *Melosira varians*, *Aulacoseira granulata*, *Pandorina morum*, *Pediastrum boryanum*, *P. duplex*, *Lacunastrum gracillimum*, *Scenedesmus quadricauda*) and summer-autumn (*Microcystis pulvereae*, *Tabellaria fenestrata*, *T. flocculosa*, *Mucidosphaerium pulchellum*). The Vakh River demonstrates specific characteristics of boreal flowing waterways. The northern composition is represented in a big rate of families (44.2%) and genera (109 77.9) with one to three species. The richest genera *Closterium* (31 taxa), *Eunotia* (27 taxa), *Pinnularia* (22 taxa), *Desmidium* (11 taxa) and the family *Desmidiaceae* (45 taxa) ensure diversity of phytoplankton. Ecological and geographical analysis demonstrates predominance of cosmopolitan algae (56.6%). Plankton represents 44.7% of all algae, oligogalobs - 78.8% and indifferent algae – 36.7%. Water meets the requirements for β -mezosaprobian pollution zone, class of satisfactory purity (III class).

1. Introduction

First findings about phytoplankton in the Vah River date back to 2001 (Naumenko, 2001). The findings rely on the materials collected in the estuary of the river (June 1981-1985 and July 1986) and present 105 species of algae belonging to 5 groups. Further researches conducted in the area of Middle Taiga Vakh River allowed us to identify more types of plankton, which we added to the list. Among newly discovered types is *Stelxomonas dichotomus* Lack (Safonova, Shaulo, 2006). The research for the phytoplankton in the Vakh River may be called fragmentary, however, it is still immensely valuable for one of the major oil producing regions. The main objective of the study is to assess floristic and saprobiological characteristics of phytoplankton in the Vakh River. Specific objectives are to establish diversity of plankton algae in the Vakh River and to give taxonomic, ecological, geographical and saprobiological characteristics to the phytoplankton in the area.



2. Materials and methods

2.1. Study area

The Vakh River is a deep river in Western Siberia, a right-bank tributary of the Ob River, flowing in the forest area of Khanty-Mansiysk Autonomous Area located in latitudinal, East-West direction, roughly on the 61st parallel. The flatness of the area (along with height differences from 170 to 32 meters above the sea level) defines the River's tortuosity index of 3-4. The Vakh River is the mainstream river in the Nizhnevartovsk Region with asymmetric basin, mainly right-bank prevalence. The wetland areas in the river amount to 60-80%, the drainage area covers over 76 thousand square kilometers, the average annual runoff ranges from 411 to 632 cubic meters. The runoff mostly attributes to snow melting, which amounts to 65% of the annual runoff. Its 30% attributes to groundwater and 5% - to rain. The seasonal floods in the River basin last from 2 to 2.5 months; the water level during springtime rises up to 7.5 – 9.0 meters compared to wintertime and the peak is in the middle of June (Beirom, 1975). The climate in the watercourse basin is continental with brief interseason period; summer season lasts for 95 days (Beirom, 1975). The observations allow us to conclude the following: (1) the rivers remain completely frozen for 178-222 days; (2) the maximum ice thickness is 71 centimeters; (3) the snow height is 40 centimeters. The river shifts to the summer conditions in the first part of June. The water temperature reaches +21°C, occasionally it is +26°C by the end of July and it drops to +4°C in the last decade of October. The critical drop below +0.2°C is generally observed in the end of October – beginning of November.

The Vakh River is 964 kilometers (Beirom, 1975). The width of the river varies from just several meters near the river head and 600 meters around the estuary; its depth is around 19 meters, the speed is 0.3 – 1.1 m/s, the coastline height in some places is over 40 meters. According to its morphometric, hydrologic and hydrochemical characteristics, the river is divided into three areas – upstream, middlestream and downstream.

The chemical composition of the water is hydrocarbonated with mineralization reaching 13 - 88 mg/L. The water is soft, its hardness amounts to 1.5 mg/L (Alekin, 1953). The total amount of ions does not exceed 93.4 mg/L (Beirom, 1975). The Vakh River had demonstrated low water transparency during all the years of study (2005-2008). In the period between March and October it varies between 12 and 33 cm and pH value ranges from 5.3 to 8.1. The degree of peat formation determines high algal blooming and high iron amount. The Khanty-Mansiysk Regional Centre for Hydrometeorology and Environment Monitoring established that in the period of 2005-2007 there were high levels of algal blooming ranging 35 – 196 degrees, BOD was 0.1 – 1.8 mg/L and the amount of iron was 0.3 – 9 mg/L.

2.2. Collected material

Seven hundred and twenty-three phytoplankton samples, collected along the Vakh River from 2005 to 2008 (during all seasons), were used for the study.

The phytoplankton was collected using routing method and stationary method. It was collected in one liter containers along the river (left bank, right bank and the middle of the river) at the depth of 20 cm. The process followed all the proper methods and requirements for sample material collection and processing (Fjodorov, 1979; Guidelines...1981; Algae, 1989). Other measurements needed for the study were taken: width, depth, speed of the water flow. A surface bucket thermometer was used for measuring the temperature on the surface. The transparency was estimated via Secchi disk; pH values were measured with a portable pH-tester “pHs can WP2”.

The observations were conducted in the area of village Korliki and Laryak (upstream Vakh River), village Vakhovsk (middlestream Vakh River), and in the area of ferry crossing (downstream) during the year. The samples were taken three times per month in three places: right and left banks and centre of the streambed (Figure 1).

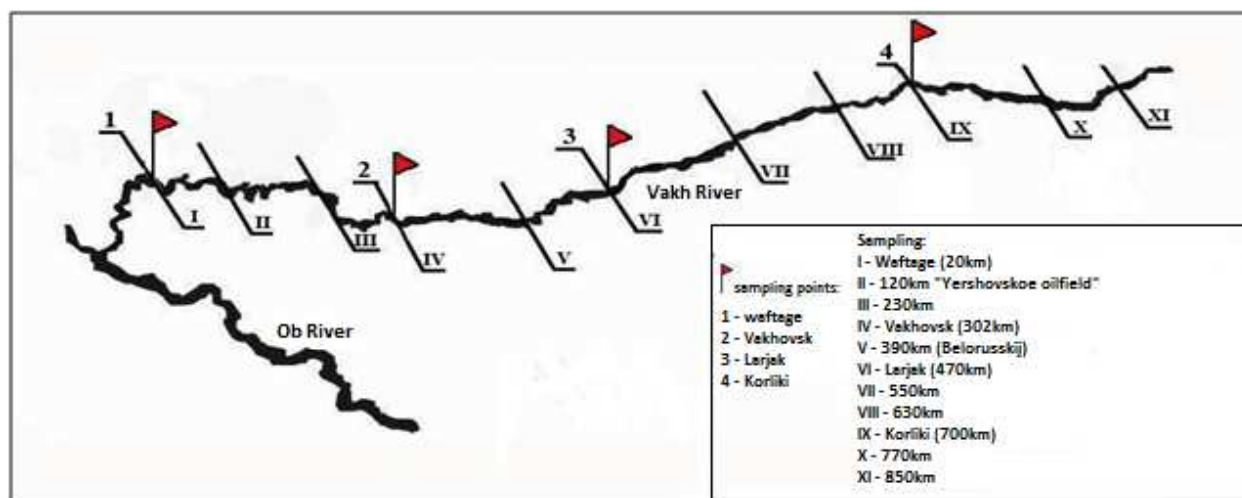


Figure 1. Map of stationary (1-4) and rout (I-XI) water sampling points on the Vakh River.

Sedimentation was used to determine the amount of algological material. The qualitative composition of the samples was determined using cone-shaped net and gauze No. 76.

All observations were performed on living or fixed in 4% solution of formalin material. All algae were studied under microscopes "Amplival" (Carl Zeiss, Jena) and «Mikmed-5» (Lomo, St. Petersburg) with manifold increase of 640 – 1600. We processed the samples to eliminate protoplast of cells (Zabelina, Kiselev et al., 1951; Algae, 1989) to establish what species the diatoms belong to. Cleaned diatom valves were mounted into Canada balsam with refractive index of 1.68 (Elyashev, 1957).

We referred to generally recognized national and foreign field guides and guide books on algology to identify the collected samples. In the systematic positioning of algae we accounted for changes and revisions for Cyanophyta (Kondratyeva, 1972; 1975; 1981; 1984), Chlorococcales (Tsarenko, 1990; 2005), *Pediastrum*, *Scenedesmus* (Hegemald, 2000) and Desmidiaceae (Palamar-Moedvintseva, 1982). The following field guides were used to identify diatoms (Gollerbach..., 1951; Lange-Bertalot, 2001; Krammer..., 2000; 2002; 2003). Floristic composition analysis was conducted with the use of systems proposed by Russian diatomologists Glezer Z.I., Karaeva N.I., Makarova I.V. et al. (Diatoms..., 1988) with account for recent revisions of *Aulacoseira*, *Fragilaria*, *Diatoma*, *Achnanthes*, *Navicula*, *Pinnularia*, *Cymbella*, *Gomphonema*, *Eunotia* (Bukhtiarova, Round, 1996; Genka, Bondarenko, Schur..., 2011; Kharitonov, Genkal..., 2012, Dorofejuk, Kulikovskiy..., 2012). "Biodiversity of algae indicators" field guide was used to conduct ecological analysis (Barinova et al., 2006). The data is presented in the tables (Table 1-4).

3. Results and discussions

We identified 404 taxonomic units represented by 463 species, varieties and forms of algae, belonging to 140 genera, 51 families, 13 classes and 7 divisions (Table 5). Chlorophyta has the biggest number of species - 40.1 %; it is followed by Bacillariophyta – 38.9%; Chrysophyta – 7.0%; Cyanophyta — 5.9%; Euglenophyta – 5.9%. Xanthophyta and Dinophyta comprise 2.2 % (Table 1).

In order to give a full and precise overview of the plankton algae in the Vakh River, the author assesses floristic characteristics at the level of infraspecific taxonomic units (further: IST) including type-species.

Chlorophyta and Bacillariophyta make up species composition of phytoplankton in the Vakh River and comprise 78.9% of total IST plankton. It is worth noting that it is not only Bacillariophyta that plays an important part in the composition of phytoplankton of the Vakh River, but also Chlorophyta. Their share is almost equal to 39.4% for Bacillariophyta and 39.5% for Chlorophyta. Bacillariophyta usually dominates over other algal divisions in Siberian rivers. This observation is confirmed by the

composition of the Ob River (Naumenko, 1996) and its tributaries (Naumenko, 1985, 1991, 1998), Viluy (Remigaylo, 1995), Molodo (Gabyshev, 1999), Nizhnyaya Kolyma (Kopyrina, 2009) etc.

Table 1. Systematic composition of plankton algae in the Vakh River.

Division	Number of species	Share, %	Number of specific and intraspecific taxonomic units	Share, %
Cyanophyta (Cyanobacteria)	24	5.9	31	6.7
Chrysophyta	28	7.0	31	6.7
Bacillariophyta	157	38.9	182	39.4
Euglenophyta	24	5.9	26	5.6
Xanthophyta	7	1.7	7	1.5
Dinophyta	2	0.5	3	0.6
Chlorophyta	162	40.1	183	39.5
Total:	404	100	463	100

The first five classes in ranking were found to encompass 407 algae, which represent 87.9% of the total plankton found. The most numerous is Pennatophyceae with 171 IST. Its share in the total number of found algae is 36.9%. Pennatophyceae is followed by Chlorophyceae – 103 (22.2%), Conjugatophyceae – 76 (16.4%), Chrysophyceae – 31 (6.7%), Euglenophyceae – 26 (5.6 %). The amount of IST ranges from 1 to 17 in the remaining 8 classes.

The top ten families contain more than half of the identified algae taking the leading role in formation of algae in the River. 276 IST (57.3 %) were determined in Bacillariophyta and Chlorophyta leading families. It emphasizes their leading role in algae composition of the river. Euglenophyta and Chrysophyta are leading families and comprise 26 (8.2 %) and 14 (4.4 %) respectively, leading the research to the conclusion that these families are important for the phytoplankton of the river (Table 2).

