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# PHYTOPLANKTON SPECIES COMPOSITION IN SEVEN FISH PONDS WITH A GRASS CARP POLYCULTURE (2018-2019)

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Abstract. The present article is an attempt to analyze the seasonal changes in the structure and the biomass of phytoplankton in fish ponds with a polyculture with two-year-old grass carp as a mean of biological control of unwanted aquatic vegetation. During a two-year study (2018 2019), 259 planktonic algae were identified with considerably higher number of species during the first year (216) in comparison with the second year (150), when the grass carp stocking densities were twice less. This decrease in the biodiversity was accompanied by a significant change in the dominant structure: in 2018, the most intense blooms were caused by potentially toxic cyanoprokaryotes *Dolichospermum planctonicum* (Brunnthaler) Wacklin, L. Hoffmann & Komarek and *D. spiroides* Klebhan) Wacklin, L. Hoffmann & Komarek L. Hoffmann & K. Sivonen, while in 2019 the most abundant species were from Pyrrhophyta *(Ceratium furcoides* (Levander) Langhans), Euglenophyta *{Euglena gracilis* G.A. Klebs) and Ochrophyta, Raphidophyceae *{Gonyostomum* cf. *ovatum* Fott and *Gonyostomum depressum* (Lauterbom) Lemmermann).

Key words: algae, cyanoprokaryotes, dominants, species alteration, toxic algae

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## INTRODUCTION

Biodiversity in small ponds is higher than the biodiversity in the larger water bodies, but despite this fact they are rarely studied due to their variable water balance, small volume and spatial heterogeneity. Water basins supplied with organic matter, as a result of agricultural activity, have rich algal flora (Borics e t a l. 2003). The loads of agricultural chemicals and the mismanagement of artificial fish ponds, can lead to eutrophication. Fertilizers are often used in fisheries to stimulate the development of the primary production and to increase the yields, which is why fish ponds are eutrophic with frequent algal blooms (R adojicic & Kopp 2016). Due to their different hydrology and small water depth they lack seasonal temperature stratification (Kopp e t a l. 2016). The use of high fish stocking densities increases the trophic status of the water bodies, which commonly causes cyanobacterial blooms, fluctuations in oxygen and high levels of nitrogen that destabilize these aquatic ecosystems.

Cyanoprokaryotes often are the main contributors to the total phytoplankton biomass in the summer, causing intense blooms and death among fish due to oxygen depletion. The specific features of cyanobacteria make them more adaptable to specific conditions, such as reduced light and depletion of nitrogen (Sevrin-Reyssac & P letik o sic 1990; Komarkova 1998). At the same time, many cyanoprokaryotes are widely known as toxin producers which cause severe harm to human and ecosystem health. Therefore, the study of the summer ecosystems of small fish-breeding ponds achieves greater importance.

According to M ichev & Stoyneva (2007) the species composition of algae found in fish farms in Bulgaria consisted of approximately 600 species. Detailed data on algal diversity in fish ponds in the country were published by V odenicharov e t a l. (1974), Ludskanova & Paskaleva (1975), Paskaleva (1975), Kiryakov e t a l. (1982), Paskaleva & V odenicharov (1984) and D ochin e t a l. (2020; in press). The aim of the present study is to report the general changes in the phytoplankton composition in fish ponds with polyculture with two-year-old grass carp as a mean ofbiological control of unwanted aquatic vegetation.

## MATERIAL AND METHODS

The study was carried out during a two-year period (2018-2019) in the experimental ponds of the Institute of Fisheries and Aquaculture, Plovdiv, Bulgaria. During the study, in these ponds common carp (***Cyprinus carpio*** L.), hybrid bighead carp ***(Hypophthalmichtys nobilis*** Rich, x ***Hypophthalmichtys molitrix*** Val.) and grass carp ***(Ctenopharyngodon idella*** Val.) were grown. During the second year (2019) the stocking density of grass carp in the experimental ponds was twice lower than the stocking density in2018.

