10.1515/botlit-2015-0013

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BOTANICA LITHUANICA
ISSN 2029-932X

2015, 21(2): 99–118

PHYTOBENTHOS CYANOBACTERIA SPECIES NEW TO LITHUANIAN RIVERS

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Abstract

Vitonytė I., Kasperovičienė J., 2015: Phytobenthos cyanobacteria species new to Lithuanian rivers [Naujos Lietuvos upėms fitobentoso melsvabakterių rūšys]. – Bot. Lith., 21(2): 99–118.

A total of 23 new to Lithuania cyanobacteria species were recorded in phytobenthos of 70 rivers in 2009–2011. New species belong to the *Chroococcales* and *Oscillatoriales* orders, 10 families and 12 genera. Descriptions of species morphology and original photos are presented; cyanobacteria's ecological groups and distributions are analysed. The paper contains information about the possibility of employment of new species as indicators for the assessment of ecological status of Lithuanian rivers.

Keywords: cyanobacteria, indicators, Lithuania, new species, river phytobenthos.

INTRODUCTION

Cyanobacteria are one of the numerous algal groups in river ecosystems. Benthic species have more morphological adaptations than planktonic; they form abundant populations on rocks, stones, slimy sands, macrophytes, on other macroalgae, also small populations could be found within mucilage of macroalgae. Species diversity can reach up to 56% of all algal records (Whitton, 2002; Komárek, 2003; Komárek et al., 2003). Unfortunately, data on phytobenthos cyanobacteria diversity and distribution in Lithuanian rivers are still sparse (Vailionis, 1930; Pocienė & Stočkus, 1987; Bakūnaitė & Kostkevičienė, 1998; Vitėnaitė, 2001; Vitonytė & Kostkevičienė, 2009). There are no comprehensive data on algal nutrient requirements and influence on individual cyanobacteria species growth in rivers. The data on benthic species in Lithuanian lakes and rivers are published in Karosienė (2003), Vitonytė & Kostkevičienė (2008), Karosienė & Kasperovičienė (2008, 2009), Kostkevičienė & Špakaitė (2009).

Cyanobacteria develop in rivers under different ecological conditions, therefore, some species are used for the assessment of the ecological status of rivers. Schaumburg et al. (2006), creating water quality assessment methods required by the Water Framework Directive of the European Union (EU WFD, 2000/60/EC), used phytobenthos parameters and included 36 cyanobacteria species in the list of water quality indicators. In accordance with their methods, eighteen species are used in the rivers assessment of the lowland calcareous region. Consequently, the same species can be also used for the evaluation of water quality of Lithuanian rivers. To date, there are no adequate research data on phytobenthos of Lithuanian rivers and it is complicated to distinguish and fill in the algal indicator list.

The aim of this study was to describe new to Lithuania cyanobacteria species. Descriptions of the morphology and original photos of 23 new species were given; cyanobacteria's ecological groups and distribution were analysed. Furthermore, the data of this paper include information concerning the new cyanobacteria involvement possibility into indicator species lists for the assessment of Lithuanian rivers.

MATERIALS AND METHODS

The studies on phytobenthos were carried out in 70 rivers of Lithuania from July to August in 2009−2011 (Table 1). A total of 226 samples were collected from different submerged substrates and preserved with 40% formaldehyde till final 4% concentration in the sample. River width and depth, current velocity, turbidity and transparency, riverbed meandering and naturalness, shading by riparian vegetation and substrate were visually evaluated *in situ* and described according to Schaumburg et al. (2006) protocol. Main average values of hydrological and hydrophysical-chemical data were taken from the database of Lithuanian Environmental Protection Agency (EPA) (Aplinkos Apsaugos Agentūra, 2005−2010, 2009).

Phytobenthos species were observed and their

Table 1. Lithuanian rivers investigated in 2009−2011

River	River number*	Study year	Coordinates of sampling site		River	River number*	Study year	Coordinates of sampling site	
			N	E				N	E
Aitra	[1]	2009	55º41’25”	22º01’50”	Notė	[36]	2009	56º05’32”	21º39’55”
Akmena-Danė	[2]	2010	55º57’26”	21º16’40”	Nova	[37]	2011	54º51’35”	22º56’42”
Alkupis	[3]	2009	55º44’00”	24º08’52”	Pelyša	[38]	2009	55º38’59”	25º06’10”
Ančia	[4]	2009	55º24’03”	22º33’31”	Peteša	[39]	2009	54º33’11”	25º18’38”
Apaščia	[5]	2009	56º23’49”	24º46’05”	Ringuva	[40]	2010	56º03’03”	22º58’21”
Armona	[6]	2010	55º11’34”	24º41’19”	Rudamina	[41]	2009	54º30’59”	25º15’26”
Ašva I	[7]	2009	56º20’35”	22º23’02”	Salantas	[42]	2009	56º02’43”	21º42’49”
Ašva II	[8]	2009	56º22’20”	22º18’29”	Saria	[43]	2010	55º03’19”	25º52’21”
Babrungas I	[9]	2009	55º53’08”	21º45’55”	Siesartis	[44]	2011	54º57’56”	22º57’29”
Babrungas II	[10]	2009	55º54’36”	21º46’05”	Strėva	[45]	2010	54º48’27”	24º16’56”
Baltoji Ančia	[11]	2009	53 57’21”	23º50’01”	Suraižos upelė	[46]	2009	55º19’46”	25º32’54”
Bartuva	[12]	2010	56º13’31”	21º32’24”	Šalčia	[47]	2009	54º20’30”	24º53’51”
Beržupis	[13]	2009	54º14’40”	24º34’28”	Šaltuona	[48]	2010	55º18’03”	23º00’39”
Bubinas	[14]	2009	56º04’26”	21º37’01”	Šeškinė	[49]	2009	55º23’08”	26º25’20”
Dysna	[15]	2009	55º24’28”	26º23’32”	Šešupė	[50]	2011	54º35’47”	23º23’05”
Dotnuvėlė	[16]	2010	55º21’34”	23º53’33”	Šešuvis	[51]	2009	55º12’52”	22º17’05”
Dubysa	[17]	2010	55º36’10”	23º04’53”	Širvinta	[52]	2011	54º36’53”	22º59’05”
Gauja	[18]	2009	54º10’23”	25º44’36”	Šyša I	[53]	2009	55º20’59”	21º30’30”
Jara-Šetekšna	[19]	2009	55º51’38”	25º18’26”	Šyša II	[54]	2009	55º20’03”	21º25’14”
Jūra	[20]	2010	55º33’00”	21º58’08”	Šušvė	[55]	2010	55º20’54”	23º39’28”
Jūrė	[21]	2011	54º44’08”	23º20’38”	Šventoji I	[56]	2009	55º37’01”	25º33’17”
Kamatis	[22]	2009	56º11’40”	24º22’21”	Šventoji II	[57]	2009	55º39’50”	25º10’59”
Kiršinas I	[23]	2009	55º39’19”	23º47’27”	Tatula	[58]	2009	56º07’22”	24º28’44”
Kiršinas II	[24]	2009	55º41’31”	23º56’12”	Varduva I	[59]	2009	56º19’48”	22º08’15”
Kražantė	[25]	2010	55º39’28”	23º00’06”	Varduva II	[60]	2009	56º24’55”	22º12’00”
Laukesa	[26]	2009	55º43’59”	26º15’38”	Veiviržas	[61]	2009	55º35’40”	21º35’32”
Lokysta	[27]	2009	55º28’49”	22º09’43”	Venta I	[62]	2010	56º24’58”	22º12’03”
Mera-Kūna	[28]	2010	55º01’15”	25º52’06”	Venta II	[63]	2009	56º20’22”	22º14’18”
Merkys I	[29]	2009	54º26’55”	25º30’11”	Verknė	[64]	2010	54º36’05”	24º05’26”
Merkys II	[30]	2009	54º18’23”	24º39’44”	Verseka I	[65]	2009	54º18’39”	24º48’04”
Minija	[31]	2010	55º44’22”	21º26’02”	Verseka II	[66]	2009	54º16’04”	24º48’49”
Mūša	[32]	2010	56º07’47”	23º29’18”	Virinta	[67]	2009	55º19’10”	25º25’18”
Nemunėlis	[33]	2009	56º22’04”	24º37’50”	Visinčia	[68]	2009	54º22’22”	25º13’58”
Nevėžis	[34]	2010	55º42’01”	24º25’59”	Žeimena	[69]	2009	55º04’57”	25º55’31”
Nikajus	[35]	2009	55º42’05”	26º08’20”	Žemoji Gervė	[70]	2009	56º21’10”	24º47’28”

* − river number used in descriptions of cyanobacteria distribution

abundance was estimated according to Gutowski et al. (2004) and Schaumburg et al. (2004, 2005, 2006) methodology based on a five-point scale as follows: (estimation *in situ*) 5 – species is dominant, cover 35–100% of the riverbed in sampling section; 4 – species is abundant, cover 5–35% of the riverbed; 3 – species is just visible, covers 5% of the riverbed; (estimation in the laboratory) 2 – species is microscopically abundant, many individuals; 1 – species is microscopically rare, several individuals. Morphological parameters of algae were analysed using light microscope Motic B3, photomicrographs were taken using a Moticam 2300 camera. The descriptions of new species include original photos, measurements of morphological parameters (length × width, μm), ecological group and species distribution in Lithuania. Ecological groups of new cyanobacteria were determined based on species attachment peculiarities to the substrate. Distribution patterns of new cyanobacteria were assigned into five groups as follows: very rare species found in < 2% of rivers, rare − 3−10%, frequent − 11−20%, common − 21−50%, very common − 51−100%. Two species of the *Homoeothrix* genera (species are marked with an asterisk, *) belong to different cyanobacteria families according to Komárek & Anagnostidis (2005).

Statistical analysis was performed using Brodgar 2.7.2 programme; multivariate redundancy analysis (RDA) was applied to evaluate the interaction between the abundance of new cyanobacteria and environmental variables of rivers. Specimens of phytobenthos are stored at the Herbarium of the Institute of Botany of the Nature Research Centre (BILAS) in Lithuania.

