
Analysis of phytoplankton structure in Lithuanian rivers

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Analysis of river phytoplankton structure has been carried out, based upon data collected during 1968–1999 on 177 Lithuanian rivers and streams. Totally, 455 phytoplankton taxa have been identified. The greatest species diversity was noted for *Bacillariophyceae* (42% of all taxa) and *Chlorophyceae* (34%). Representatives of other classes were significantly less abundant: *Cyanophyceae* (13%), *Euglenophyceae* (7%), *Chrysophyceae* (2%), *Dinophyceae* (1.5%), *Cryptophyceae* (0.4%), *Xantophyceae* (0.2%). The diatoms consisted mainly of *Pennales* representatives. *Centrales* were significantly less abundant. The greatest diversity of *Chlorophyceae* species was found for *Chlorococcales*. The diversity of *Zygnematales* species was significantly poorer. River phytoplankton consists of planktonic, meroplanktonic and benthic algae in the ratio 3:2:1. Planktonic algae population consists of limnoplanktonic (30% of total species number), potamoplanktonic (5%) and unknown inoculum (65%) species. Even 70% of phytoplankton were rarely found species detected only in 1–10% of the rivers.

Key words: river phytoplankton, structure, Lithuania

INTRODUCTION

In Lithuania, as well as in many other European countries, river phytoplankton is less investigated than lake phytoplankton. Throughout the years, there have been many attempts to unravel the features of river phytoplankton, but they still remain elusive. There are known some data about phytoplankton structure in the Nemunas River, Šešupė and its basin rivers, Merkys and its basin rivers, Žeimena, Nevėžis, Skroblus, Spermia, Bamberna and Dovinė [1–11].

Since 1968, regular phytoplankton investigations have been done in more than 100 rivers. However, up to now rich and valuable long-term data of phytoplankton studies have been neither generalised nor published. So, the aim of this paper was to summarise data on phytoplankton obtained during 1968–1999 in Lithuanian streams and rivers and to determine regularities in phytoplankton structure.

MATERIALS AND METHODS

Phytoplankton studies were carried out in 177 Lithuanian streams and rivers from 15 river basins: Nemunas, Neris, Šventoji, Žeimena, Merkys, Nevėžis, Šešupė, Mūša, Miniija, Dubysa, Venta, Jūra, also the

Baltic Sea, Bartuva and Akmena–Danė during 1968–1999. Phytoplankton samples were collected from the upper level of water (0–50 cm) directly to 21 bottles or with sample nets (pore 25 and 100 μm). Samples were fixed with 4% formaldehyde or Lugol iodine solution and concentrated (to 10 ml volume) through a sedimentation procedure.

RESULTS AND DISCUSSION

During the study period, 455 taxa of algae have been identified in the rivers. The total river phytoplankton taxonomic spectrum is shown in Table 1.

Long-term phytoplankton data analysis shows that diatoms (*Bacillariophyceae*) and green algae (*Chlorophyceae*) were predominant in rivers (Fig. 1). They comprised respectively 42% and 34% of all identified taxa. Other groups of algae are presented in a decreasing order: *Cyanophyceae* – 13%, *Euglenophyceae* – 7%, *Chrysophyceae* – 2%, *Dinophyceae* – 1.5%, *Cryptophyceae* – 0.4% and *Xantophyceae* – 0.2%. Comparative analysis of our data and C. Rojo et al. [12] summarised data on phytoplankton on 67 temperate rivers shows that such taxonomic structure of phytoplankton is characteristic of many temperate rivers.

Table 1. Systematic spectrum of phytoplankton in Lithuanian rivers (1968-1999)

