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PHYTOPLANKTON COMPOSITION OF VAYA LAKE (2004–2006)

R. DIMITROVA[1], E. NENOVA[2], B. UZUNOV[1], M. SHISHINIOVA[2] and M. STOYNEVA[1]
[1] *Sofia University"St. Kliment Ohridski", Faculty of Biology, Department of Botany, BG – 1164 Sofia, Bulgaria*
[2] *Sofia University"St. Kliment Ohridski", Faculty of Biology, Department of Zoology and Anthropology, BG – 1164 Sofia, Bulgaria*

Abstract

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Vaya (= Burgas Lake), is the biggest natural lake in Bulgaria and the shallowest Black Sea Costal lake. With regard of its origin, Vaya is a liman and recently it is mixooligohaline with fluctuating halinity due to a siltated channel connection with the Black Sea. The lake is located on the 'Via Pontica' ornithological migratory route and is important for the conservation of rare and endangered species of national, European and global significance. The lake is a Ramsar site, a Protected area and Natura 2000 site, included as critically endangered in the Red List of Bulgarian Wetlands.During the last decades Vaya has undergone significant changes due to different anthropogenic factors, which disturb the water balance of the lake and lead to introduction of biogenic elements in the wetland with a negative effect on the chemical composition of the water with impacts on the flora and fauna of the aquatic ecosystem.The phytoplankton studies, represented in this work, have been conducted during the summer and autumn months of three consecutive years – 2004–2006. A rich species composition has been established – 165 species, 8 varieties and 1 form of 80 genera from 8 divisions. The green algae (Chlorophyta and Streptophyta) are characterized by the biggest number of taxa (89), followed by the blue-green algae (Cyanoprokaryota – 51), among which the tropical toxic invasive species *Cylindrospermopsis raciborskii,* was detected for the first time in Vaya lake. Most of the species have low frequency quotients and only three can be pointed as widely distributed during the studied period (*Planktothrix agardhii*, *Pseudanabaena limnetica, Scenedesmus acuminatus*). On the basis of data from the same periods of close preceding years, a comparison is made between the algal flora of Vaya and other Black Sea coastal wetlands – Shabla, Ezerets and Dourankoulak. In all of them, 30 common taxa have been registered. A comparison has been done also between the obtained data on the recent taxonomic composition and former data on lake algal flora of other authors. The results show the general negative trend in the development of Vaya wetland with increase eutrophication.

Key words: coastal wetlands, phytoplankton, anthropogenic impact, cyanoprokaryotes, green algae, invasive species

Introduction

Vaya (Burgas Lake) is the biggest natural lake in Bulgaria and the shallowest Black Sea Costal Lake. Vaya is a part of the large wetland complex of several Burgas lakes (incl. Atanasovsko Lake and Mandra Dam), located on the 'Via Pontica' ornithological migratoryroute and is important for the conservation of rare and endangered species of national, European and global significance. The lake is a Ramsar site, a protected area in the Bulgarian legislation and the national ecological network Natura 2000. During the last decades the aquatic ecosystem of Vaya has undergone significant changes due to different anthropogenic factors. The main among them are the disturbance of the water balance and the introduction of biogenic elements in the lake, which have a negative effect on the chemical composition of the water and its flora and fauna. Therefore it has been included as critically endangered in the Red List of Bulgarian Wetlands (Michev and Stoyneva, 2005, 2007).

**E-mail: elena_pnenova@abv.bg*

The aim of our investigations was to determine the species composition of the phytoplankton in Vaya Lake in the changed conditions of the lake due to the anthropogenic impact and to compare the results with previous research data (Valkanov, 1936; Zashev and Angelov, 1957–58; Vodenicharov, 1964; Petrova, 1967; Petrova-Kardjova, 1974; summarised by Stoyneva and Temniskova, 2007). The present study is a part of a more complete biological investigation of the chemical composition and the invertebrate fauna of Vaya Lake, which is conducted in the frame of a PhD thesis of one of the authors (E. Nenova).

Materials and Methods

The investigations on the phytoplankton were carried out during the summer and autumn months of three consecutive years: 2004, 2005 and 2006. Fourteen points in the lake have been chosen for sampling, but in this report the results from 8 of them (1–5, 8, 9 and 11) are represented (Figure 1).