General characteristics of rivers

The investigation on phytobenthos was carried out in multiple rivers across Lithuania (Table 1). According to Schaumburg et al. (2006), small, narrow and shallow rivers with hardly noticeable or very slow current velocity were distinguished based on morphometric and hydrophysical parameters evaluated *in situ.* Medium-sized rivers were two times wider (up to 15 m) and deeper (0.15–0.50 m) than small, and were characterized by rapid or very rapid water flow. The maximum width of the large rivers was up to 30 m (rarely 50 m); rivers were distinguished by relatively slow current velocity and mostly moderate or strong water turbidity. In all rivers water transparency reached bottom, except the large rivers. Slimy sand (20−95% of the riverbed) or loam (30–95%) dominated in small rivers, in some places up to 30% the gravel occurred. In medium-sized rivers dominated coarse (gravel 20–90%, boulders up to 80%) and fine (sand 10–95%) sediments. In large riverbed, slimy sand, sand (50−100%) and gravel (up to 90%) prevailed; at some sites the boulders also occurred. Most of the investigated rivers (81−99%) were natural. The strongest (up to 95%) shading of the bank by riparian vegetation was observed in small rivers.

The small rivers were distinguished by the smallest (< 100 km^2), whereas the largest rivers – by the biggest (> 1000 km^2) catchment areas. Average annual temperature of the river water was 8.0−12.0ºC. Water was from neutral to slightly alkaline. Average annual values of pH 7.40−8.20 were measured. Water conductivity ranged between 264.0 and 934.3 μS/ cm, min. and max. values were determined in small and medium-sized rivers. The amount of suspended matter increased from 1.0 mg/l in the small to 32.3 mg/l in the large rivers. The dissolved oxygen concentration in the water was 8.0−11.0 mg/l, and BDS_7 values ranged from 1.5 to 4.0 mg/l. The average amount of total nitrogen (TN) gradually decreased from small (2.82 mg/l) to large (1.60 mg/l) rivers. Water status based on TN in about 29% of the investigated rivers corresponded to derived reference values (≤ 1.40 mg/l) as recommended in the national guidelines (Aplinkos Apsaugos Agentūra, 2010; Vaitiekūnienė et al., 2011). Based on total phosphorus (TP), 43% of the investigated rivers corresponded to the reference values (≤ 0.06 mg/l) (Aplinkos Apsaugos Agentūra, 2010; Vaitiekūnienė et al., 2011). The highest average amount of TP (0.108 mg/l) was observed in the smallest rivers; in the other rivers, TP was two or more times lower.

RESULTS AND DISCUSSION

A total of 149 phytobenthos species and intraspecific taxa, belonging to four divisions (*Cyanobacteria*, *Rhodophyta*, *Heterokontophyta*, *Chlorophyta*) were observed. Cyanobacteria were the most numerous (86 species) in the rivers, accounting for the 57.7% of all phytobenthos diversity. Twenty three species of cyanobacteria were new to Lithuania (accounted 15.4% of all recorded cyanobacteria). New species were widespread and occurred in all studied rivers. They were found in 215 samples (95%) of phytobenthos. The most common species of new cyanobacteria *Heteroleibleinia pusilla*, *H. ucrainica* and *H.* cf. *leptonema* were observed in more than a half samples, other species were found in less than 40 samples.

New species from the river benthos belong to *Chroococcales* and *Oscillatoriales* orders, 10 families and 12 genera. Cyanobacteria descriptions, photos, ecological preference and distribution in Lithuania are given below.

New to Lithuania cyanobacteria species from the river phytobenthos

CYANOPHYCEAE

Chroococcales

Merismopediaceae Elenkin 1933

Microcrocis obvoluta (Tiffany) Frank et Landman 1988 (Fig. 1)

Holopedium obvolutum Tiffany 1934; *Microcrocis dietelii* f. *obvoluta* (Tiffany) Fott 1972; *Microcrocis* sp. sensu Frank et Landman 1988 incl.

Colonies microscopic, plate-shaped, diameter of colony 56–81 μm. Cells elongate oval, rounded at both ends, in a plate located in irregular rows. Cells blue-green, (4.7–)5.1–6.3 × 2.5–5.1 μm. Epipelic, epipsamic species; found among *Oedogonium* spp. and *Spirogyra* spp. assemblages. Cyanobacterium common, found in [1, 4, 5, 6, 8, 10, 12, 19, 24, 26, 31, 34, 40, 42, 51, 53, 65] rivers.

Entophysalidaceae Geitler 1925

Chlorogloea microcystoides Geitler 1925 (Fig. 2)

Colonies microscopic, mucilaginous; surrounded by hardly visible mucilaginous sheath, within colony cells located in regular rows, in some places very densely. Cells without or with individual envelopes, which are distinct or hardly visible. Cells spherical, ellipsoidal, blue-green, 2.7–3.9(6.0) × 2.8–3.9(8.3) μm, content finely granulated. Epiphytic, grows on macrophytes; very rare, found in the Rivers Aitra and Šyša II.

Chamaesiphonaceae Borzí 1882

Chamaesiphon carpaticus Starmach 1929 (Fig. 3)

Colonies microscopic, solitary. Daughter cells are attached to the margin of mother cell mucilaginous sheath at the apical part, total height up to 101 μm. Sheath pale blue-green, at the apical part almost fully

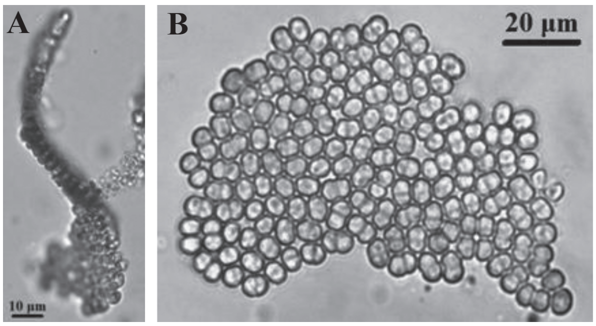

Fig. 1. *Microcrocis obvoluta* (A – Armona, 2010; B – Kiršinas II, 2009)

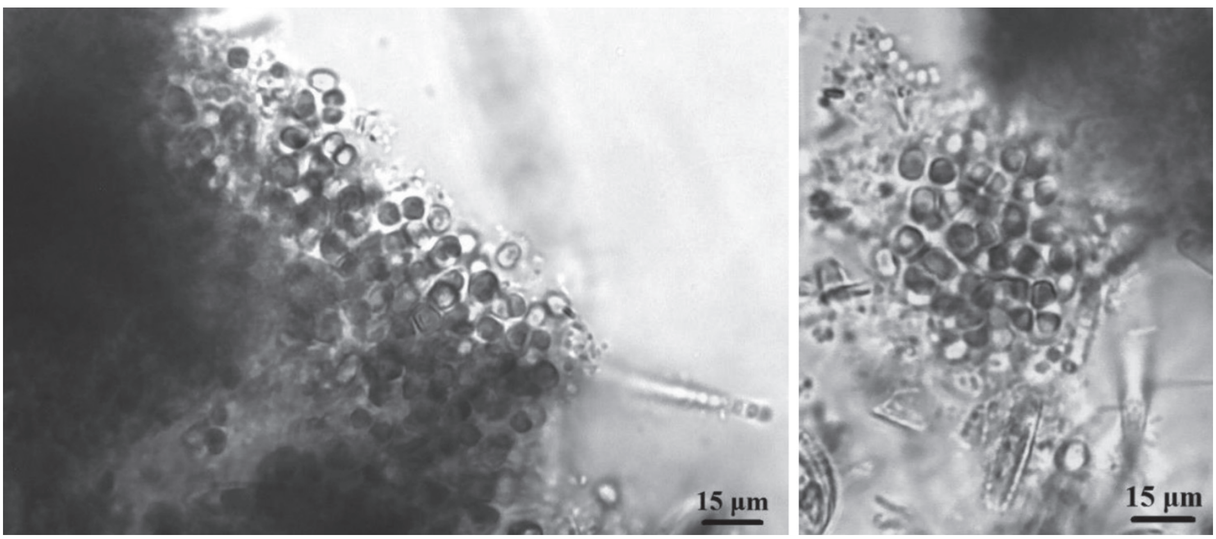

Fig. 2. *Chlorogloea microcystoides* (Šyša II, 2009)

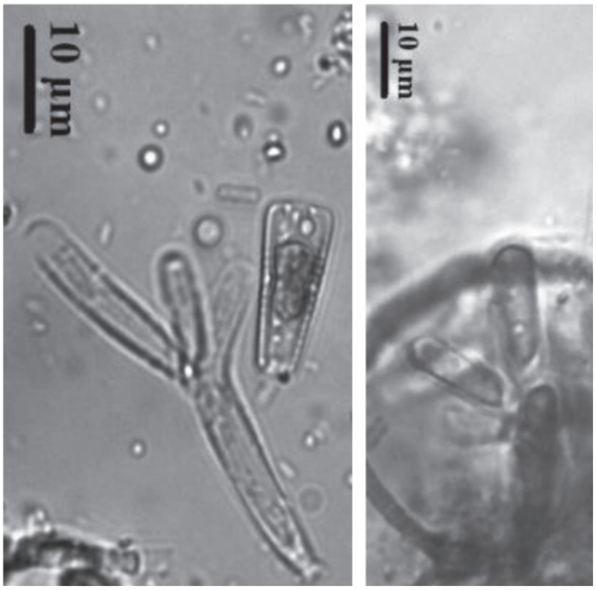

Fig. 3. *Chamaesiphon carpaticus* (Mera-Kūna, 2010)

closed. Cells narrow club-shaped, slightly curved, rounded at the ends and narrowed at the base, 22.8–25.3 × 3.8–5.1 µm. Epiphytic, grows on macroalgae; very rare, found only in the River Mera-Kūna.

Chamaesiphon confervicolus A.Braun in Rabenhorst 1865 (Fig. 4)

Brachythrix confervicola A.Braun in Rabenhorst 1865; *Chamaesiphon curvatus* Nordstedt 1878; *C. torulosus* Borzì 1882; *C. confervicolus* var. *curvatus* Borzì ex Hansgirg 1883

Colonies microscopic, solitary. Each cell individually attaches to substrate by mucilaginous sheath. Sheath narrow, colourless. Cells club-shaped, curved: at apical part slightly narrowed, at the base – gradually attenuated; cells in sheath located above cell attachment area. Cells blue-green, 21.4–23.0 × 3.1 µm. Right away forms 1–2 spherical (sometimes slightly compressed from the top) exocytes (1.5 × 3.1 µm); before opening of sheath exospores are aggregated at the apical part of mother cell, when sheath opens – they release. Epiphytic, grows on macroalgae. Cyanobacterium common, found in [9, 19, 22, 23, 28, 35, 39, 41, 43, 47, 51, 58, 65, 68, 69] rivers.