During the two-year period, 108 phytoplankton samples were taken from seven

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ponds (P6, P7, P12, P16, P18, P19 and P23), each with area between 0.18 to 0.40 ha. The macrophytic vegetation in the ponds was represented by *Ceratophyllum demersum* ***L.,*** *Nuphar lutea* (L.) Sm. and *Typha angustifolia* L.).

The sampling was conducted at the depth of 0.5 m bimonthly in the late spring-summer period (from April/May to September) of both years with the results discussed as average values per month. The phytoplankton samples were collected and processed by standard methods of fixation with formalin to final concentration 4% and further sedimentation (ISO 5667-l:2006/AC:2007; ISO 5667-3:2003/AC:2007) with some additional living samples for identification of raphidophytes. Microscope work was done on Burker chamber. The species composition was determined by light microscope (Carl Zeiss, Axioscope 2 plus) with magnification 400x using standard taxonomic literature with critical use of AlgaeBase (Guiry & Guiry 2020). Diatoms were identified after Cox (1996). The main counting unit was the cell and the biomass was estimated by the method of stereometrical approximations (R o tt 1981; D eisinger 1984). Counting units were cells, filaments and colonies. The total biomass of each sample was assessed and it was defined as the amount of biomass of all species summarized in separate taxonomic groups. Dominant species were determined according to the percentage of individual species to the total biomass.

## RESULTS AND DISCUSSION

During a two-year study (2018-2019), totally 259 taxa of planktonic algae from 6 divisions were identified **(Table 1).**

During the first year of investigation, the total number of identified taxa was 216 and during the second year it was 150 **(Table 1, Fig. 1-3).** The number of species ranged around 100 per month during the first year, and was about twice less during the second year **(Figs. 1, 3).** These pronounced differences in total number of taxa during each studied month **(Figs. 1, 2)** were accompanied with changes in the dominant structure of the phytoplankton **(Table 1).**

In April 2018, only 10 phytoplankton taxa, mostly from Ochrophyta, were identified. In May 2018, among the 102 taxa identified the most abundant were *Aulacoseira granulata* (Ehrenberg) Simonsen, *Anabaena sphaerica* Burnett & Flahault and *Trachelomonas hispida* (Perty) F. Stein. In June 2018, number of species was 100 and *Dolichospermum spiroides, Dolichospermum planctonicum* and *Aphanizomenon flosaquae* Ralfs ex Bomet & Flahault reached the highest biomass. In July 2018, 105 taxa were identified, with the highest biomass of *D. spiroides, A. sphaerica* and *A.*

*granulata*. InAugust2018, among 103 species *found,Microcystis aeruginosa* (Kutzing) Kutzing and *Oscillatoria limosa* C. Agardh ex Gomont from Cyanoprokaryota and *Desmodesmus communis* (Hegewald) Hegewald from Chlorophyta were the most abundant. In September 2018, 110 taxa were found and *D. spiroides, M. aeruginosa, Trachelomonas planctonica* Svirenko and *A. granulata* were dominants **(Table 1).**



Table 1. List of phytoplankton taxa in fish ponds with grass carp polyculture during different months ofboth studied years, where * - occurrence and ** - dominance.

**T axa/Y ear 2018 2019 M onth** IV V VI VII VIII IX V VI VII VIII IX

**Cyanoprokaryota**

*Anabaena* sp. * *Anabaena sphaerica* Bornet **&** Flahault ** ** ** ** ** * *

*Anabaenopsis arnoldii* Aptekar * *

*Anathece clathrata* (West & G. S. West) Komárek, Kastovsky & Jezberová **&** Flahault * * * * * * * * * * ** ** * * ** ** * *

*Aphanizomenonflosaquae* Ralfs ex Bornet

*Aphanizomenon gracile* Lemmermann * * ** *Aphanocapsa delicatissima* West&G.S. West * * * * *

*Aphanocapsa* sp. * * * * * * * * *

*Aphanothece elabens* (Brébisson ex Meneghini) Elenkin * *

*Chroococcus turgidus* (Kützing) Nägeli) * * * * * * * * *Coelosphaerium confertum* West & G. S. West *

*Cuspidothrix issatschenkoi* (Usachev) P. Rajaniemi, Komárek, R.Willame, P. Hrouzek, K. Kastovská, L. Hoffmann & K. Sivonen Wacklin, L. Hoffmann & Komárek * *