Fig. 1. Vaya Lake with sampling points, which are located as follow: 1 – in the western part of Vaya; 2 – to opposite to the residential district of Gorno Ezerovo; 3 and 4 – along the central longitudinal axis of the lake; 5 – next to the sewage disposal canal of the water treatment plant of the city of Burgas; 8 – opposite to the channel; 9 – in the already mentioned channel; 11 – opposite to Dolno Ezerovo district.

The points were detected using GPS "GARMIN" and samples were collected with a motor boat. The 11 samples were collected in glass bottles and fixed by 2–4% formalin with further sedimentation in laboratory conditions. Forty-four samples collected in August and October, 2004, 2005 and 2006 were processed in a standard way using Thoma blood-counting chamber on Amplival microscope. A total of 308 temporary microscopic slides were prepared, of which 176 were used for phytoplankton counts and 132 for additional, more detailed identification of the species composition. The standard taxonomic manuals and guides were used in combination with recent taxonomic papers. Frequency quotient (FQ) of each infrageneric taxon was estimated as ratio of the number of samples, in which it was found to the total number of collected samples.

Results and Discussion

As a result of the investigation, 165 species, 8 varieties and one form from 80 genera and 7 divisions, were identified (Table 1).

The distribution according to the number of infrageneric taxa -, which hereafter will be used as "number of species", revealed some peculiarities of the Vaya phytoplankton.

The most diverseis the division Chlorophyta (40 genera, 86 species and 3 varieties) and the highest number of taxa belonged to class Trebouxiophyceae (76 species and 3 varieties from 30 genera), in which the genus *Scenedesmus* was the richest (Figure 2). The second division is Cyanoprokaryota (25 genera, 49 species, one variety and one form), in which the richest order is Chroococcales (18 species belonging to 11 genera), followed by order Oscillatoriales (15 species from 8 genera) and order Nostocales is represented by 13 species from 5 genera. The richest among them is the genus *Anabaena*, from which 5 different species were found. The number of infrageneric taxa found, was much higher in comparison with the number given in former studies: 8 – Valkanov (1936) and Zashev and Angelov (1957–58), 50 – Vodenicharov (1964), 27–37 – Petrova (1967) and Petrova-Karadjova (1974).

During this study the tropical cyanoprokaryote species *Cylindrospermopsis raciborskii* was detected for the first time in Vaya Lake. This species is known for its high toxicity and until now, from Bulgaria it has been reported only from "Srebarna" Reserve (Draganov and Stoyneva, 1992; Stoyneva, 1995, 1998a, b, 2003). The reports of the species from different European water bodies started before the period of our investigation (e.g. Hindák, 1988; Padisak, 1997; Komárková et al., 1999; Couté et al., 2004) and are continuing in the recent years (e.g. Kokociński and Soininen, 2012). *C. raciborskii* is characterized by high morphological variability and preference for high temperatures (27–30°C) (Fabbro and Duivenvoorden, 1996). Other potentially toxic cyanoprokaryotes were detected in the lake (e.g. representatives if genera *Microcystis, Aphanizomenon*, etc. – Table 1) which is on conformity with the finding of three microcystin types in lake waters in August 2004 (Pavlova,

Table 1

List of species composition of the phytoplankton of Vaya (2004–2006). The mean frequency quotients of species (pF) for the periods 2004 – 2006 and frequency of establishment in regard to periods (percent classes): 1 – (0–20%), 2 – (20–40%), 3 – (40–60%), 4 – (60–80%), 5 – (80–100%), ▲– 100%