Chamaesiphon longus G.Hällfors et R.Munsterhjelm 1982 (Fig. 5)

Colonies microscopic, solitary. Each cell individually attaches by distinct gelatinous stack, which extend into the adhered disc. Cells are from dark purple to pale blue-green in colour. Cells cylindrical, straight or slightly curved, along its length gradually attenuated towards ends; sheath closed or opened. Cell length (incl. sheath) 55.7–93.6 µm (rarely opened sheaths can continue ~ 60 µm), without sheath – (20.3)25.3–60.7(78.4) µm. Cells width at the apical part (2.8–)3.8–6.3(–7.6) µm, at the base – 2.5–3.4 µm. Length and width ratio from 6.6 to 24.7. Forms one large exospore, (1.3)2.5–3.8 × 2.5(3.79) µm. Species grows in epiphyton with *Heteroleibleinia ucrainica*; rare, found in [28, 43, 47, 65] rivers.

Chamaesiphon cf. ***sideriphilus*** Starmach 1929 (Fig. 6)

Colonies solitary, microscopic. Each cell individually attaches by mucilaginous sheath. Sheath thick (0.3–1.5 µm), up to 13.9–23.0 µm length, opened, yellow-brown in colour. Cells cylindrical, slightly curved, blue-green, 7.0–15.0 × 1.5–3.1 µm; one exospore at the top, 1.6 × 1.5–3.1 µm. Epiphytic, grows

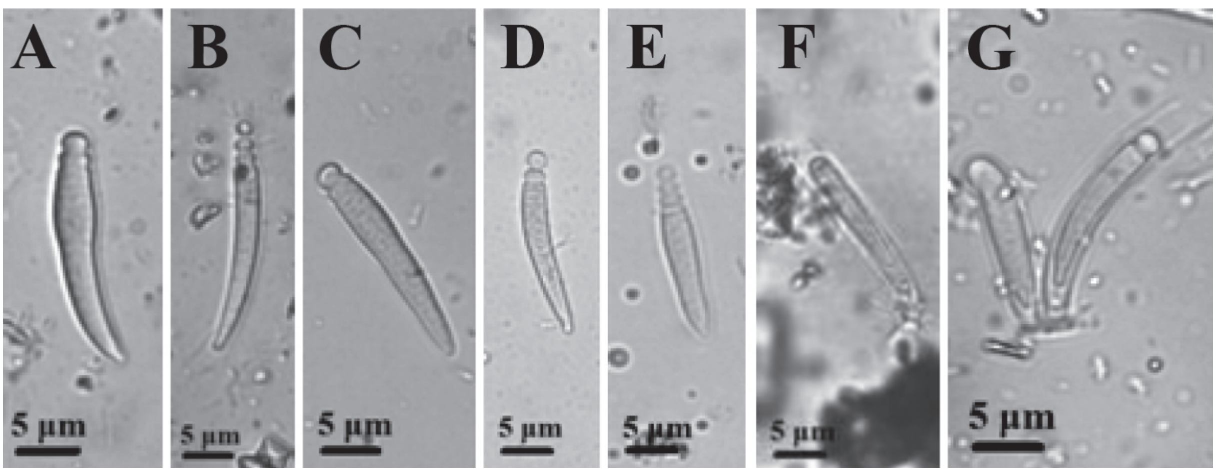

Fig. 4. *Chamaesiphon confervicolus* (A–E – Babrungas I, 2009; F – Verseka I, 2009; G – Mera-Kūna, 2010)

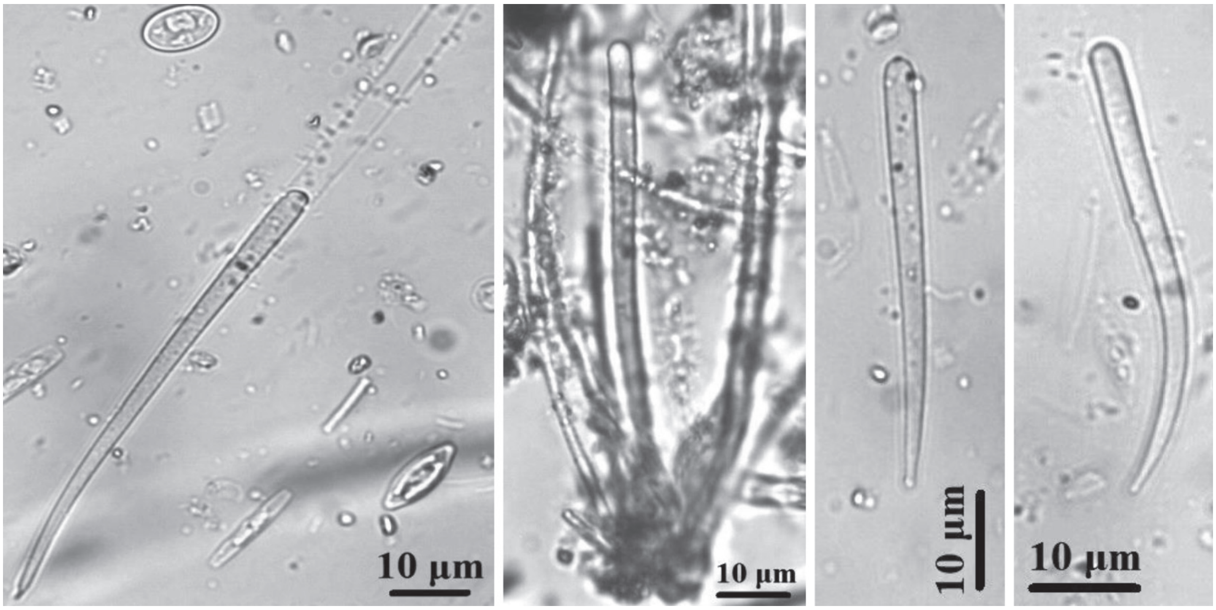

Fig. 5. *Chamaesiphon longus* (Šalčia, 2009)

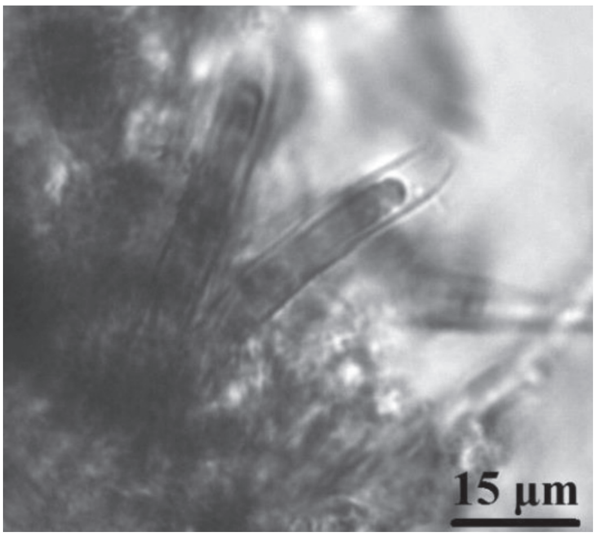

Fig. 6. *Chamaesiphon* cf. *sideriphilus* (Jara-Šetekšna, 2009)

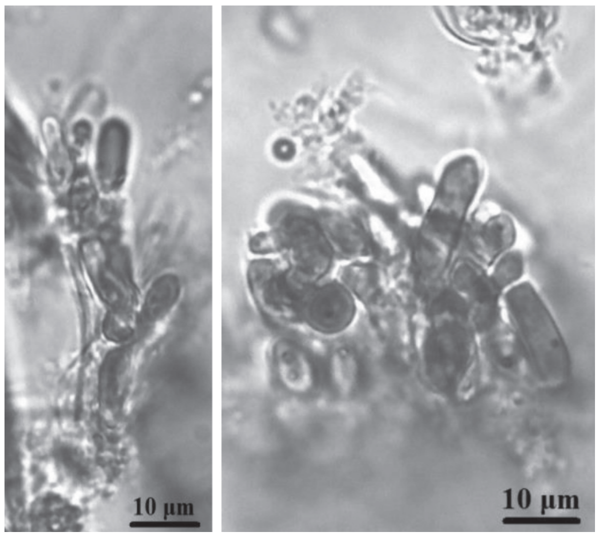

Fig. 7. *Chamaesiphon starmachii* (Šyša II, 2009)

on macroalgae; very rare, found only in the River Jara-Šetekšna.

Chamaesiphon starmachii Kann 1972 (Fig. 7)

Chamaesiphon fuscoviolaceus Starmach 1969, non *C. fuscoviolaceus* (Hansgirg) Margalef 1952

Colonies solitary, microscopic. Sheath thin, colourless, at the apical part wide-opened. Cells short, aggregated in several (till 3) layers perpendicularly. Some cells have one distinct granule at the base. Elongate cells blue-green, 9.2–16.5 × (3.1)4.3–5.1 µm. Exospores (1–2) spherical or rounded-polygonal; they are remaining adherent at the apical part of cell. Grows in epiphyton on macrophytes; very rare, found only in the River Šyša II.

Oscillatoriales

Pseudanabaenaceae Anagnostidis et Komárek 1988

Heteroleibleinia kuetzingii (Schmidle) Compère 1985 (Fig. 8)

Leibleinia martensiana Kützing 1845; *Lyngbya martensiana* Meneghini sensu Hansgirg 1892; *L. kuetzingii* Schmidle 1897; *L. kuetzingii* var. *minor*

Gardner 1927, *L. kuetzingii* f. *woronichinii* Elenkin 1949 incl.; non *L. kuetzingiana* Kirchner ex Hansgirg 1892

Filamentous microscopic; filaments short, straight, unbranched, attached by one end to substrate. Sheaths thin, colourless, not longer than trichome. Trichomes ungranulated, not constricted at translucent cross-walls. Cells bluish, (0.8)2.5–3.1 × 1.0–2.5 µm. Apical cell rounded, not attenuated, without calyptra or thickened cell wall. Epipelic and epiphytic on *Audouinella* spp., *Cladophora glomerata*, *Vaucheria sessilis*, macrophytes; frequent, found in [2, 3, 7, 12, 13, 21, 30, 37, 53, 54, 62] rivers.

Heteroleibleinia cf. ***leptonema*** (Skuja) Anagnostidis et Komárek 1988 (Fig. 9)

Lyngbya leptonema Skuja 1964

Filamentous microscopic, solitary or densely aggregated. Filaments 3.3–5.9(6.9) µm long, to substrate attached by one end. Cells pale blue or whitish colour, (0.8)2.5 × 0.6–0.9 µm. The apical cell rounded. Epiphytic on *Audouinella*, *Batrachospermum*, *Chroodactylon*, *Cladophora*, *Geitlerinema*, *Heteroleibleinia*, *Homoeothrix*, *Microspora*, *Mougeotia*, *Phormidium*, *Pseudanabaena* and *Vaucheria* species. Cyanobacterium very common, found in [1, 3−10, 12−16, 18−20, 22, 23, 25−38, 40−49, 51, 53−57, 59−63, 65−70] rivers.