Table 2. Leading families of phytoplankton of the Vakh River.

Rank	Family	Number of specific and intraspecific taxonomic units		Number of genera
		absolute number	share, %	
1	Naviculaceae	64	21.2	17
2	Desmidiaceae	45	14.9	13
3	Scenedesmaceae	43	14.2	8
4	Closteriaceae	31	10.3	1
5	Eunotiaceae	27	8.9	1
6	Euglenaceae	26	8.6	5
7	Fragilariaceae	21	7.0	6
8	Selenastraceae	16	5.3	7
9	Surirellaceae	15	5.0	3
10	Dinobryaceae	14	4.6	2
Total:		302	65.5	63

Other families contain one third (166) of the identified algae which comprises 34.5%. They are presented in the descended order: Hydrodictyaceae (13 taxonomic units ranking lower than genus), Cymbellaceae (11), Chrysococcaceae (10), Microcystidaceae (8), Gomphonemataceae, Oocystaceae, Achnanthaceae, Nitzschiaceae (each 7), Anabaenaceae, Coelastraceae and Synuraceae (each 6), Stephanodiscaceae and Diatomaceae (each 5), Oscillatoriaceae, Aulacoseiraceae, Chlorellaceae, Tabellariaceae and Pleurochloridaceae (each 4).

The most represented are 12 genera that encompass 40.0% of the plankton algae (Table 3).

Table 3. Leading genera of phytoplankton of the Vakh River (based on the number of taxonomic units lower than genus).

Rank	Genus	Taxonomic units lower than genus	% of the total number of algae
1	<i>Closterium</i>	31	7.0
2	<i>Eunotia</i>	27	5.8
3	<i>Pinnularia</i>	22	4.8
4	<i>Scenedesmus</i>	17	3.6
5	<i>Dinobryon</i>	13	2.8
6	<i>Surirella</i>	12	2.5
7–9	<i>Navicula</i>	11	2.3
7–9	<i>Desmodesmus</i>	11	2.3
7–9	<i>Staurastrum</i>	11	2.3
10–12	<i>Fragilaria</i>	10	2.2
10–12	<i>Trachelomonas</i>	10	2.2
10–12	<i>Cosmarium</i>	10	2.2
Total:	12	185	40.0

Genera at the top of the list each contain from 31 to 10 taxonomic units ranking lower than genera. Genera are presented in the descending order: *Phacus*, *Kephyrion* – 9 IST each; *Pediastrum* – 8; *Microcystis* – 7; *Anabaena*, *Ulnaria*, *Gomphonema*, *Nitzschia* and *Staurodesmus* – 6 each; *Stauroneis* and *Tetrastrum* – 5 each; *Cyclotella*, *Aulacoseira*, *Planothidium*, *Cymbella*, *Cymbopleura*, *Monoraphidium*, *Coelastrum*, *Lagerheimia* – 4 each.

109 genera (77.9% of all genera) are species-poor. This entails that the largest part of the whole flora in the Vakh River is represented by small amounts of genera and families. It means that phytoplankton of the river is allochotonic and emphasizes the complexity of historical development of the species and plankton in the river.

In general, the distribution of families and genera in the phytoplankton of the Vakh River corresponds to the taxonomic spectrum of the northern flowing water bodies (Getsen, 1985; Vasilyeva, 1989; Vorobjeva, 1995; Naumenko, 1985, 1996).

There are twenty-five genera that are only present in one of the river areas and can be called specific to those areas: *Coelosphaerium*, *Nostoc*, *Rivularia*, *Plectonema*, *Chromulina*, *Mallomonas*, *Mayamaea*, *Achanthes*, *Rhoicosphenia*, *Pseudostaurastrum*, *Centrtractus*, *Characiopsis*, *Katodinium*, *Ankyra*, *Hydrodictyon*, *Golenkiniopsis*, *Micractinium*, *Dictyosphaerium*, *Radiococcus*, *Franceia*, *Pseudodidimocystis*, *Pleurotaenium*, *Raphidiastrum*, *Pachyphorium* and *Bambusina*. Among the rare genera are ones that are known to be generally rare for Siberian water bodies: *Raphidiastrum*, *Golenkiniopsis*, *Micractinium*, *Franceia*, *Didymocystis* etc.

There are 91 genera (65% of all the genera present) develop in all parts of the river. It implies that the ecological conditions are similar along the whole river current in the latitudinal direction.

There are 190 taxonomic units (41.0 % of all) ranking lower genus similar for all the river parts, of them diatoms are 83, Chlorophyta – 77, Cyanobacteria – 13, Chrysophyta – 9, Euglenophyta – 6, Xanthophyceae and Dinophyta 1 each. The majority of these algae play an important role in structural composition of algae communities and are functional nucleus of the water stream. There are dominating species that develop all year around and maintain high population: *Aulacoseira italica*, *Asterionella formosa*, growing in the summer period *Microcystis aeruginosa*, *Melosira varians*, *Aulacoseira granulata*, *Pandorina morum*, *Pediastrum boryanum*, *P. biradiatum*, *Lacunastrum gracillimum*, *Scenedesmus quadricauda* and in summer – fall period: *Microcystis pulvereae*, *Tabellaria fenestrata*, *T. flocculosa*, *Mucidosphaerium pulchellum* (Skorobogatova, 2012). *Aulacoseira italica* has the biggest coenotic value (Skorobogatova, 2010).

The abundance of species *Eunotia*, *Closterium*, *Pinnularia* and family Desmidiaceae is a specific characteristic of the Vakh River and algal for the Taiga wetlands in Western Siberia. They develop in waters with low amount of salts and low acid reaction and form “boggy complex” which takes 27% of the whole composition. The valves of *Eunotia bilunaris*, *E. monodon*, *E. praerupta* and their variations, *E. undulata* and *E. neosibirica* are frequent in the samples. There are 9 representatives of these species that can be classified as rare (Naumenko, Skorobogatova, 2009). Representatives of *Closterium* species grow in the Vakh River from the first decade of June until middle of October with maximum species diversity appearing in the first decade of September. 5 taxonomic units of *Closterium* species that have not been determined earlier in the Middle Taiga were identified in the Vakh River phytoplankton (Skorobogatova, Naumenko, 2009). Desmidiaceae have a rich composition but are not evenly distributed along the river flow and do not have high populations.

The Vakh River flora proportions, ratio of number of genera and species to one family, is 1:2.7:9.1. The richness in genera along the stream is 3.3. There have been identified 141 specific taxonomic units; the coefficient of algae specificity of genera is relatively low – 17.9%, the specificity of species is considerably higher – 30.5%. The class of Conjugatophyceae demonstrates the highest specificity.

In the upstream of the Vakh River 255 species, types and forms of algae from 7 divisions, 41 families and 105 genera were found (Table 4).

Table 4. Systematic division of plankton algae in correlation with the River part.

Division	Upstream		Middlestream		Downstream	
	Number of taxonomic units	%	Number of taxonomic units	%	Number of taxonomic units	%
Cyanophyta (Cyanobacteria)	15	5.8	18	5.7	30	7.4
Chrysophyta	18	7.1	17	5.4	24	5.9
Bacillariophyta	106	41.6	129	41.0	165	40.4
Euglenophyta	7	2.7	11	3.5	25	6.1
Xanthophyta	4	1.6	3	0.9	4	1.0
Dinophyta	2	0.8	1	0.3	3	0.7
Chlorophyta	103	40.4	136	43.2	157	38.5
Total:	255	100	315	100	408	100

The leading families of the phytoplankton spectrum of the Vakh River upstream are Naviculaceae (34 specific and infraspecific taxonomic units), Scenedesmaceae (33), Eunotiaceae (21), Desmidiaceae (17), Closteriaceae (12), Dinobryaceae (11), Hydrodictyaceae (10). Five genera are distinguished based on the diversity of algae: *Eunotia* (21 species, types and forms), *Scenedesmus* (13), *Pinnularia* and *Closterium* (12 each), *Dinobryon* (10 IST). They encompass almost one third of the whole phytoplankton composition of the upstream Vakh River (26.7 %).

The coefficient of algae specificity of genera is 5.7%, the specificity of species is 7.8%. The flora proportions of the upstream area are 1:2.5:6.2; the richness of genera is 2.4.

The middle stream of the river hosts 315 species, types and forms made up of 110 genera, 50 families, 7 divisions. The top five families are Naviculaceae (48 taxonomic units ranking lower than genera), Scenedesmaceae and Desmidiaceae (33 each), Closteriaceae (25) and Eunotiaceae (23). In total, it makes up 51.4% of all identified. It is important to emphasize the leading position of the Chlorophyta (91 IST) and diatoms (71 IST). The leading genera of phytoplankton have 29.8% IST of all identified in the middle stream area: *Closterium* (24 IST), *Eunotia* (23), *Pinnularia* (16), *Scenedesmus* (13), *Dinobryon* and *Cosmarium* (9 each).

The coefficient of algae specificity of genera is 2.7%, the specificity of species is 8.9%. The phytoplankton proportions of the middlestream area is 1:2.2:6.3; the richness of genera is 2.8.

The estuarial part of the river houses 408 specific and infraspecific taxonomic units, 52 families and 124 genera, which are 56.7% of identified phytoplankton downstream Vakh River. The families are distributed as follows: Naviculaceae (59 IST), Scenedesmaceae (42), Desmidiaceae (34), Eunotiaceae and Euglenaceae (25 each), Closteriaceae (23), Fragilariaceae (21). The share of Diatoms in the leading families in the downstream Vakh River is 45.9%, Chlorophyta – 43.2%, Euglenophyta – 10.9%.

The most diverse in the genera composition in this area are *Eunotia* (25 IST), *Closterium* (23), *Pinnularia* (19), *Scenedesmus* (17), *Dinobryon* (12), *Navicula*, *Surirella*, *Desmodesmus* and *Trachelomonas* (10 each). The listed genera consist of 33.6% of all identified in the downstream Vakh River.

The coefficient of algae specificity of genera is 8.8%, the specificity of species is 23.3%. The flora proportions of the downstream are 1:2.4:7.9; the richness of genera is 3.3.

Therefore, the level of species diversity increases from the upstream areas to the estuary. The species, types and form diversity in the middle stream is of 60 representatives (19.0%) higher than in the upstream, the diversity in the downstream is 93 (22.8%) higher than in the middle stream and 153 (37.5%) higher than in the upstream.

Diatoms and Chlorophyta, which take top two positions, frequent lists of the leading algae for various water bodies and regions. Depending on water body type and its geographical location, they may vary in rankings and order.

Algae relations with main characteristics of the environment were accounted for in the study. Identified species are not homogenous in their ecological composition because the phytoplankton of the Vakh River is made up from benthos algae and fouling community, plankton algae of the catch basin and river plankton itself. Ecological analysis demonstrated that plankton algae have the highest diversity – 207 IST (44.7%). All identified plankton forms belong to seven divisions with leading representatives from Chlorophyta. Scenedesmaceae, Selenastraceae, Closteriaceae and others are noted for their diversity. *Microcystis aeruginosa*, *M. pulvereae*, *Cyclotella meneghiniana*, *Aulacoseira distans*, *A. granulata*, *A. italica*, *Ulnaria acus*, *Asterionella formosa*, *Tabellaria fenestrata*, *Pandorina charkoviensis*, *Pediastrum boryanum*, *P. duplex*, *Actinastrum hantzschii*, *Acutodesmus acuminatus*, *S. serratus*, *S. quadricauda*, *Desmodesmus lefevrii* and others belong to the plankton that grows particularly intensively during one of the year periods. Appearance of *Merismopedia*, *Coelosphaerium*, *Rivularia*, *Oscillatoria*, *Chromulina*, *Mallomonas*, *Catenochrysis*, *Strombomonas*, *Lepocinclis*, *Cosmarium* is singular. Benthos algae is represented in 100IST (21.6%), of which the most common are *Navicula radiosa*, *N. viridula*, *Hippodonta capitata*, *Sellaphora rectangularis*, *Stauroneis anceps*, *Pinnularia gibba*, *Gyrosigma acuminatum* etc.