Taxa	2004/ Aug.	2004/ Oct.	2005/ Aug.	2005/ Oct.	2006/ Aug.	2006/ Oct.	pF
1	2	3	4	5	6	7	8
CYANOPROKARYOTA							
CYANOPHYCEAE							
Order Chrooccoccales							
Aphanocapsa incerta (Lemmermann) Cronberg et Komárek	1		2	3	1	2	20,5
Aphanocapsa holsatica (Lemmermann) Cronberg et Komárek	1	3	1	3	1	2	25
Aphanocapsa sp.	3	4	1		1	2	29,5
Aphanothece smithii Komárková - Legnerová et Cronberg		1	2		2		6,8
Chroococcus minor var. dispersa Keissler	3	4	2	2	1	2	43,2
Coelomoron pusillum (Van Goor) Komárek	1	4	2	3		2	27,3
Cyanogranis ferruginea (Wawrik) Hindák ex Hindák		3			2		13,6
Merismopedia glauca (Ehrenberg) Kützing	1	1	2	2	1		13,6
Merismopedia tenuissima Lemmermann	3	4	4	▲	2	4	65,9
Microcystis aeruginosa (Kützing) Kützing	2		1		1	1	9,1
Microcystis flos-aquae (Witrock) Kirchner	1	1	3	1			13,6
Microcystis viridis (Braun in Rabenhorst) Lemmermann	1		2				6,8
Microcystis wesenbergii (Komárek) Komárek in Kondrateva	3	4	3	3	1	2	45,5
Microcystis sp.	2	3	3	2	1	2	38,6
Microcrocis sp.	1						2,3
Pannus sp.			1				2,3
Snowella lacustris (Chodat) Komárek et Hindák		1	1		3		4,5
Synechococcus sp.	3	1	1	1			13,6
Woronichinia naegeliana (Unger) Elenkin				3			6,8
Order Nostocales							
Anabaena affinis Lemmermann	3		1	3		1	20,5
Anabaena bergii Ostenfeld	4		2	1	4		29,5
Anabaena crassa (Lemmermann) Komárková - Legnerová et Cronberg	4		2	1	▲		36,4
Anabaena sphaerica f. conoidea Elenkin	3		3		1		18,2
Anabaena spiralis Thompson	1	2	4	1	1		22,7
Anabaena spiroides Klebahn	3	3	4		4	2	47,7
Anabaena sp.	3	1	1	4	1	2	31,8
Anabaenopsis circularis (G.S. West) Miller	1						0
Anabaenopsis cuningtonii Taylor	4	1	1	1	1		27,3
Anabaenopsis elenkinii V. Miller	5	4	▲	3	5		63,6
Aphanizomenon aphanizomenoides (Forti) Hortobági et Komárek	1				1		9,1
Cylindrospermopsis raciborskii (Woloszynska) Subba Raju	2	2	4	1	5	1	36,4
Cuspidothrix issatschenkoi (Usačev) Rajaniemi et al.	2	2	4	▲	▲	2	61,4
Order Oscillatoriales							
Jaaginema geminataum (Meneghini ex Gomont) Anagn. et Komárek)			1				2,3
Jaaginema quadripunctulatum (Brühl et Biswas) Anagn. et Komárek			3	1	1		11,4
Limnothrix redekei (Van Goor) Meffert	3	3	4	3	1	5	61,4
Phormidium amoenum Kützing ex Anagnostidis et Komárek	4		2				15,9
Phormidium autumnale (Agardh) Trevisan ex Gomont				1			0
Phormidium bulgaricum (Komárek) Anagnostidis et Komárek	2		2	1			11,3