Heteroleibleinia pusilla (Hansgirg) Compère 1985 (Fig. 10)

Lyngbya pusilla (Rabenhorst) ex Hansgirg 1892, sec. *Heteroleibleinia pusilla* (Hansgirg) Anagnostidis et Komárek 1988; *Lyngbya kuetzingii* var. *minor* Gardner sensu Hällfors 1984

Filamentous microscopic, solitary or densely aggregated. Filaments 15.2–33.7 µm long, width up to 0.9 µm, trichomes − pale blue-green. Filaments flexible, attached by one end to substrate. The apical cell rounded. Epiphytic on *Audouinella*, *Chamaesiphon*, *Cladophora*, *Heteroleibleinia*, *Homoeothrix*, *Microspora*, *Oedogonium*, *Phormidium*, *Tolypothrix* and *Vaucheria* species. Cyanobacterium very common, found in [1−16, 19, 20, 22, 23, 25−27, 29−41, 43−49, 51, 53−55, 57−62, 64, 66−70] rivers.

Heteroleibleinia ucrainica (Širšov in Elenkin) Anagnostidis et Komárek 1988 (Fig. 11)

Lyngbya kuetzingii var. *ucrainica* Širšov in Elenkin 1949; *L. kuetzingii* f. *ucrainica* (Širšov) Elenkin 1949

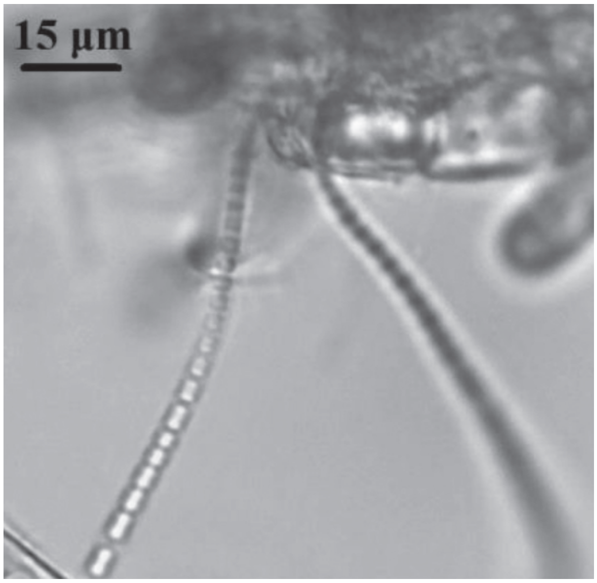

Fig. 8. *Heteroleibleinia kuetzingii* (Beržupis, 2009)

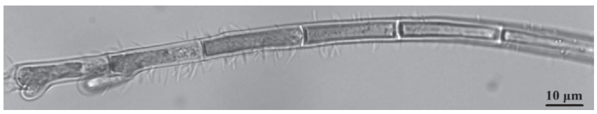

Fig. 9. *Heteroleibleinia* cf. *leptonema* on the filament of *Audouinella hermannii* (Beržupis, 2009)

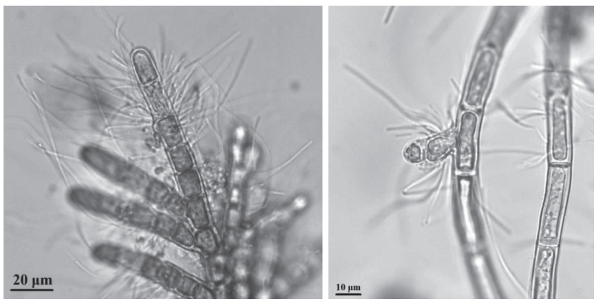

Fig. 10. *Heteroleibleinia pusilla* on the filament of *Audouinella* sp. (Beržupis, 2009)

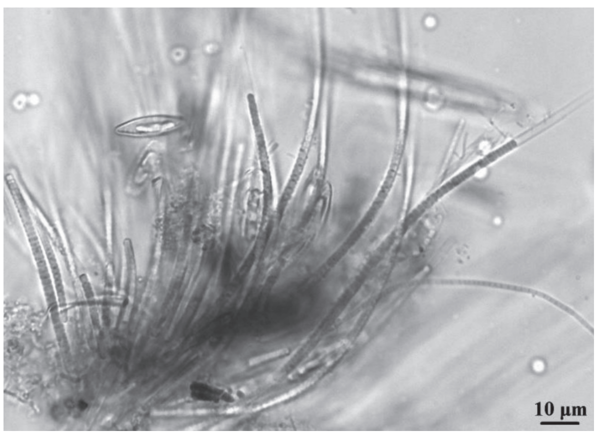

Fig. 11. *Heteroleibleinia ucrainica* (Šyša II, 2009)

Filamentous macroscopic; epilithic or epiphytic populations mucilaginous, visible to the naked eye. Filaments straight, sometimes slightly curved at the base, unbranched, attached by one end to substrate. Filaments not attenuated towards the ends. Sheaths very thin, colourless. Trichomes without granulation; distinctly constricted at the translucent cross-walls. Cells pale blue-green, (1.0–)1.4–1.6(–1.9) × 1.9–2.2 µm. Apical cell rounded, without calyptra or thickened cell wall. Epipelic and epiphytic on macroalgae (*Audouinella* spp., *Cladophora glomerata*, *Oedogonium* spp., *Rhizoclonium hieroglyphicum, Vaucheria sessilis*), macrophytes; very common, found in [1, 4−6, 8−14, 16−20, 22, 23, 25, 26, 28−30, 32−34, 36−45, 47, 48, 50−58, 60−69] rivers.

Homoeothrix crustacea* Voronichin 1923 (Fig. 12)

Homoeotrix globulus Voronichin 1932, incl.; *H. woronichinii* Margalef 1953; non *H. crustaceae* (Borzì) Margalef 1953

Filamentous macroscopic, unbranched and solitary, aggregated in small groups or tufts, length up to 114 µm. Filaments flexible, distinctly constricted at cross-walls, attached by one end to substrate. Trichomes with thin smooth and whitish or bright sheaths, in old filaments sheaths at the base empty. Trichome attenuated at both ends: gradually in apical part, strikingly – at the base. Cells blue-green (1.1–2.2 × 2.4–2.7 µm) and short, barrel-cylindrical shape, sometimes at the base up to two times longer than width. Cells in apical part 0.8–3.0 × 1.6–2.2 µm, ending in a fragile hair, at the base 1.3–2.8 × 1.3–2.5 µm. Grows on stones, *Audouinella* spp. and *Cladophora glomerata* thallus; in epilithon and epiphyton grows with *Audouinella hermannii*, *Heteroleibleinia ucrainica*, *Rivularia dura*. Cyanobacterium frequent, found in [6, 9, 26, 29, 32, 48, 51, 61, 66, 67, 69, 70] rivers.

Leptolyngbya batrachosperma Anagnostidis 2001 (Fig. 13)

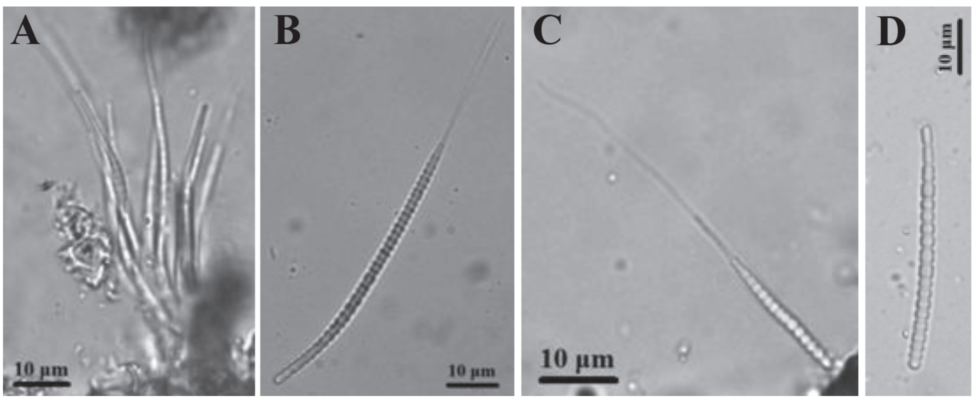

Fig. 12. *Homoeothrix crustacea* (A, B – Laukesa, 2009; C – Žeimena, 2009; D – Mūša 2010)

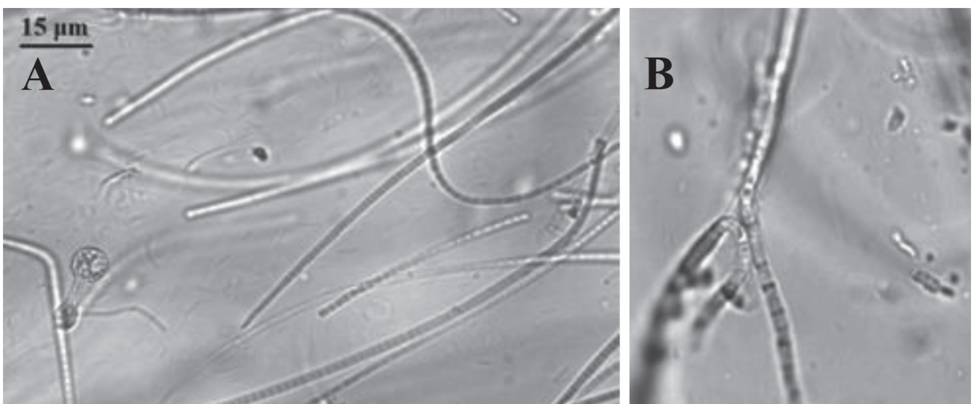

Fig. 13. *Leptolyngbya batrachosperma* (A – Žemoji Gervė, 2009; B – Babrungas I, 2009)

Lyngbya rivularianum Gomont sensu Skuja 1926

Filaments microscopic, pseudobranched, slightly attenuated at the ends. Trichomes flexuous, slightly constricted at cross-walls. Sheaths thin, colourless. Cells light blue in colour, 0.8–1.3 × 2.0–2.5 µm. The apical cell not attenuated, rounded. Species grows within the mucilage of *Batrachospermum arcuatum* and *B. gelatinosum*; rare, found in [1, 9, 35, 36, 70] rivers.