*Dolichospermumflosaquae* (Brébisson ex Bomet & Flahault) P. Wacklin, L. Hoffmann & Komárek * * * *

*Dolichospermum lemmermannii* (Richter) P. Wacklin, L. Hoffmann & Komárek *

*Dolichospermum planctonicum* (Brunnthal er) Wacklin, L. Hoffmann & Komárek * ** * ** ** * * ** ** ** ** ** ** ** *

*Dolichospermum spiroides* (Klebhan)

*Gomphosphaeria aponina* Kützing * *

*Limnococcus limneticus* (Lemmermann) Komárková, Jezberová, O. Komárek & Zapomelová * * *

*Limnothrix redekei* (Goor) Meffert *

*Merismopedia elegans* A. Braun ex Kützing * *Merismopedia glauca* (Ehrenberg) Kützing * *

*Merismopedia punctata* Meyen * * * *

*Merismopedia* sp. * * 61

**T axa/Y ear 2018 2019 M onth** IV V VI VII VIII IX V VI VII VIII IX *Merismopedia tenuissima* Lemmermann * * * * *Microcystis aeruginosa* (Kützing) Kützing * ** ** ** ** ** ** *Microcystis* sp. * * * *

*Microcystis wesenbergii* (Komärek) Komärek ex Komärek * * * * ** **

*Noctoc sp.* *

*Oscilatoria* sp. * * * * * *Oscillatoria limosa* C. Agardh ex Gomont ** * ** ** * ** ** *

*Phormidium* sp. * *

*Planktolyngbya limnetica* (Lemmermann) Komärkovä- Legnerovä & Cronberg * * ** ** ** *

*Planktolyngbya* sp. *

*Planktothrix agardhii* (Gomont) Anagnos tidis & Komärek *

*Pseudanabaena catenata* Lauterbom ** *Pseudanabaena galeata* Böcher * *

*Pseudanabaena limnetica* (Lemmermann) Komärek *

*Pseudanabaena* sp. *

*Synechococcus linearis* (Schmidle & Lauterborn) Komärek *

*Snowella lacustris* (Chodat) Komärek & Hindäk * * *

**Chlorophyta**

*Actinastrum hantschii* Lagerheim * * * * * * * * * *

*Ankistrodesmus bibraianus* (Reinsch) Korshikov * * * * * *

*Ankistrodesmus falcatus* (Corda) Ralfs * * *Ankistrodesmus fusiformis* Corda * * * * * * *

*Ankistrodesmus longissimus* (Lemmer mann) Wille

*Ankistrodesmus spiralis* (W. B. Turner) Lemmermann

*Ankyra ancora* f. *issajevii* (Kisselev) Fott *

* * * * *

*Ankyra judayi* (G. M. Smith) Fott * * * *Ankyra ocellata* (Korshikov) Fott * *Ankyra* sp. * *Carteria klebsii* (P. A. Dangeard) Francé *

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*Characium angustum* A. Braun * * * *

*Characium* sp. * * *Chlamydomonas* cf. *incerta* Pascher * * *Chlamydomonas simplex* Pascher **

*Chlamydomonas* sp. * *Chlorella vulgaris* Beyerinck * *Chlorolobion braunii* (Nägeli) Komárek *

*Coelastrum astroideum* De Notaris * * * * * * *Coelastrum microporum* Nägeli in A. Braun * * * * *

* ** *Coelastrum* sp. * * *Coelastrum sphaericum* Nägeli *

*Coenochloris* sp. * *Crucigenia quadrata* Morren ** * * ** * ** * ** * *Crucigenia* sp. * *Crucigenia tetrapedia* (Kirchner) Kuntze * ** * * ** * *

*Crucigeniella pulchra* (West & G. S. West) Komárek

*Desmodesmus protuberans* (F. E. Fritsch & M. F. Rich) Hegewald * * * * *

*Desmodesmus bicaudatus* (Dedusenko) P. M. Tsarenko

*Desmodesmus brasiliensis* (Bohlin) He gewald ** * * *

*Desmodesmus communis* (Hegewald) Hegewald *

*Desmodesmus denticulatus* (Lagerheim) S. S. An, T. Friedl & Hegewald ** ** ** ** ** ** ** ** ** ** * * * * * ** * *