<i>Taxa</i>	Species No.	Species No. %	<i>Taxa</i>	Species No.	Species No. %	<i>Taxa</i>	Species No.	Species No. %
CYANOPHYTA			Bacillariophyceae			<i>Chlorella</i>	2	0,4
Cyanophyceae			Centrales			<i>Chlorogloea</i>	1	0,2
Chroococcales			<i>Aulacoseira</i>	7	1,5	<i>Coelastrum</i>	4	0,9
<i>Aphanocapsa</i>	1	0,2	<i>Cyclotella</i>	6	1,3	<i>Coenocystis</i>	4	0,9
<i>Aphanothece</i>	2	0,4	<i>Ellerbeckia</i>	1	0,2	<i>Crucigenia</i>	4	0,9
<i>Chroococcus</i>	2	0,4	<i>Melosira</i>	1	0,2	<i>Crucigeniella</i>	1	0,2
<i>Coelosphaerium</i>	1	0,2	<i>Stephanodiscus</i>	4	0,9	<i>Dictyosphaerium</i>	2	0,4
<i>Cyanothece</i>	1	0,2	Pennales			<i>Enallax</i>	1	0,2
<i>Gloeocapsa</i>	1	0,2	<i>Achnanthes</i>	4	0,9	<i>Eremosphaera</i>	1	0,2
<i>Gomphosphaeria</i>	3	0,7	<i>Amphora</i>	2	0,4	<i>Golenkinia</i>	1	0,2
<i>Marsoniella</i>	1	0,2	<i>Asterionella</i>	2	0,4	<i>Golenkiniopsis</i>	2	0,4
<i>Merismopedia</i>	4	0,9	<i>Caloneis</i>	3	0,7	<i>Goniochloris</i>	2	0,4
<i>Microcystis</i>	3	0,7	<i>Campylodiscus</i>	1	0,2	<i>Hyaloraphidium</i>	1	0,2
<i>Snowella</i>	1	0,2	<i>Cocconeis</i>	2	0,4	Kirchneriella	5	1,1
<i>Synechococcus</i>	1	0,2	<i>Cymatopleura</i>	4	0,9	<i>Korshikoviella</i>	1	0,2
<i>Synechocystis</i>	1	0,2	Cymbella	15	3,3	Lagerheimia	7	1,5
<i>Woronichinia</i>	2	0,4	<i>Diatoma</i>	4	0,9	<i>Micractinium</i>	3	0,7
Oscillatoriales			<i>Diploneis</i>	1	0,2	<i>Monoraphidium</i>	2	0,4
<i>Arthrospira</i>	2	0,4	<i>Epithemia</i>	4	0,9	Oocystis	7	1,5
<i>Jaaginema</i>	1	0,2	<i>Eunotia</i>	3	0,7	Pediastrum	7	1,5
<i>Limnothrix</i>	2	0,4	Fragilaria	19	4,2	<i>Pseudostaurastrum</i>	2	0,4
<i>Lyngbya</i>	1	0,2	Gomphonema	13	2,9	<i>Raphidonema</i>	1	0,2
Oscillatoria	6	1,3	Gyrosigma	8	1,8	Scenedesmus	18	4,0
Phormidium	8	1,8	<i>Hantzschia</i>	1	0,2	<i>Schroederia</i>	1	0,2
<i>Planktolyngbya</i>	1	0,2	<i>Meridion</i>	1	0,2	<i>Selenastrum</i>	2	0,4
<i>Planktothrix</i>	3	0,7	Navicula	24	5,3	<i>Sphaerocystis</i>	2	0,4
<i>Pseudoanabaena</i>	1	0,2	<i>Neidium</i>	3	0,7	<i>Tetraedriella</i>	1	0,2
<i>Spirulina</i>	1	0,2	Nitzschia	17	3,7	Tetraedron	8	1,8
<i>Tychonema</i>	1	0,2	Pinnularia	12	2,6	<i>Tetrastrum</i>	4	0,9
Nostocales			<i>Rhoicosphaenia</i>	1	0,2	<i>Willea</i>	1	0,2
Anabaena	5	1,1	<i>Rhopalodia</i>	1	0,2	Ulothricales		
<i>Aphanizomenon</i>	1	0,2	<i>Stauroneis</i>	5	1,1	<i>Ulothrix</i>	2	0,4
<i>Cylindrospermum</i>	1	0,2	Surirella	14	3,1	Zygnematales		
<i>Komvophoron</i>	1	0,2	Synedra	4	0,9	Closterium	16	3,5
CHROMOPHYTA			<i>Tabellaria</i>	3	0,7	Cosmarium	6	1,3
Dinophyceae			Xantophyceae			<i>Cosmoastrum</i>	3	0,7
Peridinales			Tribonematales			<i>Euastrum</i>	1	0,2
<i>Ceratium</i>	1	0,2	<i>Tribonema</i>	1	0,2	<i>Gonatozygon</i>	1	0,2
<i>Glenodinium</i>	1	0,2	EUGLENOPHYTA			<i>Pleurotaenium</i>	1	0,2
<i>Peridiniopsis</i>	3	0,7	Euglenophyceae			<i>Spondylosium</i>	1	0,2
<i>Peridinium</i>	2	0,4	Euglenales			Staurastrum	7	1,5
Cryptophyceae			<i>Euglena</i>	7	1,5	<i>Staurodesmus</i>	2	0,4
Cryptomonadales			Phacus	10	2,2	Volvocales		0,0
<i>Cryptomonas</i>	1	0,2	<i>Strombomonas</i>	2	0,4	<i>Chlamydomonas</i>	3	0,7
<i>Rhodomonas</i>	1	0,2	Trachelomonas	12	2,6	<i>Eudorina</i>	1	0,2
Chrysophyceae			CHLOROPHYTA			<i>Gonium</i>	1	0,2
Ochromonadales			Chlorophyceae			<i>Pandorina</i>	1	0,2
Dinobryon	5	1,1	Chlorococcales			<i>Paulschulzia</i>	1	0,2
<i>Syncrypta</i>	1	0,2	<i>Actinastrum</i>	2	0,4	<i>Phacotus</i>	1	0,2
<i>Synura</i>	1	0,2	Ankistrodesmus	7	1,5	<i>Volvox</i>	2	0,4
			<i>Characium</i>	1	0,2	Total	455	100,0