Leptolyngbya cf. ***gloeophila*** (Kützing ex Hansgirg) Komárek in Anagnostidis 2001 (Fig. 14)

Lyngbya gloeophila (Kützing) Hansgirg ex Hansgirg 1892; invalid name in respect to *Leptolyngbya gloeophila* (Borzì) Anagnostidis et Komárek 1988

Filaments microscopic, solitary aggregated. Trichomes unbranched, with thin sheaths. Cells pale blue, isodiametric – 1.5 µm. The apical cell rounded. Species grows within *Chaetophora incrassata* mucilage and among *Gloeotrichia natans* colonies; very rare, found in the Rivers Nemunėlis and Žeimena.

SCHIZOTRICHACEAE Elenkin 1934

Schizothrix cf. ***facilis*** (Skuja) Anagnostidis 2001 (Fig. 15)

Schizothrix lacustris var. *facilis* Skuja 1964

Colonies microscopic; filaments pseudobranched, containing 1–2 trichomes in large up to 2.6 µm width sheaths. Sheaths bright blue, yellow to brownish; gradually attenuated towards the ends, sometimes they parallel lamellate; in young stages sheaths colourless. Trichomes at cross-wall not or scarcely constricted.

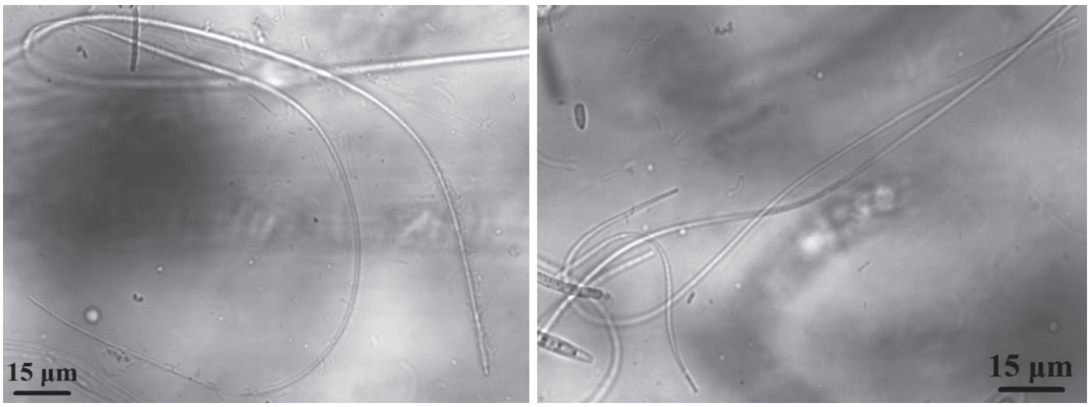

Fig. 14. *Leptolyngbya* cf. *gloeophila* (Nemunėlis, 2009)

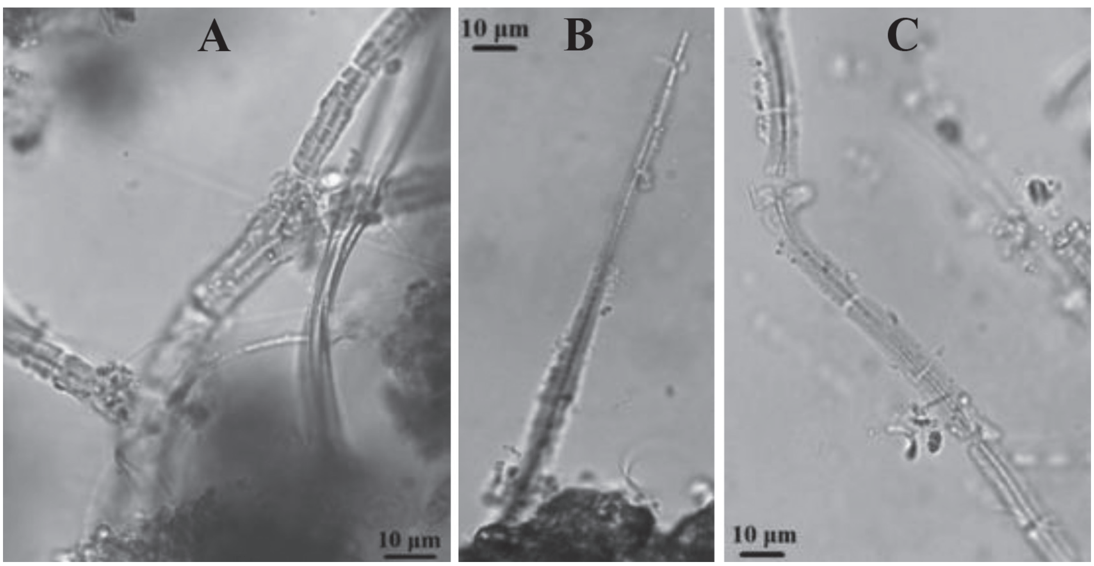

Fig. 15. *Schizothrix* cf. *facilis* (A – Šaltuona, 2010; B, C – Peteša, 2009)

Cells pale blue-green, cylindrical, (2.5–)5.3–12.0 × (0.9)1.3–1.7 μm. Apical cell obtuse-rounded. Epiphytic, grows with *Cladophora glomerata* on macrophytes. Cyanobacterium frequent, found in [13, 20, 32, 39, 43, 48, 49, 51, 57, 67, 68] rivers.

BORZIACEAE Borzì 1914

Komvophoron schmidlei (Jaag) Anagnostidis et Komárek 1988 (Fig. 16)

Pseudanabaena schmidlei Jaag 1938; incl. *P. schmidlei* f. *gracilis* Skuja 1949

Colonies macroscopic; filamentous bright blue in colour, length up to 848 μm; trichomes at the cross-walls strongly constricted. In the trichomes well distinguished centro- and chromatoplasma, isthmus interval from 0.8 to 1.2 μm. Cells short, barrel shaped, (4.8–)5.1–8.9 × 5.31–8.9 μm. Apical cell cylindrical or lengthened-conical, abruptly attenuated, 7.6 × 5.3 μm. Epipelic, epipsamic species; found among other macroalgae (*Cladophora glomerata*, *Geitlerinema splendidum*, *Oedogonium* spp., *Oscillatoria ornata*, *Phormidium amoenum*, *P. autumnale*, *P. subfuscum*, *P. uncinatum*, *Ulva flexuosa*). Cyanobacterium common, found in [4, 6, 8−10, 12, 23, 24, 26, 28, 30, 34, 35, 38, 40, 45, 47, 59, 60, 62, 64, 65, 66, 68] rivers.

PHORMIDIACEAE Anagnostidis et Komárek 1998

Phormidium cf. ***corium*** Gomont 1892 (Fig. 17)

Lyngbya corium (Agardh) ex Hansgirg 1892; *Lyngbya paulistana* Senna 1983; *Phormidium corium* f. *woronichiniana* Elenkin 1949; *P. corium* fa. sensu Anagnostidis 1961

Colonies microscopic; filaments with thin sheaths, not attenuated. Trichomes at cross-walls transparent, ungranulated. Cells blue-green, (2.5–)3.9–6.7(7.5) × 3.2–5.6 μm. Apical cell rounded, without thickened cell wall. Epipelic, epiphytic species; in epiphyton it grows with *Phormidium autumnale*. Cyanobacterium rare, found in [2, 20, 28, 43, 48] rivers.

Phormidium stagninum Anagnostidis 2001 (Fig. 18)

Lyngbya stagnina Kützing ex Gomont 1892 sensu auct.

Filaments macroscopic with thick and distinct sheaths, up to 0.63 μm thick. Sheaths colourless or slightly yellowish. Cells slightly granulated near the cross-walls, unconstricted. Cells 2.53–3.96 × 7.92–8.86 μm. The apical cell widely rounded, without thickened cell wall. Grows in epipelon and epiphyton (on macrophytes) with *P. tinctorium*; very rare, found in the Rivers Kiršinas I and Venta I.

Phormidium tinctorium Kützing ex Gomont 1892 (Fig. 19)

Lyngbya tinctoria (Kützing) Kirchner ex

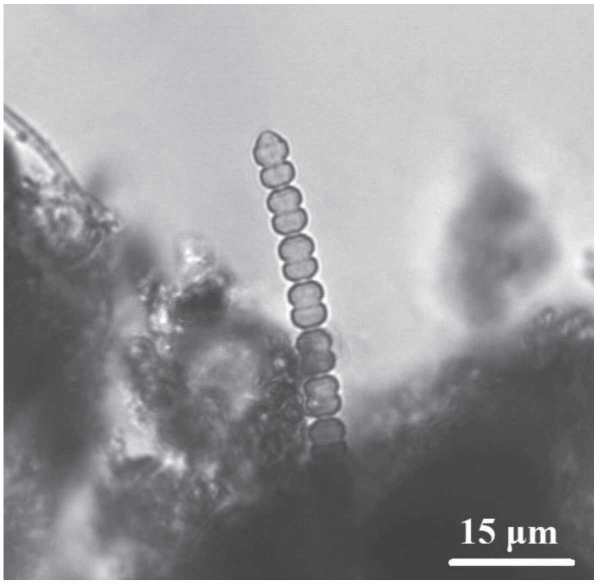

Fig. 16. *Komvophoron schmidlei* (Kiršinas II, 2009)

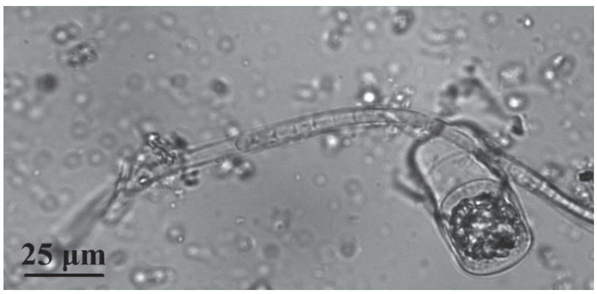

Fig. 17. *Phormidium* cf. *corium* (Mera-Kūna, 2010)

Fig. 18. *Phormidium stagninum* (Kiršinas I, 2009)