Periphyton includes 66 IST (14.3%) with more commonly appearing *Fragilaria construens*, *Ulnaria ulna*, *Eunotia bilunaris*, *E. monodon*, *E. undulata*, *E. praerupta*, *E. bidens*, *E. curtagrunowii*, *Cymbella naviculiformis*, *Eucyonema minutum*, *Gomphonema acuminatum*, *G. acuminatum* var. *coronatum*. Only one species of attache bioforms from Cyanobacteria was found. It is called *Lyngbya kuetzingii* and it was found only once downstream of the river.

The distribution of algae in downstream, middlestream and upstream area in correlation to the environmental conditions is similar to the distribution of algae in the river in general.

The algae of the River are divided into oligogalobs and mezogalobs. The oligogalobs include 365 IST (78.8%) with leading indifferent forms – 286 (61.7%), galofobs and galofils – 47 and 32 IST (10.2% and 6.9%) respectively. *Chrysococcus rufescens*, *Meridion circulare* var. *constrictum*, *Neidium iridis*, *Eunotia* representative are common for soft waters of the Vakh River. Only one species of mezogalobs, *Surirella ovalis*, was found. It was spotted in the downstream and upstream.

As for pH factor, neutral algae take the lead with 170 IST (36.7%), 50 algae (10.8%) are acidophile, which can be explained by fermenting from marshy flood bed. *Aulacoseira distans*, *Tabellaria fenestrata*, *T. flocculosa*, *Eunotia bilunaris*, *E. monodon*, *Ankistrodesmus falcatus* develop most actively.

The geographical distribution of algae populating a river is important in studies of phytoplankton. The majority of plankton is cosmopolitan, with taxonomic units ranking lower than genus (56.6%), and boreal – 71 (15.3%). Only 38 alpinoarctic taxonomic units ranking lower than genus (8.2%) have been identified. Stenothermal cold-loving diatoms *Cyclotella antiqua*, *Fragilariforma virescens*, *Meridion circulare*, *Eunotia praerupta*, rare alpinoarctic species *Tetracyclus lacustris*, *T. lacustris* var. *capitata*, *Stauroneis parvula*, *Frustulia rhomboides*, *Eunotia parallela* signify harsh weather conditions.

IST are markers of water saprobity. 126 of them belong to β -mesosaprobies, 62 to transitioning zone. Such tendency has been noted in all river parts. The richness and abundance of β -mesosaprobies and species of transitioning zone allows the Vakh River water to have III class of purity (satisfactory class).

Table 5. Systematic composition of phytoplankton in the Vakh River (U.S. – upstream river ; M.S. – middlestream river; D.S. – downstream river; H - habitat: P – plankton species, F – fouler; B – benthonic; Ha – halobility: hb – halophobe; i – indifferent; hl – halophile; mg – mezogalob; oh – oligogalob; A – acidophilism: az – acidophile; i – indifferent; al – alkaliphile; Geo. – geographical distribution: k – cosmopolit, aa – arctalpine, b – boreal; C – saprobity: x – xenosaprobe, (o-x) – oligo-xenosaprobe, (x-o) – xeno-oligosaprobe, o – oligosaprobe, (o- β) – oligo- β -mesosaprobe, (β -o) – β -oligosaprobe, β – β -mesosaprobe, (β - α) – β - α -mesosaprobe, (α - β) – α - β -mesosaprobe, α – α -mesosaprobe; p – polysaprobe, «+» – species present, «-» – species not present; «?» – biographically, biologically and geographically understudied species)

Species, type, from, variation	U.S.	M.S.	D.S.	Ecological and geographical characteristics				
				H	Ha	A	Geo	S
CYANOPHYTA (CYANOBACTERIA)								
<i>Merismopedia elegans</i> A. Br.	-	-	+	P	i	i	k	β
<i>M. punctata</i> Meyn.	-	-	+	P	i	i	k	β
<i>M. tenuissima</i> Lemm.	-	+	+	P	i	i	k	β-α
<i>Microcystis aeruginosa</i> Kütz. emend. Elenk. f. <i>aeruginosa</i>	+	+	+	P	i	i	k	β
<i>M. aeruginosa</i> f. <i>flos-aquae</i> (Witr.) Elenk.	+	+	+	P	i	i	k	β
<i>M. pulvereae</i> (Wood) Forti emend. Elenk. f. <i>pulvereae</i>	+	+	+	P	i	i	k	o-β
<i>M. pulvereae</i> f. <i>incerta</i> (Lemm.) Elenk.	-	-	+	P	i	i	k	β
<i>M. pulvereae</i> f. <i>irregularis</i> (B.-Peters.) Elenk.	-	-	+	P	i	i	aa	?
<i>M. pulvereae</i> f. <i>pulchra</i> (Lemm.) Elenk.	-	-	+	P	i	i	aa	?
<i>M. grevillei</i> f. <i>pulchra</i> (Kütz.) Elenk.	-	-	+	P	hl	?	k	?
<i>Aphanothece clathrata</i> f. <i>brevis</i> (Bachm.) Elenk.	+	+	+	P	i	i	aa	?
<i>Gloeocapsa minuta</i> (Kütz.) Hollerb. ampl.	+	-	+	P	i	i	k	o
<i>Chroococcus turgidus</i> (Kütz.) Näg.	+	+	+	B	hl	al	k	o-β
<i>Coelosphaerium pusillum</i> Goor	-	-	+	P	i	?	k	?
<i>Gomphosphaeria aponina</i> Kütz.	-	-	+	P	hl	al	k	o
<i>G. lacustris</i> Chod. f. <i>lacustris</i>	-	+	+	P	i	i	k	o-β
<i>G. lacustris</i> f. <i>compacta</i> (Lemm.) Elenk.	-	+	+	P	i	i	b	β
<i>Anabaena constricta</i> (Scaf.) Geitl.	+	+	+	P	i	i	b	p
<i>A. flos-aquae</i> (Lyngb.) Breb.	+	+	+	P	i	i	k	β
<i>A. lemmermannii</i> P. Richt.	+	+	+	P	i	i	k	β
<i>A. scheremetievi</i> Elenk.	+	+	+	P	i	al	k	o-β
<i>A. spiroides</i> f. <i>contorta</i> (Kleb.) Elenk.	+	-	+	P	i	?	k	?
<i>A. sphaerica</i> Born. et Flah.	+	+	+	P	i	?	k	o-β
<i>Aphanizomenon flos-aquae</i> (L.) Ralfs	+	+	+	P	hl	i	k	β
<i>Nostoc kihlmani</i> Lemm.	-	+	-	P	i	?	k	o-β
<i>Rivularia planctonica</i> Elenk.	-	-	+	?	?	?	?	?
<i>Lyngbya kuetzingii</i> (Kütz.) Schmidle	-	-	+	F	hl	?	k	o-β
<i>L. putealis</i> Mont.	-	+	+	B	?	?	k	?
<i>Oscillatoria limosa</i> Ag.	+	+	+	P	hl	al	k	β-α
<i>O. limnetica</i> Lemm.	+	+	+	P	i	?	k	o-β
<i>Plectonema notatum</i> Schmidle	-	-	+	?	?	?	?	β

CHRYOSOPHYTA								
<i>Chromulina rosanoffii</i> (Woronin) Bütschli	-	-	+	P	hb	?	k	o-ß
<i>Kephyrion bacilliforme</i> Conr.	-	-	+	?	?	?	?	?
<i>K. boreale</i> Skuja	+	+	+	P	i	?	b	o
<i>K. circumvallatum</i> (Schiller) Bourr.	+	+	-	?	?	?	?	o-ß
<i>K. francevii</i> Gus.	-	-	+	B	i	?	?	?
<i>K. incostans</i> (Sehmid) Bourr.	+	-	-	?	i	?	b	ß
<i>K. laticollis</i> (Conr.) Bourr.	+	-	-	?	?	?	?	?
<i>K. mosquense</i> Gus.	+	-	+	P	i	?	?	?
<i>K. rubri-claustri</i> Conr.	-	-	+	B	i	?	b	o
<i>K. spirale</i> (Lack.) Conr.	-	-	+	B	i	?	?	ß
<i>Chrysococcus rufescens</i> Klebs	+	+	+	P	hb	?	k	o-ß
<i>Dinobryon bavaricum</i> Imh.	+	+	+	P	i	az	b	o
<i>D. cylindricum</i> Imh. var. <i>cylindricum</i>	+	+	+	P	i	?	k	o-ß
<i>D. cylindricum</i> var. <i>palustre</i> Lemm.	+	+	+	P	i	az	b	?
<i>D. divergens</i> Imh. var. <i>divergens</i>	+	+	+	P	i	i	k	ß
<i>D. divergens</i> var. <i>angulatum</i> (Sel.) Brunnth.	+	-	+	P	i	?	k	?
<i>D. elegantissimum</i> (Korsch.) Bourr.	+	-	+	?	?	?	?	?
<i>D. pediforme</i> (Lemm.) Stein.	-	-	+	P	i	?	b	ß
<i>D. sertularia</i> Ehr.	-	+	+	P	i	al	k	o
<i>D. suecicum</i> Lemm. var. <i>suecicum</i>	+	+	+	P	i	i	aa	o
<i>D. suecicum</i> var. <i>longispinum</i> Lemm.	+	+	+	?	?	?	aa	?
<i>D. sociale</i> Ehr.	+	-	+	P	i	az	k	ß
<i>D. spirale</i> Iwan.	-	+	+	?	i	?	k	o
<i>D. stokesii</i> Lemm.	+	+	-	?	?	?	?	?
<i>Pseudokephyrion undulatisimum</i> Scherf.	+	-	+	P	?	?	?	o
<i>Mallomonas denticulata</i> Matv.	-	+	-	P	hb	?	k	?
<i>M. caudata</i> Iwan.	-	+	-	P	i	az	k	?
<i>Catenochrysis hispida</i> (Phillips) Perman	-	+	+	?	?	?	?	?
<i>Synura petersenii</i> Korsch.	-	+	-	P	hb	az	?	ß
<i>S. uvella</i> Ehr. emend. Korsch.	+	+	+	P	i	az	k	ß
<i>S. sphagnicola</i> Korsch.	-	-	+	P	hb	i	k	o
BACILLARIOPHYTA								
<i>Stephanodiscus hantzschii</i> Grun.	+	+	+	P	i	i	k	α
<i>Cyclotella antiqua</i> W. Sm.	+	-	-	P	hb	az	aa	?
<i>C. kuetzingiana</i> Thw.	-	-	+	P	hl	al	k	ß
<i>C. meneghiniana</i> Kütz.	+	+	+	P	hl	i	k	α-ß
<i>C. stelligera</i> (Cl. & Grun.) van Hurch	+	+	+	P	hl	i	k	?
<i>Melosira varians</i> Ag.	+	+	+	P	hl	al	k	ß
<i>M. undulata</i> var. <i>normanii</i> Arn.	+	+	+	?	?	?	?	?
<i>Aulacoseira distans</i> (Ehr.) Sim. var. <i>distans</i>	+	+	+	P	i	az	aa	x-o
<i>A. alpigena</i> (Crun.) Krammer = <i>A. distans</i> var. <i>alpigena</i> (Grun.) Sim.	+	+	+	P	i	i	aa	x-o
<i>A. granulata</i> (Ehr.) Sim.	+	+	+	P	i	al	k	ß
<i>A. italica</i> (Ehr.) Sim.	+	+	+	P	i	i	k	o-ß
<i>Fragilaria bicapitata</i> A. Mayer	-	-	+	?	i	?	k	o
<i>F. capucina</i> Desm. var. <i>capucina</i> = <i>Fragilaria capucina</i> var. <i>mesolepta</i> Rabenh.	-	-	+	P	i	i	k	?
<i>F. capucina</i> var. <i>auaustica</i> (Raben.) Raben. = <i>Synedra amphicephala</i> var. <i>austriaca</i> Grun.	-	-	+	?	?	?	?	x
<i>F. construens</i> (Ehr.) Grun.	-	-	+	F	i	al	k	o-ß
<i>F. crotonensis</i> Kitt.	+	+	+	P	hl	al	k	o-ß
<i>F. cyclopum</i> (Brut.) L.-B. = <i>Synedra cyclopum</i> Brutschy	-	-	+	F	i	i	k	?
<i>F. danica</i> (Kütz.) L.-B. = <i>Synedra ulna</i> var. <i>danica</i> (Kütz.) Grun.	+	+	+	F	i	al	k	o
<i>F. leptostauron</i> (Ehr.) Hust.	-	+	+	F	hb	i	b	?
<i>F. virescens</i> var. <i>mesolepta</i> Schönf.	-	-	+	B	oh	i	?	?
<i>F. virescens</i> var. <i>oblongella</i> Grun. = <i>F. virescens</i> var. <i>oblongella</i> (Grun.) Bukht.	-	-	+	B	oh	i	?	?
<i>Fragilariforma virescens</i> (Ralfs) Will. & Round = <i>Fragilaria virescens</i> Ralfs	+	+	+	F	i	az	aa	x
<i>Pseudostaurosira brevistriata</i> (Crun.) Will. & Round = <i>Fragilaria brevistriata</i> Grun.	-	-	+	F	i	i	k	o