*Desmodesmus intermedios* (Chodat) He gewald *

*Desmodesmus opoliensis* (P. G. Richter) Hegewald *

*Desmodesmus perforatus* (Lemmermann) Hegewald ** * ** * ** ** * ** ** *

*Desmodesmus spinosus* (Chodat) Hegewald * * * * * * * *Dictyosphaerium ehrenbergianum* Nägeli *

*Eudorina elegans* Ehrenberg * *Golenkinia radiata* Chodat * * ** * ** ** *Gonium pectorale* O. F.

Müller *

*Hariotina polychorda* (Korshikov) Hegewald
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*Hyaloraphidium contortum* Pascher & Korshikov * * * *

*Hyaloraphidium rectum* Korshikov *

*Kirchneriella lunaris* (Kirchner) Möbius * *

*Kirchneriella obesa* (West) West & G. S. West * *

*Koliella longiseta* (Vischer) Hindäk *

*Korshikoviella limnetica* (Lemmermann) P. C. Silva * * * *

*Lagerheimia ciliata* (Lagerheim) Chodat * ** *Lagerheimia genevensis* (Chodat) Chodat * ** * * *Lagerheimia* sp. * * *Lambertia* sp. *

*Lemmermannia triangularis* (Chodat) C. Bock & Krienitz * * * * * *

*Messastrum gracile* (Reinsch) T. S. Garcia ** * * * * * * *Micractinium pusillum* Fresenius * *
* * * * ** *

*Micractinium quadrisetum* (Lemmermann) G. M. Smith * * * *

*Monactinus simplex* (Meyen) Corda ** ** ** ** ** ** * ** ** **

*Monoraphidium contortum* (Thuret) Komärkovä-Legnerovä Komärkovä-Legnerovä
* * * * *

*Monoraphidium griffithii* (Berkeley)

*Monoraphidium* sp. *

*Mucidosphaerium pulchellum* (H. C. Wood) C. Bock, Proschold & Krienitz * * * * * * * * *

*Oocystidium ovale* Korshikov * * *

*Oocystis borgei* J. W. Snow * *

*Oocystis lacustris* Chodat * * * * * * ** * * * * *Oocystis* sp. * * * * *Pandorina morum* (O. F. Müller) Bory ** * * * * * * * ** * ** * *Pediastrum duplex* Meyen ** ** ** * ** ** * ** ** **

*Pseudodidymocystis planctonica* (Korshikov) Hegewald & Deason

*Pseudoschroederia robusta* (Korshikov) Hegewald & E. Schnepf * * *

*Pseudopediastrum boryanum* (Turpin) Hegewald *

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*Scenedesmus acuminatus var.biseriatus* Reinhard

*Scenedesmus arcuatus* (Lemmermann) Lemmermann

*Scenedesmus acuminatus* var. *elongatus* G. M. Smith * * * * * ** * * * * * * * ** *

*Scenedesmus apiculatus* (West & G. S. West) Chodat ** * * * * * *

*Scenedesmus obtusus* Meyen * *Scenedesmus producto-capitatus* Schmula * * *

*Scenedesmus* sp. * * *

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*Schroederia setigera* (Schröder) Lemmermann

*Schroederia* sp. * * *Schroederia spiralis* (Printz) Korshikov * * *Selenastrum bibraianum* Reinsch *

*Sphaerocystis* sp. * *Stauridium tetras* (Ehrenberg) Hegewald * * * *

*Stichococcus* sp. *

*Tetrachlorella alternans* (G. M. Smith) Korshikov *

*Tetradesmus bernardii* (G. M. Smith) M.J.Wynne *

*Tetradesmus lagerheimii* M. J. Wynne & Guiry ** ** * ** * ** ** ** * ** ** ** ** ** * ** ** *