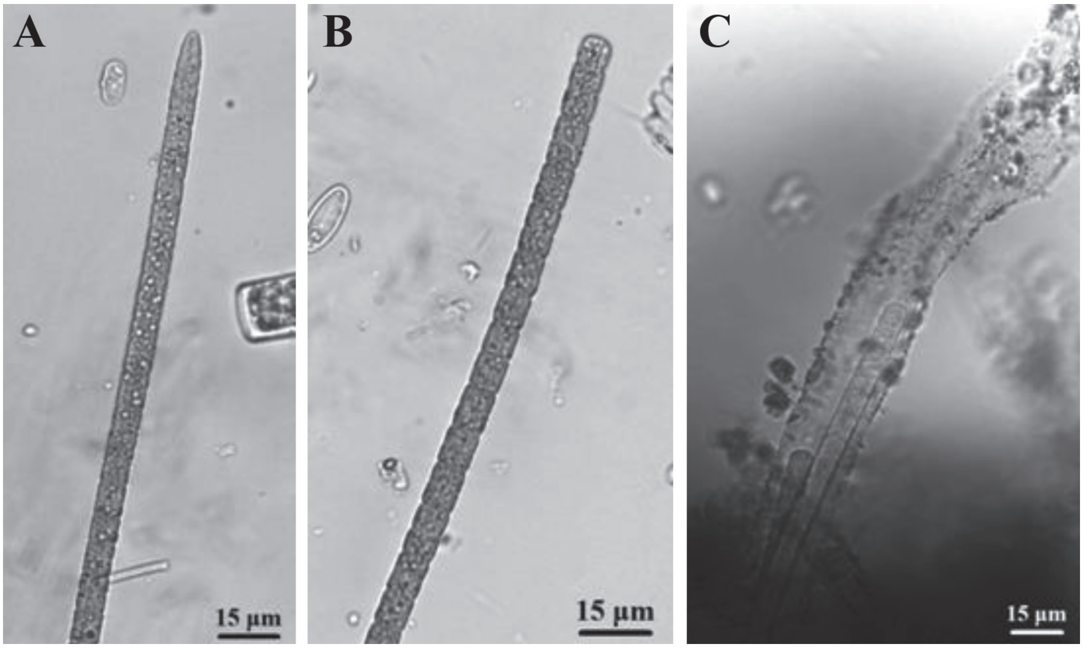

Fig. 19. *Phormidium tinctorium* (A, B – Kiršinas I, 2009; C – Verknė, 2010)

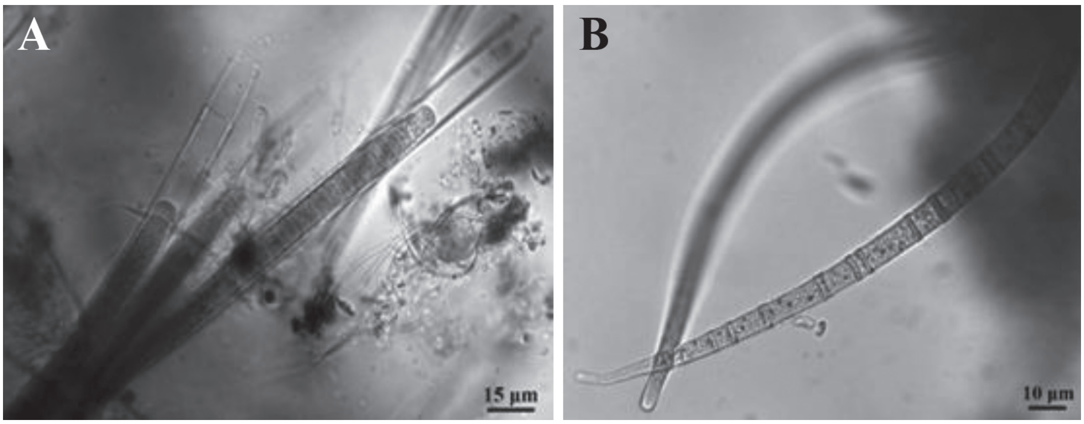

Fig. 20. *Homoeothrix juliana* (A – Dysna, 2009; B – Bartuva, 2010)

Forti 1907, sec. Compère; *P. tinctorium* var. *naegelianum* Kützing 1849 incl.

Filamentous macroscopic, dark blue-green in colour; sometimes twisted into strands. Filaments aggregated in firm gelatinous thallus with strongly mucilaginous or indistinct sheaths (1.0–1.3 µm thick), filaments aggregated in tufts thallus – without sheath. Trichomes near cross-walls distinctly constricted. Cells from pale to dark blue-green, rarely to dark-purple; isodiametric or slightly longer than width, (3.8–)5.1–7.9 × 5.7–7.9 µm, content finely granulated. Apical cell acute-conical, without calyptra. Species grows in epipelon, epilithon, epiphyton and epidendron with *Microcoleus subtorulosus*, *Phormidium retzii*; common, found in [5, 9, 15, 21, 23, 26, 28, 31, 36, 39, 45−47, 51, 55, 59, 61−64, 66] rivers.

Oscillatoriaceae (S.F.Gray) Harvey ex Kirchner 1898

Homoeothrix juliana* (Bornet et Flahault) Kirchner 1898 (Fig. 20)

Lyngbya juliana Meneghini 1841; *Calothrix juliana* Bornet et Flahault 1886; *Lyngbya paludinae* (Wittrock) ex Hansgirg 1892

Colonies microscopic; filaments dark blue-green, unbranched, up to 240 µm length, and gradually attenuated at the apical part, widened – at the base. Sheaths thick, 0.6–1.3(2.5) µm, distinct, from whitish to yellowish in colour. Cells 10.1 × (3.4)8.9–12.7 µm. Apical cells 3.1 × 2.3 µm, obtuse, gradually attenuated and sometimes ending into hair. Epilithic, epiphytic species (on *Scytonema crispum*, macrophytes); in epilithon grows with *Rivularia dura*. Cyanobacterium rare, found in [9, 10, 12, 15, 33, 35] rivers.

Nostocales

Scytonemataceae (Kützing) Elenkin

Scytonema crispum (C.Agardh) Bornet 1889 (Fig. 21)

Scytonema cincinnatum (Thuret 1875) Bornet et Flahault 1886

Filaments macroscopic, blue-green in colour, pseudobranched, 22.8–27.8 µm width. Yellow sheaths thick, distinctly lamellate. Trichomes strongly constricted at the cross-walls. Cells 3.8–6.3 × 17.7–22.8 µm. Heterocystes shortly cylindrical, 11.6–30.4 × (13.9)17.7–20.2 µm. Species epiphytic (on macrophytes), grows with *Rhizoclonium hieroglyphicum*; very rare, found only in the River Nemunėlis.

Rivulariaceae (Meneghin) Elenkin

Calothrix cf. ***fusca*** (Kützing) Bornet et Flahault 1886 (Fig. 22)

Mastichothrix fusca Kützing

Filaments microscopic, solitary; gradually attenuated towards the ends, at apical part ending into a long hair. Trichomes at cross-wall not or scarcely constricted, colourless sheaths – parallel lamellate. Cells blue-green, 3.8–6.3 × 7.6–12.7 µm. Heterocytes basal, (5.1)6.3–7.6 × (5.1)10.1–13.9 µm. Epipelic, epilithic and endogloeic species; grows within *Chaetophora elegans* thallus. Cyanobacterium very rare, found in the Rivers Babrungas II and Žeimena.

Calothrix ramenskii Elenkin 1922 (Fig. 23)

Filaments microscopic, solitary; gradually attenuated towards the ends. Trichomes unconstricted at cross-wall; colourless sheaths – parallel lamellate. Cells short, 3.8 × 34.2 µm. Heterocytes basal, 7.6 × 22.8 µm. Epiphytic species, grows on *Scytonema crispum* thallus; very rare, found only in the River Nemunėlis.

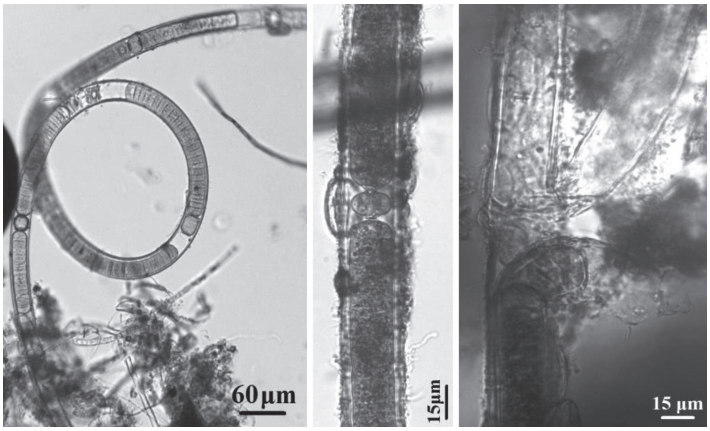

Fig. 21. *Scytonema crispum* (Nemunėlis, 2009)

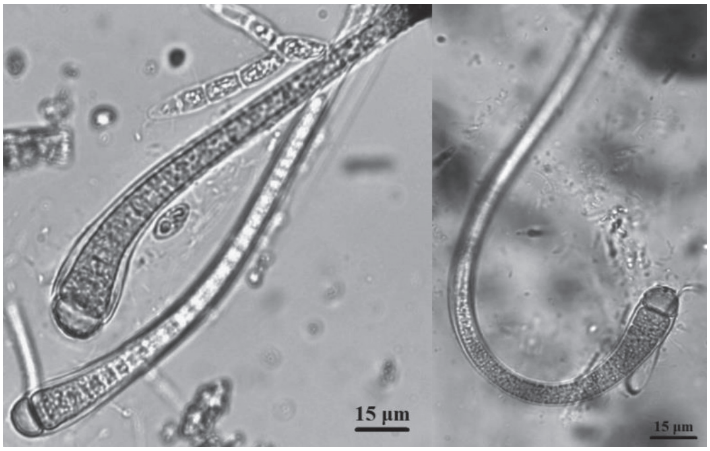

Fig. 22. *Calothrix* cf. *fusca* (Babrungas II, 2009)

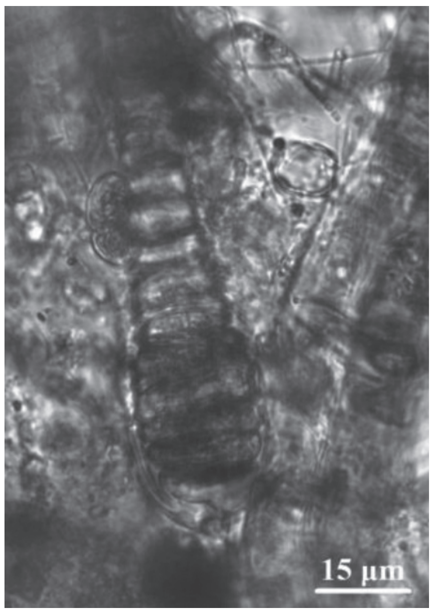

Fig. 23. *Calothrix ramenskii* (Nemunėlis, 2009)

Ecological groups of new cyanobacteria

Cyanobacteria are well adapted to develop in running waters by attaching different types of substrate. Therefore, most of the new to Lithuania cyanobacteria (11 species) were found on two types of substrate. As a result, species development in rivers largely depended on the presence of the substrate. Only two species *Phormidium tinctorium* and *Calothrix* cf. *fusca* were observed from up to four substrates. Ten recorded cyanobacteria species were found growing on only one substrate. Half of these species develop in different biotopes in almost all temperate zones (Komárek & Anagnostidis, 1998, 2005). The other five cyanobacteria are also specific to their substrate in Europe. For example, *Leptolyngbya batrachosperma*, *L.* cf. *gloeophila* are only endogloeic species (growing within mucilage of *Batrachospermum*, green algae and other cyanobacteria), *Chamaesiphon longus*, *C.* cf. *sideriphilus* – epiphytic (growing on *Cladophora*, *Oedogonium*, *Vaucheria*, etc. macrophytes) and *Chamaesiphon starmachii* – epilithic species (Elenkin, 1938, 1949; Gollerbah et al., 1953; Komárek & Anagnostidis, 1998, 2005). However, the latter species was epiphytic on macrophytes in Lithuanian rivers.