Table 1 **continued**

1	2	3	4	5	6	7	8
Phormidium insigne (Skuja) Anagnostidis	1						2,3
Phormidium spp.	3	2	2	1	1		20,5
Planktothrix agardhii (Gomont) Anagnostidis et Komárek	▲	▲	▲	▲	▲	▲	100
Planktothrix isothrix (Skuja) Komárek et Komárková	1		2	1	1	1	15,9
Planktolyngbia limnetica (Lemm.) Komárková-Legnerová et Gronberg	4	5	▲	3	5	2	72,7
Pseudanabaena catenata Lauterborn		1	3	1	1		13,6
Pseudanabaena galeata Böcher	3	1	1	1	1		15,9
Pseudanabaena limnetica (Lemmermann) Komárek	4	5	▲	▲	▲	5	90,9
Pseudanabaena papillaterminata (Kiselev) Kukk	2	1	1	4		1	22,7
Romeria sp.	1	1					2,3
Oscillatoria sp. (6μ шир.)	3						6,8
EUGLENOPHYTA							
Euglenophyceae							
Euglena limnophila Lemmermann	1	2	2	1			13,6
Euglena oblonga Schmitz				1			2,3
Euglena sp. 1 (107/8,5 μm)		1		1			4,5
Euglena sp. 2 (22/11μm)	3	3	3	4			36,4
Euglena sp.3 (60/15μm)		1	1	2			11,4
Euglena spp.					1	1	11,4
Cryptoglena skujae Marin et Melkonian	3		2		1	1	25
Lepocinclis sp.	1	2	2		2		15,9
Phacus acuminatus Stokes	3	2	2	3	1		25
Phacus curvicauda Swir	1	3					9,09
Phacus longicauda (Ehrenberg) Dujardin	1		1	2			6,82
Phacus megalopsis Pochman				1			2,27
Phacus trypanon (Ehrenberg) Stein	5	4	3	5	1	3	63,64
Phacus spp.		3		2	1		13,64
Strombomonas acuminata (Schmarda) Deflandre	3	1		3	1		18,18
Strombomonas eurystoma (Stein) Popova	1						2,27
Strombomonas fluviatilis (Lemmermann) Deflandre			2				4,55
Strombomonas gibberosa (Playf) Deflandre	3	3	4	4	2	2	50
Strombomonas gibberosa var. perlonga Playf			1		1	1	6,82
Trachelomonas oblonga Lemmermann	1	2					6,82
Trachelomonas hispida var.planktonica (Perty) Stein				2			4,55
Trachelomonas nigra Swirenko				1			2,27
Trachelomonas sp.	1	1			2		2,27
PYRRHOPHYTA (DINOPHYTA)							
Diplopsalis acuta (Apstein) Entz				2			4,5
Gymnodinium latum Skuja	1		1				4,5
Gymnodinium sp.	1	2	3	2	2		25
Peridinium sp.		2	1				6,8
OCHROPHYTA							
CHRYSOPHYCEAE							
Dinobryon sp.		1		3			11,4
TRIBOPHYCEAE=XANTHOPHYCEAE							
Goniochloris fallax Fott	3	4	2	2	2	2	40,9
Pseudostaurastrum sp.			1				2,3
CRYPTOPHYTA							

Table 1 **continued**

1	2	3	4	5	6	7	8
Cryptomonas erosa Ehrenberg	2	3	3	1	4	3	45,5
Chlorophyceae							
Chlamydomonas spp.	1	5	2	4	1	4	45,5
Chloromonas spp.	1			1			2,3
Coccomonas sp			1				2,3
Eudorina sp.			1				2,3
Pandorina morum (O.F.Müller) Bory			1				2,3
Phacotus coccifer Korshikov					1	2	9,1
Pteromonas torta Korshikov		1	2	3	1		13,6
Sphaerellopsis spp.		2	1	2		1	13,6
Spermatozopsis exultans Korshikov		1					2,3
Unidentified green flagellates	1	1	2	3	1	1	18,2
Trebouxiophyceae							
Actinastrum hantzschii Lagerheim	4	5	4	▲	1	4	72,7
Actinastrum hantzschii var. subtile Woloszynska	1	3	2	1	1	1	13,6
Amphikrikos minutissimus Korshikov	3	2					11,4
Ankyra judayi (G.M. Smith) Fott		4			1		13,6
Choricystis fina (Komárek) Hindák	3	3	2	5	2	3	50
Choricystis hindakii Tell			1	3		2	13,6
Coelastrum astroideum De Notaris	4	3	2	4		1	40,9
Crucigenia tetrapedia (Kirchner) W. West et G.S.West	2	1		2			9,1
Crucigeniella apiculata (Lemmermann) Schmidel	1	2	2				9,1
Crucigeniella divergens (Smith) Fott	4	3	1	3			27,3
Crucigeniella crucifera (Wolle) Komárek				2			4,5
Dicellula geminata (Printz) Korshikov	1	1					2,3
Dichotomococcus curvatus Korshikov	3	5	2	3	2	3	47,7
Dichotomococcus bacillaris Komárek		3	1				9,1
Dictyosphaerium simplex Korshikov	1						2,3
Dictyosphaerium tetrachotum Printz sensu Hindák	3	3		1			13,6
Dictyosphaerium sp.		3		3	1		15,9
Dictyosphaerium granulatum Hindák				1			2,3
Didymogenes anomala (Smith) Hindák				2		1	6,8
Diplochloris lunata (Fott) Fott	3	3	1	4		1	31,8
Elakathotrix gelatinosa Wille				2	1	1	9,1
Golenkinia radiata Chodat		1	2		1	1	11,4
Granulocystopsis coronata (Lemmermann) Hindák					1		2,3
Kirchneriella contorta (Schmidle) Bohlin	3			1	3	2	13,6
Kirchneriella obesa (W.West) Schmidle		1					2,3
Kirchneriella subcapitata Komárek et Fott	3		1	1	1		11,4
Kirchenriella lunaris (Kirchner) Moebius	3	2	2	2	2		25
Lagerheimia genevensis (Chodat) Chodat				2			4,5
Lagerheimia ciliata (Lagerheim) Chodat	1	2	2	3	2	2	22,7
Lagerheimia cingula G.M. Smith	1		1	1			4,5
Lagerheimia marsonii Lemmermann	1			1			2,3
Lagerheimia wratislaviensis Schröder		1	1	2	1	1	11,4
Micractinium pusillum Fresenius	2	1	4	4	1	2	36,4
Micractinium quadrisetum (Lemmermann) G.M. Smith			1				2,3
Monoraphidium arcuatum (Korshikov) Hindák	4	5	2	3	2	1	45,5