*Tetradesmus obliquus* (Turpin) M. J. Wynne **

*Tetraedron minimum* (A. Braun) Hansgirg * * * ** * * * *Tetraedron caudatum* (Corda) Hansgirg * *

*Tetraedron* sp. *

*Tetrastrum* sp. * * * * *

*Treubaria planctonica* (G. M. Smith) Korshikov & Kovacik * * * * *

*Treubaria schmidlei* (Schröder) Fott

*Treubaria* sp. * * * *Vitreochlamys velata* (Korshikov) Ettl *

*Volvox aureus* Ehrenberg *

*Willea apiculata* (Lemmermann) D. M. John, M. J. Wynne & P. M. Tsarenko
* *



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**Streptophyta**

*Closterium aciculare* T. West *

*Closterium acutum* Brebisson in Ralfs * *Closterium pronum* Brebisson * ** * ** **

*Closterium* sp. * *

*Cosmarium margaritiferum* Meneghini ex Ralfs * * * *

*Cosmarium* sp. * ** * * * * *Elakatothrix gelatinosa* Wille * * * * * * * *Gonatozygon* sp. * *

*Sphaerozosma* sp. *

*Spirogyra* sp. *

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*Staurastrum* cf. *cingulum* (West &G.S. West) G. M. Smith

*Staurastrum gracile* Ralfs ex Ralfs * * * * *Staurastrum hexacerum* Wittrock * *

*Staurastrum pingue* var. *planctonicum* (Teiling) Coesel & Meersters * * * *

*Staurastrum* sp. * * * * * * * * * * *Staurastrum tetracerum* Ralfs ex Ralfs ** * *

*Zygnema* sp. *

**Euglenophyta**

*Euglena gracilis* Klebs ** * * ** ** ** *Euglena* sp. * * * ** * * ** * * * *Euglena viridis* (O. F. Müller) Ehrenberg * * * ** ** ** ** **

*Euglenaformisproxima* (Dangeard) M. S. Bennett & Triemer

*Lepocinclis oxyuris* (Schmarda) Marin & Melkonian * * * *

*Lepocinclis acus* (O. F. Müller) Marin & Melkonian

*Lepocinclis ovum* (Ehrenberg) Lemmer mann * * * * * * ** ** ** ** ** *

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*Lepocinclis* sp. ** * ** ** * ** *Phacus curvicauda* Svirenko * * * ** * * * *Phacus longicauda* (Ehrenberg) Dujardin * * * * * * * * * ** *Phacus orbicularis* K. Hübner * * * * * * * ** * ** *

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*Phacus* sp. * *Phacus tortus* (Lemmermann) Skvortzov * * * *Strombomonas* sp. * * * * * * ** ** * * *

*Trachelomonas hispida* (Perty) F. Stein **

*Trachelomonas planctonica* Svirenko * ** ** ** * ** *Trachelomonas* sp. ** * * * ** ** * * *

*Trachelomonas volvocina* (Ehrenberg) Ehrenberg * ** * ** *

**Pyrrhophyta**

*Ceratium furcoides* (Levander) Langhans ** **

*Ceratium hirundinella* (O. F. Müller) Dujardin

* ** **

*Glenodinium* sp. * * * *Gymnodinium* sp.

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*Parvodinium* cf. *inconspicuum* (Lemmermann) Carty

*Peridinium bipes* F. Stein * ** * * ** ** ** ** *Peridinium* cf. *aciculiferum* Lemmermann **

*Peridinium cinctum* (O. F. Müller) Ehrenberg * *

*Peridinium* sp. * * * * * * ** ** ** ** **Ochrophyta**

**Chrysophyceae**

*Dinobryon borgei* Lemmermann * *

*Dinobryon divergens* O.E.Imhof * * *Dinobryon sociale* (Ehrenberg) Ehrenberg * *Kephyrion* sp. *

*Uroglena* sp. *

**Eustigmatophyceae**

*Tetraedriella acuta* Pascher *

*Tetraedriella gigas* (Wittrock) Hansgirg * *

*Tetraedriella* sp. *

*Tetraedriella spinigera* Skuja * * *

**Synurophyceae**

*Mallomonas acaroides* Perty *

*Mallomonas elongata* Reverdin * *

*Mallomonas* sp. *

**Raphidophyceae**

*Gonyostomum* cf. *ovatum* Fott * ** *

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*Gonyostomum* cf. *semen* (Ehrenberg) Diesing * * * ** ** ** **