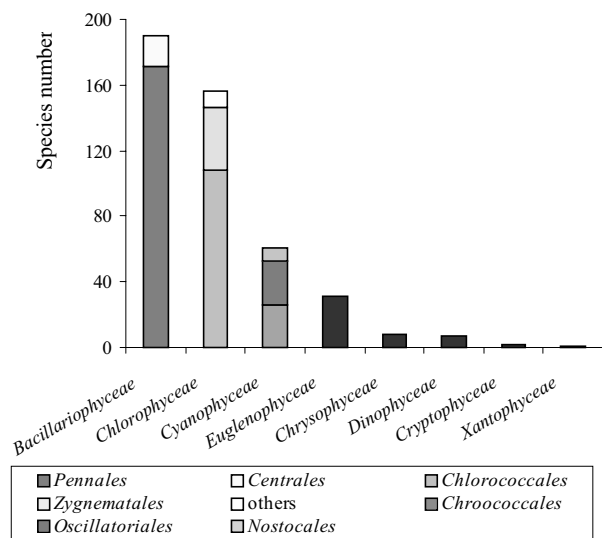


Fig. 1. Phytoplankton taxonomical structure in Lithuanian rivers (1968–1999)

The diatoms consist mainly of *Pennales* representatives. A significant part of them are euritopic in the river phytoplankton dominating algae species of the genera *Cymbella*, *Fragilaria*, *Gomphonema*, *Navicula*, *Nitzschia*, *Pinnularia* and *Surirella*, etc. *Centrales* representatives were less abundant.

The greatest diversity of *Chlorophyceae* species was found for small species of *Chlorococcales*, mainly for *Ankistrodesmus*, *Oocystis*, *Scenedesmus*, *Pediastrum* and *Tetraedron* species. The *Zygnematales* species diversity in Lithuanian as well as in other temperate rivers was significantly poorer.

Among sparse in number *Cyanophyceae* species, representatives of *Chroococcales* and *Oscillatoriales* were found in the rivers. Most of them were rarely distributed species. It seems that the main factor that limited their distribution in lotic ecosystems was water turbulence [13, 14].

The phytoplankton of Lithuanian rivers was found to contain such species as *Ankistrodesmus falcatus* (Corda) Ralfs, *Asterionella formosa* Hassal, *Aulacoseira islandica* subsp. *helvetica* (O. F. Müll.) Simonsen, *Aulacoseira granulata* var. *granulata* (O. F. Müll.) Simonsen, *Cocconeis placentula* Ehrenb., *Coelastrum microporum* Nägeli, *Diatoma tenue* C. Agardh, *D. vulgare* Bory, *Fragilaria capucina* Desm., *F. crotonensis* Kitton, *F. tenera* (W.Sm.) Lange-Bert., *F. ulna* (Nitzsch) Lange-Bert., *F. ulna* var. *acus* (Kütz.) Lange-Bert., *F. virescens* Ralfs, *Melosira varians* C. Agardh, *Meridion circulare* (Grev.) C. Agardh, *Navicula capitata* var. *capitata* Ehrenb., *Nitzschia paleacea* (Grunow) Grunow, *Pediastrum boryanum* var. *boryanum* (Turpin) Menegh., *Scenedesmus acuminatus* (Lagerh.) Chodat, *S. quadricauda* (Turpin) Bréb. and *Stephanodiscus hantzschii* Grunow

prevailing (*i.e.*, those reported in more than 50% of total studies). Some of them (marked off bold) are also phytoplankton species frequent in other temperate rivers [12].

In Lithuanian rivers, as well as in other temperate rivers, about half of phytoplankton species (54%) consist of planktonic algae (Fig. 2). The group of planktonic algae consisted of limnoplanktonic (30%), potamoplanktonic (5%) and indifferent inoculum (65%) species.

Benthic and meroplanktonic algae made about 47% of all phytoplankton species, with *Pennales* diatoms prevailing (Fig. 2). A similar ecological structure of phytoplankton is characteristic of other temperate rivers [12].