Table 1 **continued**

1	2	3	4	5	6	7	8
Monoraphidium circinale (Nygaard) Nygaard	3	▲	3	5	1	5	72,7
Monoraphidium contortum (Thuret) Komárková-Legnerová	5	5	3	5	5	3	72,7
Monoraphidium griffithii (Berkeley) Komárková-Legnerová	1	3	2	3	1	4	38,6
Monoraphidium nanum (Ettl) Hindák	1	3	1	2		2	20,5
Nephrochlamys rotunda Korshikov	1		2	1			9,1
Nephrochlamys subsolitaria (G.S. West) Korshikov	3	2	4	2	2	2	36,4
Nephrochlamys willeana (Printz) Korshikov	3	4	4	5	4	5	75
Nephrochlamys sp.	1	1					2,3
Oocystis sp	3	5	4	3	1	4	61,4
Pediastrum boryanum (Turpin) Meneghini	4	2	4	4	2	2	52,3
Pediastrum boryanum var. longicorne Reinsch			3	1	2		18,2
Pediastrum duplex Meyen	1		2	1			4,5
Pediastrum duplex var. gracillimum W. West et G.S.West	1		2	1			6,8
Pediastrum tetras (Ehrenberg) Ralfs	4	2	4	3	1	2	43,2
Pseudodictyosphaerium elegans (Bachmann) Hindák	1	2		1			9,1
Pseudoquadrigula sp.			2				0
Scenedesmus acuminatus (Lagerheim) Chodat	4	5	4	▲	4	4	81,8
Scenedesmus armatus Chodat	2	5	2	3	1	1	40,9
Scenedesmus communis Hegewald	3	4	4	4	4	5	70,5
Scenedesmus ecornis (Ehrenberg) Chodat	3	3	2			1	27,3
Scenedesmus ellipticus Corda	2	3	1		1		13,6
Scenedesmus intermedius Chodat	2	4	2	5	2	2	43,2
Scenedesmus obtusus Meyen			1	1			4,5
Scenedesmus opoliensis Richter	2	3	4	1	1	2	29,5
Scenedesmus quadrispina Chodat	1		2	1	1		11,4
Scenedesmus raciborski Woloszynska	1	2	1	2	1		13,6
Scenedesmus subspicatus Chodat	3	2	3	3	5	2	50
Schroederia setigera (Schröder) Lemmermann	3	3	2	▲	1	2	52,3
Schroederia spiralis (Printz) Korshikov	1	4	3	3	1	1	31,8
Siderocelis ornata (Fott) Fott	1	1	1				4,5
Tetraedron caudatum (Corda) Hansgirg	4	3	3	4	1	1	47,7
Tetraedron incus (Teilling) G.M. Smith			2				0
Tetraedron minimum (Braun) Hansgirg	3	5	5	▲	2	3	68,2
Tetraedron triangulare Korshikov	3	4	2	1	1	2	34,1
Tetraedron regulare Kützing		1	2		2	1	13,6
Tetrastrum elegans Playf						3	9,1
Tetrastrum staurogeniaeforme (Schröder) Lemmermann	3	5	3	5	1	5	70,5
Tetrastrum triangulare (Chodat) Komárek	4	5	2	2	1	4	56,8
Treubaria planktonica (G.M. Smith) Korshikov	2		2			3	18,2
Treubaria triappendiculata Bernard		1	2	1	1		11,4
Unidentified coccal green algae	2	5	2	3	2	2	40,9
STREPTOPHYTA							
Charophyceae							
Zygnematales							
Closterium limneticum Lemmermann	1		2	2		1	15,9
Closterium limneticum var. tenue Lemmermann	3	2	1	1			15,9
Closterium limneticum var. fallax Růžička	4			1			11,4
Cosmarium tinctum Ralfs	3	4	4	4	2	2	54,5
Staurastrum chaetoceros (Schröder) G.M. Smith				2			4,5