*Gonyostomum depressum* (Lauterbom) Lemmermann

*Gonyostomum* sp. * * * ** *Vacuolaria* sp. * **Xanthophyceae**

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*Centritractus belonophorus* (Schmidle) Lemmermann

**Bacillariophyceae**

*Amphiphora* sp. *

*Amphora* sp. * * * * * * * *Anomoeoneis* cf. *sphaerophora* Pfitzer *

*Asterionella formosa* Hassall * *

*Aulacoseira granulata* (Ehrenberg) Simonsen

** ** ** ** ** ** ** ** ** **

*Aulacoseira islandica* (O. Müller) Simonsen * * *

*Caloneis amphisbaena* (Bory) Cleve * * * *Caloneis silicula* (Ehrenberg) Cleve * * * *Cocconeis pediculus* Ehrenberg * * *Cocconeis placentula* Ehrenberg ** ** * * * * *

*Cocconeis placentula* var. *euglypta* (Ehrenberg) Grunow * *

*Cocconeis* sp. *

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*Ctenophora pulchella* (Ralfs ex Kützing) D. M. Williams & Round

*Cyclotella* cf. *glomerata* H. Bachmann *

cf. *Discostella stelligera* (Cleve & Grunow) Houk & Klee * *

*Cyclotella meneghiniana* Kützing * * * * * *

*Cyclotella* sp. ** * * * * * * ** * * * *Cymatopleura solea* (Brebisson) W. Smith * * * * *

*Cymatopleura* sp. * * * *Cymbella cymbiformis* C. Agardh * *

*Cymbella* sp. * * * * * * * *Cymbella tumida* (Brebisson) Van Heurck *

*Diatoma* sp. *



*Diatoma vulgaris* Bory * * *Diploneis elliptica* (Kützing) Cleve * *Diploneis* sp. * *

*Encyonema ventricosum* (C. Agardh) Grunow in A. W. F. Schmidt Bertalot & Krammer * * * *

*Epithemia frickei* Krammer in Lange

*Epithemia* sp. * *

*Epithemia zebra* (Ehrenberg) Kützing *

*Eunotia* sp. * *Fragilaria capucina* Desmazieres *

*Fragilaria crotonensis* Kitton * * *Gomphonema acuminatum* Ehrenberg * * * * * *

*Gomphonema acuminatum* var. *coronatum* (Ehrenberg) Rabenhorst * * *

*Gomphonema augur* Ehrenberg * * *

*Gomphonema constrictum* Ehrenberg in Kützing Van Heurck * * * * * *

*Gomphonema constrictum* var. *capitatum* (Ehrenberg) Grunow in

*Gomphonema gracile* Ehrenberg * * * * *Gomphonema* sp. *

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*Gyrosigma acuminatum* (Kützing) Rabenhorst

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*Lindavia comta* (Kützing) Nakov, Gullory, Julius, Theriot & Alverson

*Melosira varians* C.Agardh * * *Meridion circulare* (Greville) C. Agardh * * *

*Navicula gracilis* Ehrenberg *

*Navicula radiosa* Kützing *

*Navicula* sp. * * * * * * ** ** * * * *Navicula vulpina* Kützing *

*Nitzschia holsatica* Hustedt * * * * * ** * * *Nitzschia* sp. * *Pleurosigma elongatum* W. Smith * *

*Rhopalodia gibba* (Ehrenberg) O. Müller * * * *

*Stephanodiscus astraea* (Kützing) Grunow * * **

*Stephanodiscus hantzschii* Grunow in Cleve & Grunow * * * *

*Stephanodiscus* sp. * * * 69

**Taxa/Year 2018 2019 Month** IV V VI VII VIII IX V VI VII VIII IX *Surirella* sp. * * * *Synedra* sp. * *

*Tabularia tabulata* (C. Agardh) Snoeijs *

*Ulnaria acus* (Kutzing) Aboal ** ** ** ** ** ** * * ** *Ulnaria ulna* (Nitzsch) Compere ** * * * * * * *

In the first samples for 2019 (in May), 71 taxa were found. The most abundant species were from Chlorophyta and Euglenophyta. *D. communis* and *Pediastrum duplex* Meyen, *E. gracilis*, *Gonyostomum* cf. *ovatum* Fott and *A. granulata* had the highest biomass.