Concerning species occurrence through the entire listing of 177 rivers, it is surprising that even 70% of all identified taxa formed rarely distributed (detected in 1–10% of the rivers) species (Fig. 3). Similar results (about 50%) were recorded for many temperate rivers [12]. So, it might be suggested that

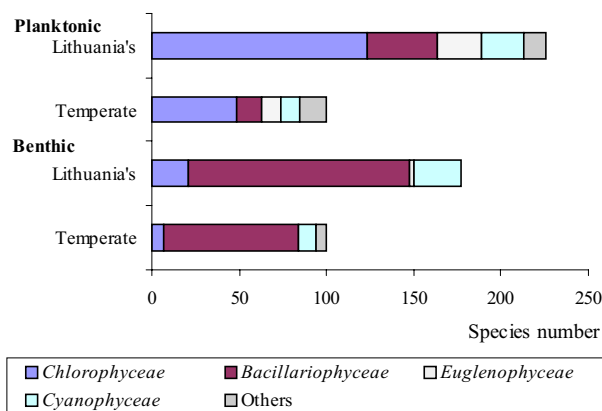


Fig. 2. The main classes of algae of Lithuanian and temperate rivers (by ecological groups)

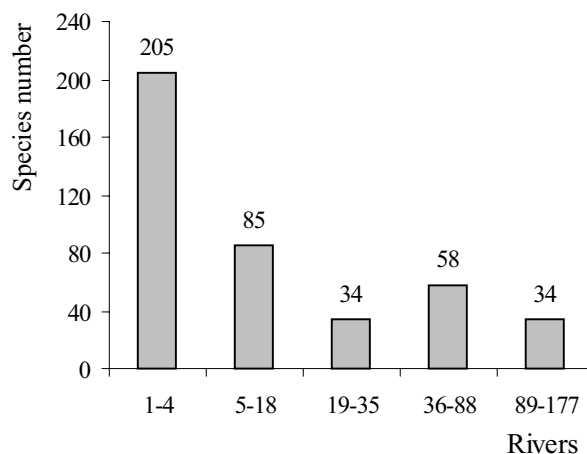


Fig. 3. Phytoplankton species frequency groups in Lithuanian rivers

in the rivers there are a wide variety of ecological niches suitable for different algae species.

Euritopic species in the river phytoplankton made up only 7% of taxa. Some of them (57%) were indifferent species widely distributed in both rivers and lakes phytoplankton. The rest part is formed of species typical of river phytoplankton and rare in lake plankton. Most of them are benthic species.

The obtained results of phytoplankton analysis show that the phytoplankton structure in Lithuanian rivers is similar to that in other temperate rivers [12]. On this basis, some characteristic features of river phytoplankton can be singled out: diatoms appear to be the best adapted taxonomic group for living in highly unstable river environment;

river phytoplankton consists of planktonic, benthic and meroplanktonic algae in the ratio 3:2:1; river phytoplankton is characterised by a high incidence of sporadic species.

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LIETUVOS UPIŲ FITOPLANKTONO STRUKTŪROS ANALIZĖ

S a n t r a u k a

Darbe analizuojami 177 Lietuvos upių ir upelių fitoplanktono 1968–1999 metų tyrimų duomenys. Tirtose vandentėkmėse identifikuoti 455 dumblių taksonai. Upių fitoplanktone vyraavo *Bacillariophyceae* (42% viso rūšių skaičiaus) ir *Chlorophyceae* (atitinkamai 34%) klasių atstovai. Kitų klasių dumbliai upėse yra retesni: *Cyanophyceae* (13%), *Euglenophyceae* (7%), *Chrysophyceae* (2%), *Dinophyceae* (1,5%), *Cryptophyceae* (0,4%), *Xantophyceae* (0,2%). Didžiąją titnagdumblainių dalį (90%) sudarė *Pennales* eilės atstovai. *Centrales* eilės atstovų buvo gerokai mažiau. Iš žaliadumblainių tirtose vandentėkmėse didžiausia rūšių įvairovė išsiskyrė *Chlorococcales* eilė. *Zygnematales* taksonų įvairovė upėse buvo žymiai skurdesnė. Lietuvos vandentėkmėse planktoninės, bentosinės ir meroplanktoninės dumblių rūšys paplitusios santykiu 3:2:1. Planktoninių rūšių bendrijas sudaro limnoplanktoninės (30% viso rūšių kiekio), potamoplanktoninės (5%) ir indiferentinės (65%) rūšys. Didžiąją dalį (70%) upių fitoplanktono sudaro retos (diagnozuotos 1–10% vandentėkmių) dumblių rūšys. Euritopinės rūšys sudarė tik 7% visų rūšių. Dauguma jų (57%) yra indiferentinės, plačiai ežerų ir upių planktone paplitusios dumblių rūšys. Visos kitos rūšys yra būdingos vandentėkmių fitoplanktonui.