Most of cyanobacteria (18 species) were epiphytic, nine species − epipelic and five – epilithic. Only three cyanobacteria were endogloeic, two – epipsamic and one – epidendric. The most widespread in rivers were epiphytic species. Despite the fact that some cyanobacteria *Heteroleibleinia pusilla*, *H.* cf. *leptonema* and *H. ucrainica* were very common, found in 80−86% of the studied water bodies, their abundance was one point scale. Only the latter species abundance in phytobenthos sometimes reaches three point scale. Epiphytic *Chamaesiphon confervicolus*, *Schizothrix* cf. *facilis*, *Phormidium tinctorium*, *Heteroleibleinia kuetzingii* cyanobacteria were up to five times less frequent in rivers, though their abundance reaches up to two point scale.

Common epipelic species *Komvophoron schmidlei* and *Microcrocis obvoluta* were recorded in 33−41% of the studied rivers. The abundance varied from one to three point scale depending on current velocity of the rivers. *Komvophoron schmidlei* is also very common in epipelon of European rivers, sometimes is found in meroplankton (Starmach, 1966; Komárek & Anagnostidis, 2005; Komárek et al., 2003; Hašler & Poulíčková, 2010). According to Komárek & Anagnostidis (1998) and Komárek (2003), *Microcrocis obvoluta* is rare species in Europe, found only in the Netherlands and deserves more attention.

The most widespread from epilithic cyanobacteria were *Homoeothrix crustacea* and *Phormidium tinctorium*, they were found in seven and five Lithuanian rivers, respectively. These species are also common in epilithon of European lotic ecosystems (Elenkin, 1949; Gollerbah et al., 1953; Starmach, 1966; Pentecost, 1988; Whitton, 2002; Komárek & Anagnostidis, 2005). *P. tinctorium* was less prevalent in the studied rivers, however, species abundance reached up to four point scale in phytobenthos. In contrary, the abundance of *Homoeothrix crustacea* in all rivers was only one point scale.

The studies on ecological groups of new cyanobacteria showed that epiphytic species were more prevalent (78% vs 57%) in Lithuanian rivers, than epilithic ones (22% vs 48%) compared to the other European freshwaters (Komárek & Anagnostidis, 1998, 2005; Whitton, 2002; Komárek, 2003, 2013; etc.). Differences in the data were determined by morphological-hydrological peculiarities of the studied rivers. Epiphytic species were dominant in rivers, because macrophytes, water moss and macroalgae are successfully developing in rapid flowing Lithuanian waters. Whereas numerous epipelic species in Lithuania occurred mostly in large rivers characterized by slow current velocity, where slimy sand dominated.

Occurrence of new cyanobacteria

A large number of new cyanobacteria species found during the investigations of benthic algae are resulting from insufficient studies of phytobenthos in Lithuanian rivers. Ten species of cyanobacteria were frequent–very common as well as in Europe (Fig. 24) (Komárek & Anagnostidis, 1998, 2005; Whitton, 2002; Cărăuş, 2003, 2012; Komárek, 2003, 2013; Guiry & Guiry, 2011; Nowicka-Krawczyk & Żelazna-Wieczorek, 2013; etc.). Thirteen new species were very rare, rare in Lithuanian rivers and seven of these are also rare in European freshwaters.

Most of frequent–very common cyanobacteria in Lithuania, e.g. *Chamaesiphon confervicolus*, *Heteroleibleinia kuetzingii*, *H. pusilla*, *Homoeothrix crustacea*, *Komvophoron schmidlei*, *Phormidium tinctorium* are also very widespread in Europe (Pfister, 1992; Cantoral Uiza & Aboal Sanjurjo, 2001; Whitton, 2002; Barranguet et al., 2005; Hašler et al., 2008; Hašler & Poulíčková, 2010;

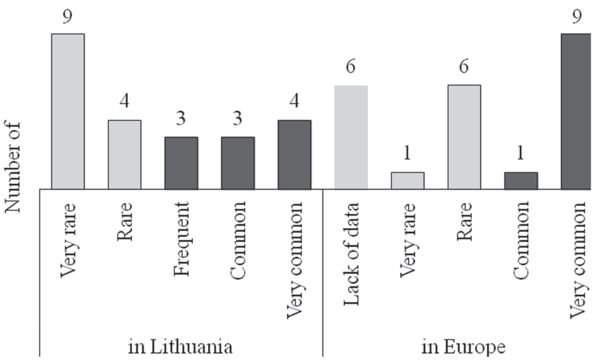

Fig. 24. The occurrence of benthic cyanobacteria in Lithuania and Europe. A group of very rare, rare species (▫) and frequent–very common (■)

Kaštovský et al., 2010; Nowicka-Krawczyk & Żelazna-Wieczorek, 2013; etc.). These species formed two–four point scale populations in phytobenthos. *Heteroleibleinia ucrainica* and *Schizothrix* cf. *facilis* were rare in Europe (Starmach, 1966; Cărăuș, 2003, 2012; Komárek et al., 2006); for *Heteroleibleinia* cf. *leptonema* and *Microcrocis obvoluta* no occurrence data were found (Komárek & Anagnostidis, 1998, 2005; Komárek, 2003). The abundance of these species population in Lithuania reaches two–three point scale.

A very rare, rare new cyanobacteria recorded in Lithuanian rivers, e.g. *Calothrix* cf. *fusca*, *C. ramenskii*, *Chamaesiphon carpaticus*, *C. starmachii*, *Scytonema crispum* are also rarely observed in Europe (Whitton et al., 1998; Cărăuș, 2003, 2012; Guiry & Guiry, 2011; Täuscher, 2011; Komárek, 2013), their estimated abundance reached one point scale. In contrast to Lithuania, the other rare cyanobacteria *Chlorogloea microcystoides*, *Phormidium* cf. *corium*, *P. stagninum*, *Homoeothrix juliana* were widespread in freshwaters of Europe (Aboal et al., 1996; Whitton et al., 1998; Bárbara et al., 2003; Cărăuș, 2003, 2012; etc.). Only the *Phormidium stagninum*, *Homoeothrix juliana* abundance reached up to three point scale in Lithuanian rivers. Cyanobacteria *Chamaesiphon* cf. *sideriphilus*, *C. longus*, *Leptolyngbya batrachosperma*, *L.* cf. *gloeophila* population abundance was very low (one point scale). No occurrence data of these species in Europe were found (Elenkin, 1938, 1949; Gollerbah et al., 1953; Komárek & Anagnostidis, 1998, 2005).

The occurrence data of new cyanobacteria species show that likewise in Lithuania most of frequent–very common and some very rare, rare species are frequent and common in European freshwaters. Taking into account the distribution of most of rare cyanobacteria in our region, they are also rare in Europe due to peculiarities of species development − some cyanobacteria grow mainly in rivers of good water quality. Furthermore, rare species occur only in mucilage of also rare macroalgae species in Europe (Komárek & Anagnostidis, 1998, 2005; Komárek et al., 2003; Hašler & Poulíčková, 2010; etc.).

Ecology of new cyanobacteria

New to Lithuania cyanobacteria are freshwater species, most of these (44%) are adapted to develop in different types of water bodies (rivers, streams, lakes, ponds, etc.), only *Chamaesiphon confervicolus* grows in slightly brackish waters. Special attachment structures of species such as *Chamaesiphon confervicolus*, *C. starmachii*, *Chlorogloea microcystoides*, *Heteroleibleinia kuetzingii*, *H. pusilla*, *Komvophoron schmidlei*, *Phormidium* cf. *corium*, *P. stagninum*, *Schizothrix* cf. *facilis* and *Scytonema crispum* lead to be prevalent in Europe (Elenkin, 1938, 1949; Gollerbah et al., 1953; Starmach, 1966; Komárek & Anagnostidis, 1998, 2005; Nowicka-Krawczyk & Żelazna-Wieczorek, 2013; etc.). Cyanobacteria *Calothrix ramenskii*, *Chamaesiphon* cf. *sideriphilus* and *Heteroleibleinia* cf. *leptonema* are more widespread in stagnant waters: lakes, ponds, swamps. According to literature, seven species (*Chamaesiphon carpaticus*, *C. longus*, *Heteroleibleinia ucrainica*, *Homoeothrix crustacea*, *H. juliana*, *Microcrocis obvoluta*, *Phormidium tinctorium*) are characteristic of running waters (Pentecost, 1988; Komárek & Anagnostidis, 1998, 2005; Whitton, 2002; Komárek, 2003).