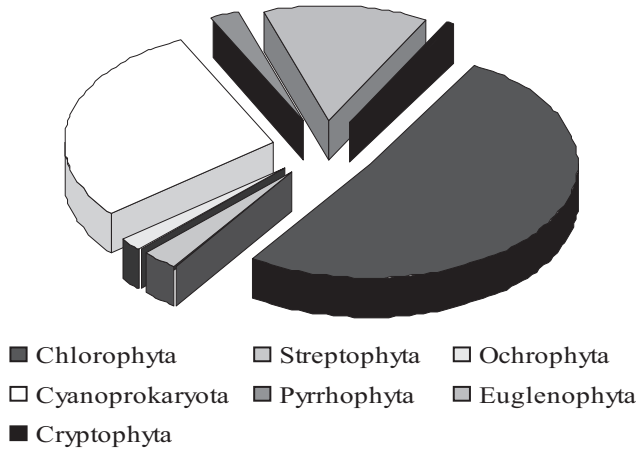

Fig. 2. Taxonomic structure of the phytoplankton of Vaya Lake (2004–2006)

2007; Pavlova et al., 2006, 2007). According to the number of species the third place in Vaya phytoplankton is occupied by the division Euglenophyta (19 species and 2 varieties from 6 genera), in which the genera *Euglena, Phacus* and *Strombomonas* contained the highest number of taxa. Some flagellates from this and other divisions have not been identified to species level because of the work with fixed samples. Three divisions are with low representation (with 3 genera each): Streptophyta (*Closterium, Cosmarium* and *Staurastrum*), Pyrrhophyta (*Gymnodinium, Peridinium* and *Diplopsalis*) and Ochrophyta (*Goniochloris* and *Pseudostaurastrum* from Tribophyceae and *Dinobryon* from Chrysophyceae), while division Cryptophyta is represented by a single genus (*Cryptomonas*).

Figure 3 shows that most of the species (102) are with low distribution frequency (FQ ≤ 20%), 26 species are represented in 20–50% of the samples, 10 species – in 50–60% and 15 species are represented in 60–80% of the samples.

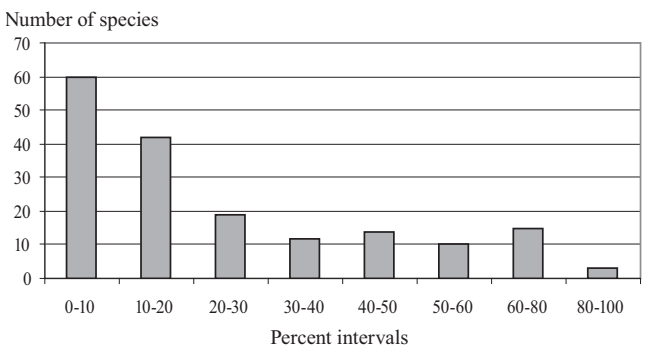

Fig. 3. Frequency quotients (FQ) of the infrageneric taxa from Vaya Lake

For the period of the investigation, only three species had frequency quotients of 80–100% (*Planktothrix agardhii*, *Pseudanabaena limnetica* and *Scenedesmus acuminatus*).