<i>P. binodis</i> (Ehr.) Edl. = <i>Fragilaria construens</i> var. <i>binodis</i> (Ehr.) Grun.	-	+	+	F	i	al	k	o
<i>Ulnaria acus</i> (Kütz.) Ab. = <i>Synedra acus</i> Kütz.	+	+	+	P	i	al	k	ß
<i>Ul. biceps</i> (Kütz.) L.-B. = <i>Synedra ulna</i> var. <i>biceps</i> (Kütz.) Schönf.	-	-	+	F	i	al	k	?
<i>Ul. delicatissima</i> var. <i>angustissima</i> (Crun.) Ab. & Sil. = <i>Synedra acus</i> var. <i>angustissima</i> Grun.	-	-	+	P	i	al	k	o
<i>Ul. ulna</i> (Nitsch.) Comp. var. <i>ulna</i> = <i>Synedra ulna</i> (Nitsch.) Ehr.	+	+	+	F	i	al	k	ß
<i>Ul. ulna</i> var. <i>amphirhynchus</i> (Ehr.) Ab. = <i>Synedra ulna</i> var. <i>amphirhynchus</i> (Ehr.) Grun.	+	+	+	F	i	al	k	?
<i>Ul. ulna</i> var. <i>spathulifera</i> (Grun.) Ab. = <i>Synedra ulna</i> var. <i>spathulifera</i> Grun.	-	+	+	F	i	al	k	?
<i>Synedra rumpens</i> var. <i>familiaris</i> (Kütz.) Grun.	-	+	+	B	i	i	k	?
<i>Asterionella formosa</i> Hass.	+	+	+	P	i	i	k	o-ß
<i>Diatoma ehrenbergii</i> Kütz. = <i>Diatoma vulgare</i> var. <i>ehrenbergii</i> (Kütz.) Grun.	-	+	+	F	i	i	b	x-o
<i>D. tenuis</i> Kütz. = <i>Diatoma elongatum</i> (Lyngb.) Ag.	-	+	+	P	hl	i	b	o-ß
<i>D. vulgaris</i> Bory.	+	+	+	P	i	al	k	ß
<i>Meridion circulare</i> (Grev.) Ag. var. <i>circulare</i>	-	-	+	F	hb	az	aa	x-o
<i>M. circulare</i> var. <i>constrictum</i> (Ralfs) V. H.	+	+	+	F	hb	az	aa	?
<i>Tabellaria fenestrata</i> (Lyngb.) Kütz.	+	+	+	P	hb	az	k	o-ß
<i>T. flocculosa</i> (Roth) Kütz.	+	+	+	F	hb	az	aa	o-x
<i>Tetracyclus lacustris</i> Ralfs var. <i>lacustris</i>	+	+	+	F	i	az	aa	?
<i>T. lacustris</i> var. <i>capitata</i> Hust.	-	+	+	F	hb	az	aa	?
<i>Adlafia minuscula</i> (Grun.) L.-B. = <i>Navicula minuscula</i> Grun.	-	+	+	B	i	al	k	ß
<i>Caloneis molaris</i> (Grun.) Krammer = <i>Pinnularia molaris</i> Grun.	-	+	-	B	i	i	aa	?
<i>Cal. silicula</i> (Ehr.) Cl.	+	+	+	B	i	al	k	o-ß
<i>Cal. undulata</i> Greg. Krammer = <i>P. undulata</i> var. <i>subundulata</i> Grun.	+	-	-	?	?	?	?	?
<i>Cavinula lacustris</i> (Greg.) Mann & Stick. = <i>Navicula lacustris</i> Greg.	+	+	+	B	i	i	b	o
<i>Cav. pusio</i> (Cl.) L.-B. = <i>Navicula pusio</i> Cl.	-	+	+	B	i	i	b	?
<i>Cosmineis pusilla</i> (Smith) Mann & Stick. = <i>Navicula pusilla</i> W. Sm.	-	+	+	B	i	i	k	?
<i>Craticula ambigua</i> (Ehr.) Mann = <i>Navicula bicapitellata</i> Hust.	-	+	+	B	i	?	k	?
<i>Cr. cuspidata</i> (Kütz.) Mann & Bound var. <i>cuspidata</i> f. <i>cuspidata</i> = <i>Navicula cuspidata</i> Kütz.	+	+	+	B	i	i	k	α
<i>Cr. cuspidata</i> f. <i>primigena</i> Dipp. = <i>Navicula cuspidata</i> f. <i>primigena</i> Dipp.	+	+	+	B	i	i	b	?
<i>Decussata placenta</i> (Ehr.) L.-B. = <i>Navicula placenta</i> Ehr.	+	+	+	B	hb	az	k	?
<i>Diploneis ovalis</i> (Hilse) Cl.	-	+	+	B	i	i	b	?
<i>Frustulia saxonica</i> Raben. = <i>Frustulia rhomboides</i> (Ehr.) D. T.	-	-	+	B	hb	az	aa	o-ß
<i>F. vulgaris</i> Thw. D.T. = <i>Frustulia rhomboides</i> f. <i>vulgaris</i> Thw.	+	+	+	B	hb	i	b	o
<i>Gyrosigma acuminatum</i> (Kütz.) Raben. var. <i>acuminatum</i>	+	+	+	B	i	al	b	ß
<i>G. acuminatum</i> var. <i>gallicum</i> Grun.	-	+	+	B	hl	?	k	?
<i>Hippodonta capitata</i> (Ehr.) L.-B., Metzeltin & Witkowski = <i>Navicula hungarica</i> var. <i>capitata</i> Cl.	+	+	+	B	hl	al	b	ß
<i>H. costulata</i> (Grun.) L.-B., Metzeltin & Witkowski = <i>Navicula costulata</i> Grun.	-	+	+	B	hl	al	b	?
<i>Mayamaea atomus</i> (Kütz.) L.-B. = <i>Navicula atomus</i> (Näg.) Grun.	-	-	+	B	hl	al	k	ß-α
<i>Navicula cryptocephala</i> Kütz. var. <i>cryptocephala</i>	+	+	+	B	i	al	k	α
<i>N. cryptocephala</i> var. <i>lata</i> Poret. et Anissim.	-	-	+	B	?	?	?	?
<i>N. gastrum</i> Ehr.	-	+	+	B	i	i	k	ß
<i>N. gibbula</i> Cl.	-	+	+	B	i	?	aa	?
<i>N. gracilis</i> Ehr.	+	+	+	B	i	i	b	o-ß
<i>N. oblonga</i> (Kütz.) Kütz. = <i>Navicula oblonga</i> Kütz.	+	-	+	?	?	?	?	?
<i>N. platystoma</i> Ehr.	-	-	+	B	i	?	k	?
<i>N. radiosa</i> Kütz.	+	+	+	B	i	i	k	o-ß
<i>N. reinhardtii</i> (Grun.) Cl.	+	+	+	B	i	al	b	o-ß
<i>N. viridula</i> Kütz.	+	+	+	B	hl	al	k	α

<i>Neidium affine</i> (Ehr.) Pfitzer f. <i>affine</i> = <i>Neidium affine</i> (Ehr.) Cl. f. <i>affine</i>	+	+	+	B	i	al	b	?
<i>N. affine</i> f. <i>capitatum</i> Skv. et Meyer	-	-	+	?	?	?	?	?
<i>N. iridis</i> (Ehr.) Cl. = <i>N. iridis</i> var. <i>amphigomphus</i> (Ehr.) V. H.	+	+	+	B	hb	i	b	?
<i>Pinnularia acrosphaeria</i> Breb.	+	-	+	B	i	al	k	?
<i>P. angusta</i> (Cl.) Krammer = <i>Pinnularia mesolepta</i> f. <i>angustata</i> Cl.	-	+	-	B	i	i	b	?
<i>P. appendiculata</i> (Ag.) Cl.	+	+	+	B	hl	i	b	?
<i>P. biceps</i> Greg. = <i>Pinnularia interrupta</i> W. Sm. f. <i>interrupta</i>	-	+	+	B	i	i	b	o-ß
<i>P. borealis</i> Ehr.	+	+	+	B	i	i	aa	?
<i>P. brauniana</i> (Grun.) Mills = <i>Pinnularia braunii</i> var. <i>amphicephala</i> (A. Mayer) Hust.	-	-	+	B	hl	i	aa	?
<i>P. brebissonii</i> (Kütz.) Raben. = <i>Pinnularia microstauron</i> var. <i>brebissonii</i> (Kütz.) Hust.	+	+	+	B	i	i	b	?
<i>P. fasciata</i> (Lagerst.) Hust.	+	+	+	?	?	?	aa	?
<i>P. gibba</i> Ehr. var. <i>gibba</i> f. <i>gibba</i>	+	+	+	B	i	i	b	x-o
<i>P. gibba</i> f. <i>subundulata</i> A. Mayer	+	-	+	B	i	i	b	?
<i>P. gracillima</i> Greg.	-	+	+	B	hl	i	k	x
<i>P. mesolepta</i> (Ehr.) W. Sm.	-	+	-	B	i	al	b	o
<i>P. microstauron</i> (Ehr.) Cl. var. <i>microstauron</i> = <i>Pinnularia gibba</i> var. <i>parva</i> (Ehr.) Grun.; <i>P. microstauron</i> (Ehr.) Cl.	+	-	+	B	i	i	b	?
<i>P. microstauron</i> var. <i>ambigua</i> Meist.	+	-	+	?	?	?	?	?
<i>P. neomajor</i> Krammer = <i>Pinnularia major</i> (Kütz.) Cl. var. <i>major</i> ; <i>Pinnularia major</i> var. <i>lacustris</i> Meist.	-	+	+	B	i	i	b	ß
<i>P. interruptiformis</i> Krammer = <i>Pinnularia interrupta</i> f. <i>minor</i> Boye P.	-	+	-	B	i	i	b	?
<i>P. stauroptera</i> (Grun.) Raben.	-	+	+	B	?	az	k	o
<i>P. subcapitata</i> Greg. = <i>P. subcapitata</i> var. <i>hilseana</i> (Janisch.) O. Müll.	-	+	+	B	hl	az	k	x-o
<i>P. subgibba</i> Krammer = <i>Pinnularia gibba</i> var. <i>linearis</i> Hust.	+	-	+	B	i	az	b	?
<i>P. sublinearis</i> Grun.	-	+	+	B	i	?	b	?
<i>P. subsolaris</i> (Grun.) Cl.	+	+	+	B	oh	i	aa	?
<i>P. viridis</i> (Nitzsch.) Ehr.	+	+	+	B	i	i	b	o-ß
<i>Placoneis dicephala</i> (Ehr.) W. Sm. = <i>Navicula dicephala</i> (Ehr.) W. Sm.	+	-	+	B	i	i	k	o-ß
<i>Pl. elliptica</i> Ohtsuka = <i>Navicula exigua</i> var. <i>elliptica</i> Hust.	-	+	+	B	i	?	k	?
<i>Sellaphora pupula</i> (Kütz.) Meresch. = <i>Navicula pupula</i> Kütz.	-	+	+	B	hl	i	k	ß
<i>Sel. parapupula</i> L.-B. in L.-B. et Metz. = <i>Navicula pupula</i> var. <i>capitata</i> Hust.	-	+	+	B	hl	i	k	?
<i>Sel. rectangularis</i> (Greg.) L.-B. Meresch. = <i>Navicula pupula</i> var. <i>rectangularis</i> (Greg.) Grun.	+	+	+	B	hl	i	k	?
<i>Stauroneis acuta</i> W. Sm.	+	-	+	B	i	al	k	o
<i>S. anceps</i> Ehr. f. <i>anceps</i>	+	+	+	B	i	i	k	ß
<i>S. gracilior</i> (Reich.) Metz., L.-B. = <i>Stauroneis anceps</i> f. <i>gracilis</i> (Ehr.) Cl.	+	+	+	B	i	i	k	?
<i>S. parvula</i> Grun.	-	+	+	B	i	i	aa	?
<i>S. phoenicenteron</i> (Nitzsch.) Ehr. = <i>Stauroneis phoenicenteron</i> Ehr.	+	+	+	B	i	i	b	ß
<i>Achnanthes inflata</i> (Kütz.) Grun.	+	-	-	?	?	?	?	?
<i>Cocconeis placentula</i> Ehr. var. <i>placentula</i>	+	+	+	F	i	al	k	o-ß
<i>C. placentula</i> var. <i>euglypta</i> (Ehr.) Cl.	-	-	+	F	i	az	b	?
<i>Planothidium ellipticum</i> (Cl.) Edl. = <i>Achnanthes lanceolata</i> var. <i>elliptica</i> Cl.	-	+	+	F	i	i	aa	?
<i>Pl. lanceolatum</i> (Breb.) Round et Bukht. f. <i>lanceolatum</i> = <i>Achnanthes lanceolata</i> (Breb.) Grun.; <i>A. lanceolata</i> f. <i>ventricosa</i> Hust.	+	+	+	F	i	al	k	o-ß
<i>Pl. lanceolatum</i> f. <i>capitata</i> (O. Müll.) L.-B. = <i>Achnanthes lanceolata</i> f. <i>capitata</i> (O. Müll.) Hust.	-	+	-	F	?	?	?	?
<i>Pl. rostratum</i> (Øest.) Round et Bukht. = <i>Achnanthes lanceolata</i> f. <i>rostrata</i> (Østr.) Hust.	+	-	+	F	i	i	k	?
<i>Eunotia arcus</i> Ehr. = <i>Eunotia arcus</i> var. <i>bidens</i> Grun.	+	+	+	F	i	al	k	?
<i>E. bigibba</i> Kütz. = <i>E. bigibba</i> var. <i>pumila</i> Grun.	-	-	+	F	i	az	aa	?