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April 2018 May 2018 June 2018 July 2018 August 2018 September ~ 2018

Fig. 1. Number of phytoplankton taxa in experimental fish ponds per month during the spring-summer period in 2018.

In June 2019, 65 taxa were recorded. In all experimental ponds, *M. aeruginosa, E. gracilis, O. limosa* and *D. communis* were dominants. In July 2019, 83 species were identified with *A. granulata* and *D. communis* dominating in that period. In August 2019, 72 taxa of algae were identified with *Ceratium furcoides* and *E. gracilis* among the most abundant. In September 2019, among the 69 taxa identified, *Ceratium furcoides, E. gracilis,* and *Gonyostomum depressum* dominated **(Table 1).** It is important to note, that among the dominants, cyanoprokaryotes from genera *Aphanizomenon, Dolichospermum* and *Microcystis,* which are well-known for their ability to be potent cyanotoxin producers affecting ecosystem and human health (*e.g.* M e r ilu o to e t a l . 2017), were found. The broad distribution of these genera and their relation with toxic blooms in Bulgaria was shown in the summary by S to y n e v a - G a r tn e r e t a l . (2017).

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May 2019 June 2019 July 2019 August 2019 September 2019

Fig. 2. Number of phytoplankton taxa in experimental fish ponds per month during the late spring-summer periods in 2019.

The results obtained during this study are in accordance also with the earlier results which have demonstrated that the high stocking density of grass carp can seriously affect the functioning of the aquatic ecosystems. For example, negative changes may be associated with alterations in the structure and abundance of plant communities, as well as in the environment they inhabit, such as changes in transparency, sediments, and increased levels of biogens after deposition of faeces (PipALOVA 2006; Dibble & K ovalenko 2009). Earlier, R ich ard e t a l. (1984) reported that three years after the introduction of grass carp Chlorophyta and Bacillariophyta should significantly increase and the amount of Cyanoprokaryota should decrease. H o ld re n & P o rte r (1986) also demonstrated that after the introduction of grass carp, changes in the dominant phytoplankton species occurred.

300

250

200

150

100

50

0

In both years Total 2018 T otal 2019

Fig. 3. Number of phytoplankton taxa in experimental fish ponds during the spring-summer periods of 2018, 2019 and in both years.



According to B orics e t a l. (2016) in small ponds, despite the expected development of small nannoplankton, summer conditions favor the development of large euglenoids, cyanoprokaryotes and chlorophytes but the size of the ponds clearly affects the detailed composition of the phytoplankton. In our study, algal biodiversity and abundance were significantly lower in 2018 compared to 2019 with registered changes in the dominant species. The most significant differences were observed in the Chorophyta, Streptophyta and Ochrophyta divisions from which more taxa were found in the first year than in the second, while there was almost no difference in the number of identified Cyanoprokaryota species. These results are on conformity with the data on the taxonomic structure of the phytoplankton obtained in our previous research (D ochin e t a l., in press).

In the early summer of 2018, after the removal of macrophytes from the grass carp, the development of phytoplankton rapidly increased and reached pronounced peaks in all experimental ponds (except P6), which will be described in details elsewhere. This rapid development with increase of the phytoplankton biomass was linked with high amount of nutrients released after the aquatic vegetation was removed by the grass carp and with the improved light regime in the water column (D o c h in e t a l . 2020, in press). In turn, the intense development of phytoplankton can cause shading and suppression of aquatic plants ( B o n a r e t a l . 2002) and this is in accordance with the lack of macrophyte overgrowth observed during 2019 (this study; D o c h in e t a l . 2020, in press).