In total, 28 of the identified taxa were more broadly distributed and had frequency quotients over 50%. Most of them were representatives of the genera, which belongs to the division Chlorophyta: *Monoraphidium* (M. *contortum, M. circinale*), *Scenedesmus* (*Sc. acuminatus, Sc. communis, Sc. subspicatus*), *Tetrastrum* (*T. Triangulare* and *T. staurogenioforme*), *Actina strumhantzschii, Choricystisfina, Nephrochlamys willeana, Oocysti* ssp., *Pediastrum boryanum, Schroederia setigera* and *Tetraedronminimum*. The most frequently found phytoplankton from the division Streptophyta was *Cosmarium tinctum*. From the division Cyanoprokaryota**,** only one species was characterized with FQ = 100% and this was *Planktothrix agardhii*, followed by *Pseudanabaena limnetica*. The other frequently distributed species were *Anabaenopsis elenkinii, Cuspidothrixis satschenkoi, Limnothrix redekei, Merismopedia tenuissima* and *Planktolyngbia limnetica*. Two species from the division Euglenophyta**,** namely *Strombomonas gibberosa* and *Phacus trypanon*, were also with a relatively frequent distribution.

Figure 4 shows that the greatest number of species was established in 2005(131 taxa in August and 123 in October). In the same period, the greatest was the number of species (88–65 taxa) with FQ up to 40%. By contrast, in 2004 (when 125 taxa were identified in August and 112 in October), more species had higher distribution frequency (FQ > 40%). The lowest number of established species was recorded in 2006 (98 taxa in August and 79 in October) and again species with low frequency distribution were prevalent (79–55 taxa).

The comparison with the studies of other Bulgarian coastal wetlands, conducted in close previous years (Stoyneva, 2000) showed that more than 30 species were common

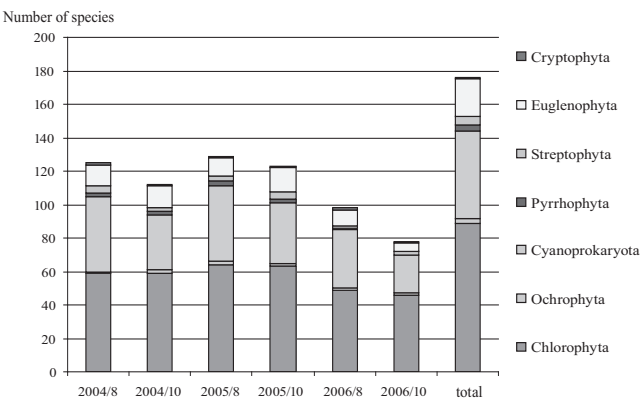

Fig. 4. Number of species in taxonomic groups during the separate periods of the investigation and their total number for the whole investigation period

for the algal flora of Shabla, Ezerets, Durankulak and Vaya. *Anabaena affinis*, *Anabaenopsis elenkini*, *Microcystis* spp. (*M. aeruginosa, M. flos-aque, M. viridis, M. wesenbergii*) and *Woronichiniana egeliana* were among them.

Conclusions

During the studied period of 2004–2006 Vaya Lake had high phytoplankton biodiversity – 165 species, 8 varieties and 1 form from 80 genera and 7 divisions. Among them Chlorophyta was with the highest number of taxa found (86 species and 3 varieties from 40 genera), followed by Cyanoprokaryota (49 species, 1 variety and 1 form belonging to 25 genera).Most of the species (102) were with low distribution frequency (20%) and only 3 species were found in 80–100% of the samples. The species number was highest in 2005 (131 taxa in August and 123 in October) while the lowest number of identified species was recorded in 2006 (98 taxa in August and 79 in October).The obvious decrease of phytoplankton biodiversity in 2006, in combination with the high representation of species from Cyanoprokaryota and recent occurrence of invasive and potentially toxic species in lake waters shows the negative trend in the development of the studied coastal wetland, which could be explained by the strong influence of the anthropogenic factors and subsequent increase of the trophic state.

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