<i>E. diodon</i> Ehr.	+	+	+	F	?	az	aa	?
<i>E. elegans</i> Østr.	+	+	+	F	?	?	?	?
<i>Eunotia gracilis</i> (Ehr.) Rabenh. = <i>Eunotia exigua</i> (Breb.)				F				
Rabenh. var. <i>exigua</i>	+	-	+		hb	az	aa	ß
<i>E. variondulata</i> Nörpel-Schempp & L.-B. = <i>Eunotia exigua</i> var.				F				
<i>tridentula</i> Østr.	+	-	-		hb	az	k	ß
<i>E. faba</i> var. <i>densestriata</i> Østr.	-	+	+	F	hb	?	b	?
<i>E. groenlandica</i> (Grun.) Nörpel-Schempp & L.-B. = <i>Eunotia</i>				F				
<i>fallax</i> var. <i>gracillima</i> Krasske	-	-	+		hb	i	k	?
<i>E. formica</i> Ehr.	+	+	+	F	i	az	k	o
<i>E. bilunaris</i> (Ehr.) Schaar. = <i>Eunotia lunaris</i> (Ehr.) Grun.; <i>E.</i>				F				
<i>lunaris</i> var. <i>capitata</i> Grun.	+	+	+		i	az	k	o
<i>E. mucophila</i> (L.-B. & Nörpel) L.-B. = <i>Eunotia lunaris</i> var.				F				
<i>subarcuata</i> (Näg.) Grun.	+	+	+		i	az	k	?
<i>E. monodon</i> (Fontell) Cl., L.-B. Metz. = <i>Eunotia monodon</i> Ehr.;				F				
<i>E. monodon</i> var. <i>major</i> (W. Sm.) Hust.	+	+	+		hb	az	k	o
<i>E. jemtlandica</i> (Fontell) Cl., L.-B. Metz. = <i>Eunotia monodon</i> var.				F				
<i>bidens</i> (Greg.) W. Sm.	+	+	+		hb	az	k	?
<i>E. parallela</i> Ehr.	+	+	+	F	i	i	aa	o
<i>E. pectinalis</i> (Dillw.? Kütz.) Rabenh. var. <i>pectinalis</i>	+	+	+	F	i	i	k	o-ß
<i>E. undulata</i> W. Smith; Krammer; L.-B. = <i>Eunotia pectinalis</i> var.				F				
<i>ventralis</i> (Ehr.) Hust.; <i>E. pectinalis</i> var. <i>undulata</i> Ralfs	+	+	+		i	i	k	?
<i>E. paratridentula</i> L.-B. & Kulikov. = <i>Eunotia polydentula</i> Brun.	-	+	-	F	hb	az	k	x-o
<i>E. septena</i> Ehr. = <i>Eunotia polyglyphis</i> Grun.	-	+	+	F	hb	az	aa	?
<i>E. praeupta</i> Ehr. = <i>Eunotia praeupta</i> var. <i>inflata</i> Grun.	+	+	+	F	hb	az	k	?
<i>E. bidens</i> Ehr.; L.-B.; Metz. = <i>Eunotia praeupta</i> var. <i>bidens</i> (W.				F				
Sm.) Grun	+	+	+		hb	az	k	?
<i>E. curtagrunowii</i> Nörpel – Schempp & L.-B. = <i>Eunotia</i>				F				
<i>praeupta</i> var. <i>musciola</i> Boye P.	+	+	+		hb	az	aa	?
<i>E. serra</i> Ehr. = <i>Eunotia robusta</i> Ralfs	+	+	+	F	hb	az	aa	o
<i>E. neosibirica</i> L.-B.; Kulikov.; & Witrow. = <i>Eunotia sibirica</i> Cl.	+	+	+	F	i	?	b	?
<i>E. septentrionalis</i> Østr.	-	+	+	F	i	az	aa	?
<i>E. sudetica</i> O. Müll. = <i>Eunotia sudetica</i> var. <i>bidens</i> Hust.	+	+	+	F	?	?	b	-
<i>E. tenella</i> (Grun.) Hust.	+	+	+	F	hb	az	aa	o
<i>E. veneris</i> (Kütz.) D.T.	+	+	+	F	hb	az	aa	o
<i>Rhoicosphenia curvata</i> (Kütz.) Grun.	-	-	+	F	hl	al	k	ß
<i>Amphora ovalis</i> Kütz. var. <i>ovalis</i>	+	+	+	B	i	al	k	o-ß
<i>A. ovalis</i> var. <i>gracilis</i> Ehr.	+	-	-	B	i	al	k	ß-o
<i>Cymbella aspera</i> (Ehr.) Cl.	-	-	+	F	i	i	aa	ß
<i>C. lanceolata</i> (Ehr.) V. H.	+	+	-	B	i	al	b	ß
<i>C. naviculiformis</i> Auersw.	+	+	+	F	i	al	b	ß
<i>C. parva</i> (W. Sm.) Cl.	-	+	-	F	i	i	b	?
<i>Cymbopleura amphicephala</i> (Naegeli) Krammer = <i>Cymbella</i>				F				
<i>amphicephala</i> Næg.	-	-	+		i	i	b	?
<i>Cymbop. angustata</i> (W. Sm.) Krammer = <i>Cymbella angustata</i>								
(W. Sm.) Cl.	-	-	+	?	?	?	?	?
<i>Cymbop. arctica</i> (Lager.) Schmidt; Krammer; L.-B. = <i>Cymbella</i>								
<i>cistula</i> var. <i>arctica</i> Lagerst.	-	+	+	B	i	al	aa	?
<i>Cymbop. cuspidata</i> (Kütz.) Krammer = <i>Cymbella cuspidata</i>								
Kütz.	+	+	+	B	i	i	k	?
<i>Eucyonema minutum</i> (Hilse) Mann = <i>Cymbella ventricosa</i> Kütz.	+	+	+	F	i	i	k	ß
<i>Gomphonema acuminatum</i> Ehr. var. <i>acuminatum</i>	+	+	+	F	i	az	b	ß
<i>G. acuminatum</i> var. <i>coronatum</i> (Ehr.) W. Sm.	+	+	+	F	i	i	b	ß
<i>G. angustum</i> Kütz. = <i>Gomphonema intricatum</i> Kütz.	+	-	-	F	i	i	b	o
<i>G. olivaceum</i> (Lyngb.) Kütz. var. <i>olivaceum</i>	-	+	+	F	i	i	b	ß
<i>G. olivaceum</i> var. <i>calcareum</i> Cl.	-	-	+	F	i	i	b	ß
<i>G. subclavatum</i> (Kütz.) Raben. = <i>Gomphonema longiceps</i> var.				F				
<i>subclavatum</i> Grun.	+	-	-		i	i	b	?
<i>Didymosphenia geminata</i> (Lyngb.) M. Schmidt	+	+	+	F	i	i	a	x
<i>Rhopalodia gibba</i> (Ehr.) O. Müll. var. <i>gibba</i>	+	+	+	F	i	i	k	o
<i>R. gibba</i> var. <i>ventricosa</i> (Ehr.) Grun.	+	-	-	F	hl	al	k	?
<i>Nitzschia acuta</i> Hantzsch	-	+	+	B	i	i	b	ß