Applying multivariate redundancy analysis (RDA), the interaction between the abundance of new cyanobacteria and environmental variables of rivers was evaluated (Fig. 25). The first two axes explain 53.42% of environmental variables and species repartition. Substrate boulders (F = 2.052, $p < 0.01$) and total nitrogen (TN) (F = 1.733, $p < 0.05$) were the most important factors influencing cyanobacteria abundance and distribution in the rivers. The investigated rivers were divided into two clusters in RDA triplot. The first cluster marked with gray arrow in a triplot, mostly consists

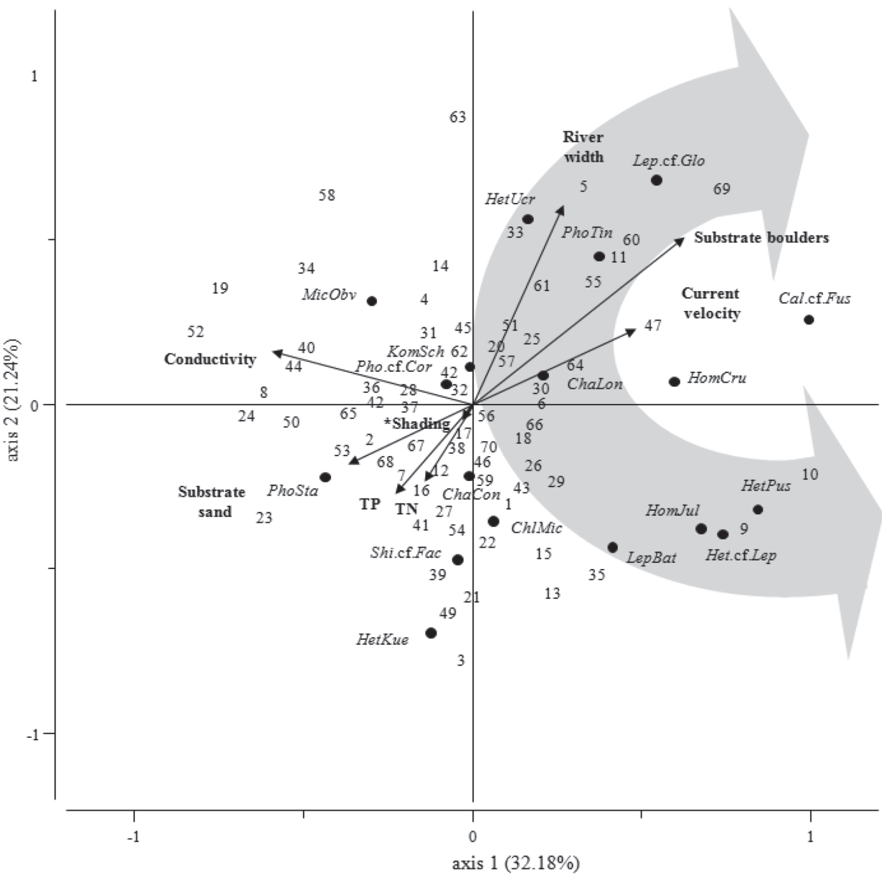

Fig. 25. Redundancy analysis (RDA) triplot showing interaction between diversity, abundance and distribution of cyanobacteria, and morphometric, hydrological, hydrophysical-chemical parameters of rivers

Abbreviations. Cyanobacteria species: *Cal.*cf.*Fus* − *Calothrix* cf. *fusca*, *ChaCon* − *Chamaesiphon confervicolus*, *ChaLon* – *C. longus*, *ChlMic* − *Chlorogloea microcystoides*, *Het.*cf.*Lep* – *Heteroleibleinia* cf. *leptonema*, *HetKue* – *H. kuetzingii*, *HetPus* – *H. pusilla*, *HetUcr* – *H. ucrainica*, *MicObv* − *Microcrocis obvoluta*, *HomCru* − *Homoeothrix crustacea*, *HomJul* – *H. juliana*, *KomSch* − *Komvophoron schmidlei*, *LepBat* − *Leptolyngbya batrachosperma*, *Lep.*cf.*Glo* – *L.* cf. *gloeophila*, *Pho.*cf.*Cor* − *Phormidium* cf. *corium*, *PhoSta* – *P. stagninum*, *PhoTin* – *P. tinctorium*, *Sch.*cf.*Fac* − *Schizothrix* cf. *facilis*; number – river number (see Table 1); *shading – shading of the bank by riparian vegetation; nutrients: TN − total nitrogen, TP – total phosphorus; gray arrow – rivers of good ecological status based on TN and TP amount.

of rivers characterized by rapid water flow, coarse sediments (boulders up to 80%) and relatively low amounts of TN and TP, 0.432−2.968(3.948) and 0.031−0.082(0.128) mg/l, respectively. Ten new cyanobacteria species located in the same cluster show their adaptation to grow in rivers of good ecological status. The second cluster of the triplot was located on the opposite side of the triplot (Fig. 25). This cluster mostly consists of rivers in which water TN and TP amount reaches 5.833(9.367) and 0.228(0.767) mg/l, respectively.

Four species of new cyanobacteria (*Chamaesiphon carpaticus*, *Heteroleibleinia pusilla*, *Komvophoron schmidlei*, *Leptolyngbya* cf. *gloeophila*) are widespread in clean and unpolluted waters (Komárek & Anagnostidis, 1998, 2005; Komárek et al., 2003; Hašler & Poulíčková, 2010). During the investigation, these species (located in the first cluster of RDA triplot, Fig. 25) were also recorded in rivers characterized by low amounts of TN and TP. In some publications, *Homoeothrix crustacea* and *Heteroleibleinia kuetzingii* are referred as specific species to mesotrophic waters (Starmach, 1966; Whitton, 2002; Komárek & Anagnostidis, 2005). However, cyanobacterium *H. kuetzingii* was observed in Lithuanian rivers of relatively poor ecological status. Only one *Chamaesiphon confervicolus*, according to Komárek & Anagnostidis (1998), is known to be widespread in water bodies of various ecological status from oligo- to eutrophic.

The most important factors influencing new species distribution in Lithuanian running ecosystems was substrate and TN amount. RDA analysis data revealed two main groups of Lithuanian rivers characterized by different nutrient (TN, TP) concentrations, which are important for cyanobacteria ecology, occurrence. In the narrow and very shaded by riparian vegetation rivers (up to 95%), benthic cyanobacteria are adapted to develop under conditions of low light intensity (Hill et al., 1995; Hill, 1996; Allan & Castillo, 2007), the obtained data were not statistically significant. The macrophytes, which caused an extra shading of epiphytic and epilithic cyanobacteria under the water, could influence the formation of phytobenthos.

New species of cyanobacteria − indicators for the assessment of river status

EU Water Framework Directive (EU WFD, 2000/60/EC of the European Parliament) defines and recommends biological elements, phytoplankton, phytobenthos, benthic macroalgae, macrophytes, zoobenthos and ichthyofauna, which must be taken for the assessment of ecological status of the surface water bodies. Two biological water quality parameters – Danish Stream Fauna Index (DSFI) and Lithuanian Fish Index (LFI) are used for the assessment of ecological status of Lithuanian rivers (Arbačiauskas, 2006; Kontautas, 2008−2010; Virbickas, 2008, 2009a, b, 2010; Aplinkos Apsaugos Agentūra, 2010; Lietuvos Respublikos vandens įstatymas, 2011). Methods for using macrophytes and benthic diatoms are under development (Gudas, 2010; Sinkevičienė, 2010–2011; Zviedre, 2013). Due to the lack of detailed studies on benthos in Lithuanian rivers, phytobenthos (without diatoms) are not used. An assessment system for phytobenthos in the rivers meeting the requirements of the WFD was created and successfully applied in Germany (Gutowski et al., 2004; Foerster et al., 2004; Schaumburg et al., 2004, 2006; Gutowski & Foerster, 2006; Federal Ministry for the Environment, 2009; Theesfeld & Schleyer, 2011; SWD, 2012). Special attention was paid to the parameters as follows: phytobenthos index BI, indicative algal species and their abundance (estimated on five-point abundance scale). The possibility to employ BI index for the assessment of Lithuanian rivers water quality was analysed in Vitonytė (2014). Based on the study, five newly recorded benthic cyanobacteria are in the list of indicative species of phytobenthos index (BI) proposed by Schaumburg et al. in 2006 (Table 2). In 2012, German researchers corrected and supplemented the list of indicative species. Therefore, currently observed nine of new cyanobacteria are among indicative species.

Table 2. Indicative cyanobacteria species used for phytobenthos index (BI) (after Schaumburg et al., 2006, 2012) found newly in Lithuanian rivers

	Schaumburg et al.	
	In 2006	In 2012
Chamaesiphon confervicolus	✓	✓
Chamaesiphon starmachii	✓	✓
Heteroleibleinia kuetzingii	✓	✓
Homoeothrix crustacea	✓	✓
Phormidium cf. *corium*	✓	
Chlorogloea microcystoides		✓
Homoeothrix juliana		✓
Komvophoron schmidlei		✓
Microcrocis obvoluta		✓
Phormidium tinctorium		✓

The rest of new cyanobacteria, which are not included into the list of indicative species, are not relevant for the assessment of the ecological status of rivers due to lack of sufficient information. Some of these are very rare or rare in Lithuanian rivers or form small populations (one–two point scale), which do not show major differences in species development at particular environmental conditions. We can emphasize two cyanobacteria *Chamaesiphon longus* and *Heteroleibleinia ucrainica* as potential indicators of good ecological status of rivers according to RDA analysis (Fig. 25). Despite the fact that *Chamaesiphon longus* is rare in Lithuania, it's abundance in good status rivers reaches up to three point scale. In addition, based on the received RDA data (Fig. 25), three cyanobacteria species, proposed by Schaumburg et al. in 2012 (Table 2), *Homoeothrix crustacea*, *Phormidium tinctorium* and *Homoeothrix juliana*, were also confirmed as indicative species of Lithuanian rivers of good ecological status.

The study of new cyanobacteria showed that five new species *Homoeothrix crustacea*, *Phormidium tinctorium*, *Homoeothrix juliana*, *Chamaesiphon longus* and *Heteroleibleinia ucrainica*, based on their population abundance and distribution in Lithuania, are potential indicators of rivers of good ecological status. However, the further detailed studies on factors influencing cyanobacteria development in river benthos should be carried out.

ACKNOWLEDGEMENTS

The authors are grateful to Dr Zofija Sinkevičienė (Nature Research Centre, Institute of Botany) for the collaboration during the research. We thank reviewers for valuable comments and suggestions to the manuscript.

Research was supported by the State Studies Foundation (Lithuania), Nr. 410044, and Research Council of Lithuania, Nr. DOK−12763.

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NAUJOS LIETUVOS UPĖMS FITOBENTOSO MELSVABAKTERIŲ RŪŠYS

Irma VITONYTĖ, Jūratė KASPEROVIČIENĖ

Santrauka

2009–2011 m. liepos–rugpjūčio mėn. 70-je Lietuvos upių aptiktos 23 naujos fitobentoso melsvabakterių rūšys priklauso *Chroococcales* ir *Oscillatoriales* eilėms, 10 šeimų ir 12 genčių. Straipsnyje pateikiami išsamūs melsvabakterių morfologiniai aprašymai, originalios nuotraukos, atlikta melsvabakterių ekologinių grupių ir paplitimo analizė. Rūšių ekologinių grupių ir paplitimo rezultatai yra palyginti su kitų Europos šalių duomenimis. Gausų naujų rūšių skaičių lėmė mažas Lietuvos upių fitobentoso ištirtumas ir kai kurių rūšių specifinės vystymosi sąlygos. Straipsnyje taip pat pateikiama informacija apie naujai aptiktas melsvabakterių rūšis – upių ekologinės būklės indikatores.