<i>N. palea</i> (Kütz.) W. Sm.	+	+	+	B	i	i	b	α
<i>N. forticola</i> Grun.	+	-	-	B	i	i	b	α - β
<i>N. gracilis</i> Hantzsch	+	-	+	B	i	i	b	β - α
<i>N. intermedia</i> Hantzsch	-	-	+	?	?	?	?	?
<i>N. sublinearis</i> Hust.	-	-	+	B	i	i	b	α - β
<i>Hantzschia amphioxys</i> (Ehr.) Grun.	+	+	+	B	i	al	k	α
<i>Surirella angustata</i> Kütz. var. <i>angustata</i>	+	+	+	B	i	i	b	β
<i>S. angustata</i> var. <i>constricta</i> Hust.	+	-	+	?	?	?	?	?
<i>S. biseriata</i> Breb. var. <i>biseriata</i>	+	+	+	B	i	az	k	β
<i>S. biseriata</i> var. <i>constricta</i> Grun.	-	+	-	B	i	i	b	?
<i>S. capronii</i> Breb.	-	-	+	B	i	i	k	β
<i>S. gracilis</i> (W. Sm.) Grun.	-	+	+	B	i	i	b	?
<i>S. linearis</i> W. Sm.	+	+	+	B	i	i	b	β
<i>S. grunowii</i> Kul.; L.-B. & Witk. = <i>Surirella linearis</i> var. <i>constricta</i> (Ehr.) Grun.	+	-	+	B	i	i	b	β
<i>S. ovalis</i> Breb.	-	+	+	B	mg	i	b	?
<i>S. robusta</i> Ehr.	+	+	+	B	i	i	b	β
<i>S. splendida</i> (Ehr.) Kütz. = <i>Surirella robusta</i> var. <i>splendida</i> Ehr.	-	-	+	B	i	i	b	β
<i>S. tenera</i> Greg.	-	+	+	B	i	i	b	β
<i>Cymatopleura solea</i> (Breb.) W. Sm. var. <i>solea</i>	+	+	+	B	i	al	k	β - α
<i>C. solea</i> var. <i>vulgaris</i> Meist.	-	-	+	B	i	i	b	?
<i>Stenopterobia intermedia</i> var. <i>capitata</i> Font.	+	+	+	B	?	?	?	?
EUGLENOPHYTA								
<i>Euglena acus</i> Ehr.	+	+	+	P	i	i	k	β
<i>E. oxyuris</i> Schmarda	-	+	-	?	?	?	?	α - β
<i>Phacus acuminatus</i> var. <i>acuticauda</i> (Roll) Pochm.	-	+	+	?	i	?	k	?
<i>P. agilis</i> Skuja	-	-	+	?	i	?	k	β
<i>P. caudatus</i> Hübner var. <i>caudatus</i>	-	+	+	?	i	i	k	β
<i>P. caudatus</i> var. <i>tenuis</i> Swir.	-	-	+	?	?	?	?	?
<i>P. curvicauda</i> Swir.	-	-	+	P	i	i	k	β
<i>P. longicauda</i> (Ehr.) Duj.	-	-	+	P	i	i	k	β - α
<i>P. monilatus</i> var. <i>suecicus</i> Lemm.	-	-	+	?	hb	al	b	?
<i>P. orbicularis</i> f. <i>communis</i> Popova	-	+	+	?	?	?	?	?
<i>P. pleuronectes</i> (Ehr.) Duj.	-	+	+	?	i	i	k	β
<i>Trachelomonas caudata</i> (Ehr.) Stein	-	-	+	?	hb	?	k	β
<i>T. fusiformis</i> Stokes	-	-	+	P	i	?	k	?
<i>T. hispida</i> (Perty) Stein emend. Defl.	+	+	+	P	i	i	k	β
<i>T. intermedia</i> Dang.	-	-	+	P	i	i	k	β
<i>T. lacustris</i> Drez. emend. Balech	-	-	+	P	hb	i	k	α - β
<i>T. planctonica</i> Swir. f. <i>planctonica</i>	+	+	+	P	i	al	k	β - α
<i>T. planctonica</i> f. <i>oblonga</i> (Drez.) Popova	+	+	+	P	i	?	k	β
<i>T. pavlovskoënsis</i> (Poljansk.) Popova	-	-	+	?	?	?	?	β - α
<i>T. volvocina</i> Ehr.	+	+	+	P	hl	i	k	β
<i>T. volvocinopsis</i> Swir.	-	-	+	P	i	i	k	β
<i>Strombomonas acuminata</i> (Schmarda) Defl.	+	+	+	P	hl	i	k	β
<i>S. fluviatilis</i> (Lemm.) Defl.	-	-	+	P	i	i	k	β
<i>S. shauinslandii</i> (Lemm.) Defl.	-	-	+	P	i	?	k	β
<i>Lepocinclis fusiformis</i> (Carter) Lemm.	-	-	+	P	hl	?	k	β
<i>L. ovum</i> (Ehr.) Mink.	+	-	+	?	i	i	k	α - β
XANTHOPHYTA								
<i>Isthmochloron trispinatum</i> (W. et G. S. West) Skuja	-	+	+	?	?	?	?	?
<i>Tetraëdriella spinigera</i> Skuja	+	+	-	?	?	?	?	?
<i>Pseudostaurastrum hastatum</i> (Reinsch) Chod.	+	-	-	?	?	?	?	?
<i>Centritractus belonophorus</i> Lemm.	+	-	-	?	?	i	k	α - β
<i>Ophiocytium capitatum</i> Wolle	-	-	+	P	i	?	k	α
<i>O. lagerheimii</i> Lemm.	+	+	+	?	?	i	k	?
<i>Characiopsis naegelli</i> (A. Br.) Lemm.	-	-	+	?	?	?	?	?
DINOPHYTA								
<i>Ceratium hirundinella</i> (O.F.M.) Bergh var. <i>hirundinella</i>	+	-	+	P	hb	az	k	α
<i>C. hirundinella</i> f. <i>gracile</i> Bachm.	+	+	+	P	i	?	k	α
<i>Katodinium vorticella</i> Stein	-	-	+	?	?	?	?	β - α
CHLOROPHYTA								

<i>Eudorina elegans</i> Ehr.	+	+	+	P	i	i	k	β
<i>Pandorina charkowiensis</i> Korsch.	-	-	+	P	i	i	?	β
<i>P. morum</i> (Müll.) Bory	+	+	+	P	i	i	k	β
<i>Sphaerocystis planctonica</i> (Korsch.) Bourr.	+	-	+	P	i	?	k	?
<i>Heleochloris pallida</i> Korsch.	-	+	+	?	?	?	?	?
<i>Mychonastes jurisii</i> Hind. = <i>Dactylosphaerium jurisii</i> Hind.	+	+	+	P	hb	az	k	?
<i>Ankyra judayi</i> (G. M. Smith) Fott	-	-	+	P	i	?	k	β
<i>Desmatractum indutum</i> (Geitl.) Rasch.	+	+	+	?	?	?	?	?
<i>Hydrodictyon reticulatum</i> (L.) Lagerh.	+	-	-	?	?	?	?	?
<i>Pediastrum angulosum</i> (Ehr.) Menegh.	+	+	+	P	i	i	k	o
<i>P. duplex</i> Meyen var. <i>duplex</i> = <i>Pediastrum biradiatum</i> Meyen	+	+	+	P	i	i	k	β
<i>P. duplex</i> var. <i>cornutum</i> Racib. = <i>Pediastrum boryanum</i> var. <i>cornutum</i> (Racib.) Sulek	+	+	-	P	?	i	k	?
<i>P. duplex</i> var. <i>subgranulatum</i> Rac.	-	-	+	?	?	?	?	?
<i>P. boryanum</i> (Turp.) Menegh. var. <i>boryanum</i>	+	+	+	P	i	i	k	β
<i>P. boryanum</i> var. <i>longicorne</i> Reinsch	+	+	+	P	i	i	k	?
<i>P. braunii</i> Wartm.	+	+	+	?	?	?	?	?
<i>P. tetras</i> (Ehr.) Ralfs	+	+	+	P	i	i	k	β
<i>Pseudopediastrum kawraiskyi</i> Schmidle = <i>Pediastrum kawraiskyi</i> Schmidle	+	+	+	P	i	i	b	o-β
<i>Lacunastrum gracillimum</i> (W. & G. S. West) Manus = <i>Pediastrum duplex</i> var. <i>gracillimum</i> W. & G. S. West	+	+	+	P	i	?	k	β
<i>Monactinus simplex</i> (Meyen) Corda = <i>P. simplex</i> Meyen	-	+	+	P	i	?	k	o-β
<i>Golenkinia radiata</i> Chod.	+	+	+	P	i	i	k	β
<i>Golenkiniopsis longispina</i> (Korsch.) Korsch.	+	-	-	P	i	?	k	?
<i>Micractinium bornhemense</i> (Corn.) Korsch.	-	-	+	P	i	?	k	β
<i>M. pusillum</i> Fres.	-	-	+	P	?	?	k	β
<i>M. quadrisetum</i> (Lemm.) G. M. Smith	-	-	+	P	?	?	k	?
<i>Botryosphaera sudetica</i> (Lemm.) Chod.	+	+	+	B	hb	az	b	?
<i>Mucidosphaerium pulchellum</i> (Wood) Bock, Proschold & Krienitz = <i>Dictyosphaerium pulchellum</i> Wood	+	+	+	P	i	i	k	β-o
<i>Dictyosphaerium tetrachotomum</i> Printz	-	+	-	P	i	i	k	?
<i>Radiococcus polycoccus</i> (Hind.) = <i>Sphaerocystis polycocca</i> ;								
<i>Coenococcus polycoccus</i> (Korsch.) Hind. Korsch.	-	-	+	P	i	?	k	?
<i>Coenococcus planctonicus</i> Korsch.	+	+	+	P	i	i	k	?
<i>Tetraëdron caudatum</i> (Corda) Hansgirg	+	+	-	P	i	i	k	β
<i>T. minimum</i> (A. Br.) Hansg.	+	-	+	P	i	?	k	β
<i>T. triangulare</i> Korsch.	-	-	+	P	i	?	k	β
<i>Chlorotetraedron incus</i> (Teil.) Komárek & Kovácik = <i>Tetraëdron incus</i> (Teil.) G. M. Smith	+	+	+	P	i	i	k	β
<i>Franceia ovalis</i> Lemm. = <i>Franceia tenuspina</i> Korsh.	-	+	-	P	i	?	k	?
<i>Lagerheimia ciliata</i> (Lagerh.) Chod.	-	-	+	P	i	i	k	β
<i>L. longiseta</i> (Lemm.) = <i>Lagerheimia longiseta</i> (Lemm.) Wille;								
<i>Lagerheimia citrififormis</i> (Snow) Collins	+	+	+	P	i	?	k	β
<i>L. genevensis</i> (Chod.) Chod.	-	+	+	P	i	?	k	β
<i>L. subsalsa</i> Lemm.	+	+	+	P	i	?	k	?
<i>Oocystis borgei</i> Snow	-	+	+	P	i	i	k	β-o
<i>O. solitaria</i> Wittr.	-	-	+	P	i	i	k	β-o
<i>Monoraphidium arcuatum</i> (Korsch.) = <i>Monoraphidium arcuatum</i> (Korsch.) Hindak	-	+	+	P	i	i	k	β
<i>M. contortum</i> (Thur.) Kom.-Legn.	-	+	+	P	i	?	k	β
<i>M. griffithii</i> (Berk.) Kom.-Legn.	-	+	+	P	i	?	k	β
<i>M. irregulare</i> (G. M. Smith) Kom.-Legn.	+	+	+	P	i	i	k	?
<i>Kirchneriella aperta</i> Teil.	+	+	+	P	i	i	k	?
<i>K. lunaris</i> (Kirchn.) Möb.	-	-	+	P	i	?	k	β
<i>K. obesa</i> (W. West) Schmidle	+	+	+	P	i	i	k	β
<i>Raphidocelis contorta</i> (Schmidle) Marvan, Komarek, Comas	+	-	-	P	?	?	k	β
<i>R. danubiana</i> (Hind.) Marvan, Komarek, Comas	+	+	+	P	?	?	?	?
<i>Quadrigula korschikoffii</i> Kom.	+	+	+	?	?	?	?	?
<i>Ankistrodesmus falcatus</i> (Corda) Ralfs	-	+	+	P	hb	az	b	β-α
<i>A. fusiformis</i> Corda ex Korsch.	+	+	+	P	i	?	k	β
<i>A. spiralis</i> (Turp.) Lemm.	+	+	+	P	i	?	k	β

<i>Selenastrum gracile</i> Reinsch	+	+	+	P	i	?	k	ß
<i>Hyaloraphidium contortum</i> Rasch. et Korsch. var. <i>contortum</i>	+	+	+	P	i	?	k	?
<i>H. contortum</i> var. <i>tenuissimum</i> Korsch.	-	+	-	?	i	?	k	?
<i>Coelastrum astroideum</i> De-Not.	+	-	+	P	i	i	k	ß
<i>C. pulchrum</i> Schmidle	-	-	+	P	?	?	?	?
<i>C. microporum</i> Näg.	+	+	+	P	i	i	k	ß
<i>C. sphaericum</i> Näg.	+	+	+	P	i	i	k	o-ß
<i>Actinastrum hantzschii</i> Lagerh. var. <i>hantzschii</i> .	+	+	+	P	i	i	k	ß
<i>A. hantzschii</i> Lagerh. var. <i>subtille</i> Wolosz.	-	+	+	P	i	?	k	?
<i>Crucigenia fenestrata</i> (Schmidle) Schmidle	+	+	+	P	i	?	k	ß
<i>C. quadrata</i> Morr.	+	+	+	P	i	i	k	?
<i>C. tetrapedia</i> (Kirchn.) W. et G. S. West	+	+	+	P	i	i	k	o-ß
<i>Crucigeniella apiculata</i> (Lemm.) Schmidle	+	+	+	P	i	?	k	ß
<i>Cr. irregularis</i> (Wille) Tsarenko & John = <i>Willea irregularis</i> (Wille) Schmidle	+	-	+	P	i	?	k	?
<i>Tetrastrum elegans</i> Playf.	-	+	+	P	i	?	k	o-ß
<i>T. komarekii</i> Hind.	+	+	+	P	i	i	k	ß
<i>T. staurogeniaeforme</i> (Schröd.) Lemm.	-	+	+	P	i	?	k	ß
<i>T. triacanthum</i> Korsch.	+	+	+	P	i	?	k	ß
<i>T. triangulare</i> (Chod.) Kom.	+	+	+	P	i	?	k	ß
<i>Pseudodidymocystis lineata</i> (Korsch.) = <i>Didymocystis lineata</i> Korsch.	-	-	+	P	i	?	k	?
<i>Ps. planctonica</i> (Korsch.) = <i>Didymocystis planctonica</i> Korsch.	-	-	+	P	i	i	k	ß
<i>Acutodesmus acuminatus</i> (Lagerch.) Tsarenko Balwois = <i>Scenedesmus acuminatus</i> (Lagerch.) Chod.; <i>Scenedesmus acuminatus</i> var. <i>elongatus</i> (G. M. Smith) Deduss.; <i>Scenedesmus acuminatus</i> var. <i>tortuosus</i> Skuja	+	+	+	P	i	i	k	ß
<i>Ac. obliquus</i> (Tupr.) Heg. & Hanag. = <i>Scenedesmus obliquus</i> (Tupr.) Kütz.	+	+	+	P	i	?	k	ß
<i>Enallax acutiformis</i> (Schröd.) Hindák. According to Hegewald = <i>Scenedesmus acutiformis</i> Schröd.	+	+	+	P	i	?	k	ß
<i>Scenedesmus apiculatus</i> (W. et G. S. West) Chod.	+	+	+	P	i	?	k	?
<i>S. armatus</i> (Chod.) Chod. = <i>Scenedesmus helveticus</i> Chod.	-	-	+	P	i	?	k	ß
<i>S. arcuatus</i> (Lemm.) Lemm.	+	+	+	P	i	?	k	ß
<i>S. serratus</i> (Corda) Rohlin = <i>Scenedesmus denticulatus</i> var. <i>linearis</i> Hansg.	+	+	+	P	i	i	k	ß
<i>S. ellipticus</i> Corda	+	+	+	P	i	?	?	?
<i>S. acuminatus</i> (Lagerh.) Chodat = <i>Scenedesmus falcatus</i> Chod.	+	+	+	?	?	?	?	?
<i>S. subspicatus</i> Chod. = <i>Scenedesmus gutwinskii</i> Chod.	+	+	+	P	i	?	k	o-ß
<i>S. magnus</i> Meyen var. <i>magnus</i> = <i>Scenedesmus quadricauda</i> var. <i>setosus</i> Kirchn.	+	+	+	P	i	i	k	o-ß
<i>S. magnus</i> var. <i>naegeli</i> (Breb.) Tzar.	+	+	+	?	?	?	?	?
<i>S. microspina</i> Chod.	-	+	+	?	i	?	?	?
<i>S. obtusus</i> Meyen	-	-	+	P	i	i	k	ß
<i>S. semipulcher</i> Hortob.	+	-	+	P	i	?	k	ß
<i>S. abundans</i> (Kirch.) Chod. = <i>Scenedesmus sempervirens</i> Chod.	+	+	+	P	i	i	k	?
<i>S. quadricauda</i> (Turp.) Breb.	+	+	+	P	i	i	k	ß
<i>Scenedesmus obliquus</i> (Turp.) = <i>Scenedesmus acutus</i> Meyen	+	+	+	P	i	?	k	ß
<i>S. caudato-aculeolatus</i> Chod.	-	+	+	P	i	i	k	?
<i>S. circumfusus</i> Hortob. var. <i>bicaudatus</i>	-	-	+	?	?	?	?	?
<i>Desmodesmus armatus</i> (Chod.) Hegew var. <i>armatus</i> = <i>Scenedesmus armatus</i> Chod. var. <i>armatus</i>	+	+	+	P	i	?	k	ß
<i>Des. armatus</i> var. <i>bicaudatus</i> (Ugl.) Egew. = <i>Scenedesmus armatus</i> var. <i>bicaudatus</i> (Gugl.) Chod.	-	-	+	?	?	?	?	?
<i>Des. brasiliensis</i> (Bohl.) Egew. <i>Scenedesmus brasiliensis</i> Bohl.	+	+	+	?	?	?	k	ß
<i>Des. denticulatus</i> (Lagerh.), Friedl et Egew. = <i>Scenedesmus denticulatus</i> Lagerh. var. <i>denticulatus</i>	+	+	+	P	i	i	k	ß
<i>Des. hystrix</i> (Lagerh.) Hegew. = <i>Scenedesmus hystrix</i> Lagerh.	+	-	+	P	?	al	?	ß
<i>Des. intermedius</i> (Chod.) Hegew. var. <i>intermedius</i> = <i>Scenedesmus intermedius</i> Chod. var. <i>intermedius</i>	+	+	+	P	i	i	k	?
<i>Des. intermedius</i> var. <i>acutispinus</i> (Roll) Hegew. = <i>Scenedesmus intermedius</i> var. <i>bicaudatus</i> Hortob.	+	+	+	?	?	?	?	?

<i>Des. lefevrei</i> (Defl.) Friedl et Hegew. = <i>Scenedesmus lefevrii</i> Defl.	+	+	+	P	i	?	k	ß
<i>Des. opoliensis</i> (Richt.) Hegew. var <i>opoliensis</i> = <i>Scenedesmus opoliensis</i> P. Richt var. <i>opoliensis</i>	+	-	-	P	?	i	k	ß
<i>Des. opoliensis</i> var. <i>carinatus</i> (Lemm.) Hegew. = <i>Scenedesmus opoliensis</i> var. <i>carinatus</i> Lemm.	-	-	+	P	?	?	?	?
<i>Des. spinosus</i> (Chod.) Hegew. = <i>Scenedesmus spinosus</i> Chod.	+	+	+	P	i	?	k	?
<i>Ulothrix tenerima</i> Kütz. = <i>Ulothrix variabilis</i> Kütz.	+	-	+	B	i	?	k	?
<i>Closterium abruptum</i> f. <i>brevius</i> W. et G. West	+	-	-	?	?	?	?	?
<i>C. acutum</i> (Lyngb.) Breb.	+	+	+	P	i	i	k	ß
<i>C. acerosum</i> (Schr.) Ehr. f. <i>acerosum</i>	-	+	+	B	i	i	k	ß
<i>C. acerosum</i> f. <i>elongatum</i> (Breb.) Kossinsk.	-	+	+	P	i	?	k	?
<i>C. aciculare</i> Tuffen West	+	+	+	P	i	i	k	ß
<i>C. angustatum</i> Kütz.	-	+	-	?	?	?	?	?
<i>C. diana</i> Ehr.	-	+	-	P	i	?	k	o
<i>C. ehrenbergii</i> Menegh.	-	+	+	?	hb	i	k	ß
<i>C. ehrenbergii</i> var. <i>percrassum</i> (Borge) Grönl.	-	+	-	?	?	?	?	?
<i>C. gracile</i> Breb. f. <i>Gracile</i>	+	+	+	P	hb	?	k	o
<i>C. gracile</i> f. <i>elongatum</i> (W. et G. West.) Kossinsk.	-	-	+	P	hb	?	k	?
<i>C. incurvum</i> Breb.	-	-	+	?	?	?	?	?
<i>C. jenneri</i> Ralfs	+	+	+	?	?	?	?	?
<i>C. lanceolatum</i> Kütz.	-	+	-	P	hb	?	k	?
<i>C. leibleinii</i> Kütz.	+	-	+	P	i	?	k	α
<i>C. littorale</i> Gay	+	+	-	P	?	?	?	?
<i>C. moniliferum</i> (Bory) Ehr. var. <i>moniliferum</i>	+	+	+	B	i	?	k	ß
<i>C. moniliferum</i> var. <i>concauum</i> Klebs	-	+	+	P	i	al	k	?
<i>C. parvulum</i> Näg. f. <i>parvulum</i>	-	+	+	?	i	i	k	ß
<i>C. parvulum</i> f. <i>majus</i> W. West	-	+	+	P	i	i	k	?
<i>C. peracerosum</i> Gay var. <i>peracerosum</i>	+	+	+	P	i	i	k	?
<i>C. peracerosum</i> var. <i>elegans</i> G. West	-	+	+	?	?	?	?	?
<i>C. pronum</i> Breb. f. <i>prorum</i>	+	+	+	P	i	i	k	?
<i>C. pronum</i> f. <i>brevius</i> (W. West) Kossinsk	-	+	+	?	?	?	?	?
<i>C. rostratum</i> Ehr.	-	-	+	?	?	az	?	?
<i>C. setaceum</i> Ehr.	-	-	+	P	hb	?	k	?
<i>C. siliqua</i> W. et G. West	+	-	-	?	?	?	?	?
<i>C. subulatum</i> (Kütz.) Breb.	-	+	+	?	?	?	?	?
<i>C. tumidum</i> Johns.	+	+	+	?	?	?	?	?
<i>C. venus</i> Kütz. f. <i>venus</i>	-	+	+	P	i	?	k	ß
<i>C. venus</i> f. <i>minus</i> Roll	-	+	-	B	i	?	k	?
<i>Pleurotaenium ehrenbergii</i> (Breb.) De Bary	-	-	+	B	i	?	k	o-x
<i>Euastrum validum</i> W. et G. West	+	+	+	P	hb	?	k	?
<i>Cosmoastrum orbiculare</i> (Ralfs) Pal.-Mordv.	+	+	+	P	i	?	k	?
<i>C. muticum</i> (Breb.) Pal.-Mordv.	-	+	+	B	i	?	k	?
<i>C. teliferum</i> (Ralfs) Pal.-Mordv.	-	-	+	?	?	?	?	?
<i>Raphidiastrum longispinum</i> (Bail.) Pal.-Mordv.	-	-	+	?	?	?	?	?
<i>R. lunatum</i> (Ralfs) Pal.-Mordv.	-	-	+	P	i	?	b	?
<i>Staurodesmus bilnheimeii</i> (Racib.) Brock	+	+	+	?	?	?	?	?
<i>S. cuspidatus</i> (Breb.) Thom.	-	+	+	?	?	?	?	?
<i>S. incus</i> (Breb.) Teil. var. <i>incus</i>	+	-	+	P	hb	?	k	?
<i>S. incus</i> var. <i>primigenius</i> Teil.	-	+	-	?	?	?	?	?
<i>S. jaculiferus</i> (West) Teil.	-	+	-	?	?	?	?	?
<i>S. triangularis</i> (Lagerh.) Teil.	-	+	+	P	i	?	aa	?
<i>Stauroastrum anatinum</i> Cooke et Wille	+	-	+	?	?	?	?	?
<i>S. arache</i> Ralfs	+	+	-	?	?	?	?	?
<i>S. cyrtocentrum</i> Breb.	-	+	-	?	?	?	?	?
<i>S. hexacerum</i> (Ehr.) Wittr.	-	+	+	?	?	?	?	?
<i>S. gracile</i> Ralfs	+	+	+	P	i	az	k	o-ß
<i>S. ophiura</i> Lund.	-	-	+	P	i	?	k	?
<i>S. paradoxum</i> Meyen	+	+	+	P	i	?	k	?
<i>S. sublongipes</i> G. M. Smith	+	+	+	?	?	?	?	?
<i>S. subcruciatum</i> Cooke et Wills	-	+	-	?	?	?	?	?
<i>S. tetracerum</i> Ralfs	+	+	+	?	?	?	?	?

<i>S. vestitum</i> Ralfs	-	-	+	P	hb	?	k	?
<i>Cosmarium bioculatum</i> Breb.	+	+	+	P	hb	?	k	?
<i>C. cyclicum</i> var. <i>arcticum</i> Nordst. f. <i>arcticum</i>	-	+	+	?	?	?	?	?
<i>C. impressulum</i> Elfv.	+	+	+	B	hb	i	k	ß
<i>C. lagerheimii</i> Gutw.	-	+	-	?	?	?	?	?
<i>C. punctulatum</i> var. <i>subpunctulatum</i> (Nordst.) Börg.	+	+	+	P	i	?	k	?
<i>C. subundulatum</i> Wille	-	+	-	?	?	?	?	?
<i>C. subprotumidum</i> Nordst.	-	+	+	P	?	az	?	?
<i>C. tetragonum</i> var. <i>lundellii</i> Cooke	-	+	+	?	?	?	?	?
<i>C. undulatum</i> Corda var. <i>undulatum</i>	-	-	+	?	i	az	k	?
<i>C. undulatum</i> var. <i>wollei</i> West	-	+	+	P	i	az	k	?
<i>Pachyphorium obsolentum</i> (Hantzsch) Pal.-Mordv.	+	-	-	?	?	?	?	?
<i>Xanthidium antilopaeum</i> (Breb.) Kütz.	-	+	+	P	i	?	k	o-x
<i>X. acanthophorum</i> Nordst.	-	-	+	?	?	?	?	?
<i>Spondylosium planum</i> (Wolle) W. et G. S. West	-	+	+	P	i	?	aa	ß
<i>S. pygmaeum</i> (Cooke) West	-	+	-	?	?	?	?	?
<i>S. pulchellum</i> Arch.	-	+	+	?	?	?	?	?
<i>Teilingia excavata</i> (Ralfs) Bourr.	+	+	+	P	i	i	k	?
<i>T. granulata</i> (Roy et Biss.) Bourr.	+	+	+	P	i	i	k	?
<i>T. wallichnii</i> (Jacobs.) Bourr.	-	+	-	P	i	?	k	?
<i>Desmidium graciliceps</i> (Nordst.) Lagerh.	-	+	+	?	?	?	?	?
<i>Bambusina brebissonii</i> Kütz.	+	-	-	P	?	az	?	?

4. Conclusions

The original data helps to identify rich biodiversity of phytoplankton in the Vakh River. It includes 404 taxonomic units represented by 463 species, 463 species, types and forms of algae, belonging to 140 genera, 52 families, 13 classes and 7 divisions. In its diversity Bacillariophyta and Chlorophyta serve as the basis of phytoplankton and comprise 78.9%. As for the number of algae, Cyanobacteria, Chrysophyta and Euglenophyta play an important part (88 taxonomic units ranking lower than genus). They comprise 19.0%. The floristic importance of Xanthophyta and Dinophyta (10 species, types and forms) is relatively low with only 2.1 %.

Based on the number of taxonomic units of specific and infraspecific rank diatoms and Chlorophyta take the leading position along the river stream.

14 algae are structure-forming: vegetating throughout the whole year (*Aulacoseira italica*, *Asterionella formosa*), in the summer period (*Microcystis aeruginosa*, *Melosira varians*, *Aulacoseira granulata*, *Pandorina morum*, *Pediastrum boryanum*, *P. duplex*, *Lacunastrum gracillimum*, *Scenedesmus quadricauda*) and in the summer-fall period (*Microcystis pulvereae*, *Tabellaria fenestrata*, *T. flocculosa*, *Mucidosphaerium pulchellum*).

There have been noted two new taxonomic units for subzone of middle boreal: Chrysophyta – 1, Diatoms, of genus *Eutonia* – 9, Euglenophyta – 7, Chlorophyta from *Closterium* genus – 5.

The following were identified in the Vakh River phytoplankton for the first time: 386 taxonomic units ranking lower than genus, including Chlorophyta – 159, diatoms – 135, Cyanophyta – 29, Chrysophyta- 29, Euglenophyta – 24, Xanthophyta – 7 and Dinoflagellata – 3.

The taxonomic spectrum of the Vakh River is typical for plain boreal algae plankton groups. In its composition, the dominating genera and families of phytoplankton of the Vakh River have features of undisturbed boreal northern streams. High share of families and genera with one or two species gives the River phytoplankton its northern specialty.

The taiga Vakh River gets its special features from rich genera *Closterium*, *Pinnularia*, *Desmidium*, *Eunotia* and family Desmidiaceae.

The ecological and geographical analysis demonstrated that plankton, oligogalobs and pH neutral species dominate the studied environment.

More than half of the identified phytoplankton (51.6%) are indicative of water saprobity. The water in the Vakh River meets the requirements for β -mezosaprobial pollution zone, class of satisfactory purity (III class) based on the relationship of dominants to saprobity.

References

- [1] Alekina O A 1953 *Fundamentals of hydrochemistry* (Leningrad: Gidrometeorol Publishing House)
- [2] Barinova S S, Medvedeva L S and Anisimova O V 2006 *Biodiversity of algae indicators* (Tel Aviv: Pilies Studio)
- [3] Beirom S G 1975 *Resources of surface water in USSR* **15** (1) 408
- [4] Vasiljeva I I 1989 *Analysis of species and algae development in water bodies in Yakutiya* (Yakusk)
- [5] Vasser S P 1989 *Algae: Reference book* (Kiev: Naukova Dumka)
- [6] Vorobjova S S 1995 *Phytoplankton of Angara river water bodies* Abstract of Thesis for the Degree of the Candidate of Biological Sciences (Novosibirsk)
- [7] Gabyshev V A 1999 *Plankton algae in the Lena River in the area influenced by Yakutsk ecosystem* Abstract of Thesis for the Degree of the Candidate of Biological Sciences (Yakutsk)
- [8] Genkal S I, Bondarenko N A and Schur L A 2011 *Bacillariophyta of lakes of the South and the North of Eastern Siberia* (Rybinsk: Rybinsk Publishing House)
- [9] Getsen M V 1985 *Algae in the ecosystems of the Far North* (Leningrad: Nauka Publishing house)
- [10] Gollerbach M M and Polyanski V I 1951 *Field guide of freshwater algae (General information)* **1** (Moscow: Sovetskaya Nauka)
- [11] Makarova I V 1988 *Diatoms of the USSR (fossil and living)* **2** (1) (Leningrad: Nauka)
- [12] Zabelina M M, Kiselev I A et al 1951 *Field guide of diatoms Diatoms – Bacillariophyta* **4** (Moscow: Sovetskaya Nauka)
- [13] Kondratyeva N V 1972 *Morphology and symantics of Hormogoniophyceae algae that leads to algal bloom of Dniepr and its reservoirs* (Kiev: Naukova Dumka)
- [14] Kondratyeva N V 1975 *Morphogenesis and main evolution means of Hormogoniophyceae algae* (Kiev: Naukova Dumka Publishing House)
- [15] Kondratyeva N V 1981 *Botanicheskij zhurnal* **66** (2) 215–26
- [16] Kondratyeva N V, Kovalenko O V and Prokhodjkova L P 1984 *Cyanobacteria Cyanophyta. Part 1. Field guide of fresh water algae of Ukrainian SSR* (Kiev: Naukova Dumka)
- [17] Kopyrina L I 2009 *Proceedings of the 2nd national conference “Algae: issues of taxonomy, ecology and monitoring” (Syktyvkar: 5-9 October, 2009)* (Syktyvkar) p 197–8
- [18] Vingerg G G 1981 Guidelines on collection and processing of samples in hydrobiological studies in fresh water (Leningrad: State Research Institute of River and Pond Fishery)
- [19] Naumenko J V 1985 *Phytoplankton of Ob' and Lower Irtysh and its changes under the influence of anthropogenic factors* Abstract of Thesis for the Degree of the Candidate of Biological Sciences (Novosibirsk)
- [20] Naumenko J V 1991 *Siberian Ecological Journal* **2** 28–33
- [21] Naumenko J V 2001 *Botanical studies of Siberia and Khazakhstan* **7** 43–49
- [22] Naumenko J V 1996 *Phytoplankton of the Ob' River* Abstract of Thesis for the Degree of the Doctor of Biological Sciences (Novosibirsk)
- [23] Naumenko J V 1998 *Siberian Ecological Journal* **2** 147–150
- [24] Naumenko J V and Skorobogatova O N 2009 *Turczaninowia* **12** (1-2) 65–70
- [25] Naumenko J V and Skorobogatova O N 2009 *Bulletin of Ecology, Forest Science and Landscape Ecology* **10** 49–53
- [26] Palamar-Mordvintseva G M 1982 *Field guide fresh water Algae of USSR. Issue 11(2). Chlorophyta. Conjugatophyceae Class. Desmidiáles Order* (Leningrad: Sovetskaya nauka)

- [27] Remigaylo P A 1995 *Phytoplankton of the River Viluj and Viluj Reservoir* Abstract of Thesis for the Degree of the Candidate of Biological Sciences (Novosibirsk)
- [28] Ivanov Yu N 1974 *Resources of surface water in USSR. General hydrological characteristics (1963 – 1970)* **15** (1) (Leningrad)
- [29] Safonova T A and Shaulo S P 2006 *Turczaninowia* **9** (3) 102–8
- [30] Skorobogatova O N 2010 *Natural and Technical Sciences* **3** 107–11
- [31] Fjodorov V D 1979 *On study methods of phytoplankton and its activity* (Moscow: MSU Publishing House)
- [32] Tsarenko P M 1990 *Brief field guide of Chlorococcales of Ukrainian SSR* (Kiev: Naukova Dumka)
- [33] Tsarenko P M 2005 *Algology* **15** (4) 459–67
- [34] Elyashev A A 1957 *Collection of research papers on palaeontology and biostratigraphy* **4** 123–37
- [35] Bukhtiyarova L and Round F E 1996 *Diatom Research* **11** 1–30
- [36] Hegewald E, Hanagata N and Tsarenko P 2000 *Algologia* **10** (4) 176
- [37] Kharitonov V G and Genkal S I 2012 *Diatoms of the Elgygytyn Lake and its Vicinities (Chukotka)* (Magadan: NESR FEB RAS)
- [38] Lange-Bertalot H and Krammer K 2002 *Diatoms of Europe: Diatoms of the European Inland Waters and Comparable Habitats. Cymbella* (Vol. 3) Gantner Publishing
- [39] Lange-Bertalot H and Krammer K 2000 *Diatoms of Europe: Diatoms of the European Inland Waters and Comparable Habitats. The genus Pinnulara* (Vol. 1) Gantner Publishing
- [40] Lange-Bertalot H and Krammer K 2001 *Diatoms of Europe: Diatoms of the European Inland Waters and Comparable Habitats. Navicula sensu stricto, 10 genera separated from Navicula sensu strict. Frustulia* Gantner Publishing
- [41] Lange-Bertalot H and Krammer K 2001 *Diatoms of Europe: Diatoms of the European Inland Waters and Comparable Habitats. Navicula sensu stricto, 10 genera separated from Navicula sensu strict. Frustulia* Gantner Publishing
- [42] Lange-Bertalot H and Krammer K 2001 *Diatoms of Europe: Diatoms of the European Inland Waters and Comparable Habitats. Navicula sensu stricto, 10 genera separated from Navicula sensu strict. Frustulia* Gantner Publishing
- [43] Dorofeyuk N I and Kulikovskiy M S 2012 *Diatoms of Mongolia* (Moscow)