## CONCLUSION

The changes in the phytoplankton composition in fish ponds stocked with grass carp polyculture observed by us showed relatively high algal biodiversity with considerably less identified species in 2019 than those in 2018. At the same time, a significant change in the structure of the phytoplankton dominants was detected: while the blooms of some potentially toxic species of Cyanoprokaryota were most intense in 2018, in 2019 the most abundant species were from Pyrrhophyta, Euglenophyta and Raphidophyceae. The fact of detecting potentially toxic cyanoprokaryotes as dominants in fish ponds can serve as alarm for monitoring of the summer phytoplankton in these small water bodies.

## CONFLICT OF INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.



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## References

B o n ar S. A., B olding B. & Divens M. 2002. Effects of triploid grass carp on aquatic plants, water quality, and public satisfaction in Washington State. - North Am. J. Fish. Manage. 22: 96-105.

B orics G., Tothm eresz B., G rigorszky I., Padisak J., V arbiro G. & Szabo S. 2003. Algal assemblage types of bog lakes in Hungary and their relation to water chemistry, hydrological conditions and habitat diversity. - Hydrobiologia 502: 145-155.

B orics G., Tothm eresz B., VÄRßiRÖ G., G rigorszky I., CzebelyA. & G örgenyi J. 2016. Functional phytoplankton distribution in hypertrophic systems across waterbody size. - Hydrobiologia 764 (1): 81-90.

Cox J. E. 1996. Identification of freshwater diatoms from live material, Chapman and Hall, London, 158 pp.

Deisinger G. V. 1984. Leit faden zur Best immung der planktischen Algen der Kamtner Seen und ihrer Biomasse, Kamtner Insitut fur Seenforschung, 65 pp. Dibble E. D. & Kovalenko K. 2009. Ecological impact of grass carp: A review of the available data. - J. Aquat. Plant Manage. 47: 1-15.

D ochin K., Ivanova A. & Yankova M. 2020. Effects of the application of polyculture with grass carp to control aquatic vegetation in fishponds on their phytoplankton and macrozoobenthos. - Ann. Sof. Univ., Fac. Biol., Book 2 - Botany 104: 103-114.

D ochin K., Kuneva V. & N ikolova L. Functional groups of algae in small shallow fishponds. - Bulg. J. of Agri. Sei. 3, in press.

Guiry M. D. & Guiry G. M. 2020. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway, http://www.algaebase.org; searched on 14 February 2020.

H o ld ren G. C. & P o rte r S. D. 1986. The effects of grass carp on water quality in McNeely Lake. 6. - In: Annual International Symposium ***Lake and Reservoir Management: Influences o f Nonpoint source pollutants and acid precipitation,*** Portland, 5-8 November 1986, p. 20.

KiRiAKOV I. K., V odenicharov D. G. & Paskaleva E. P. 1982. Phytoplankton composition in fish-raising reservoirs near Plovdiv. - Hidrobiologiya (Sofiya) 17: 14-28 (In Bulgarian, Russian and English summ.).

Komarkova J. 1998. Fish stock as a variable modifying trophic pattern of phytoplankton. - Hydrobiologia 369/370: 139-152.



K o p p R., Re z m c k o v a P., H adasova L., P etr ek R. & B rabec T. 2016. Water quality and phytoplankton communities in newly created fishponds. - Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis 64 (1): 71-80.

L udskanova J. & Paskaleva E. 1975. Feeding of phytophagous fish - silver carp, bighead and their hybrids from larval stage up to summerlings. - Institout po Ribna Promishlenost, Izvestiya na filiala po sladkovodno ribarstvo - Plovdiv 11: 79-95 (In Bulgarian, Russian and English summ.).

Meriluoto J., Spoof L. & Codd J. (Eds) 2017. Handbook of Cyanobacterial Monitoring and Cyanotoxin Analysis, John Wiley & Sons Ltd,

Michev T. M. & Stoyneva M. P. (2007). Inventory of Bulgarian wetlands and their biodiversity. Part 1: Non-lotic wetlands. Publishing House Elsi-M, Sofia, 364 pp. + CD supplement.

Paskaleva E. P. & Vodenicharov D. G. 1984. The effect of fertilizing on the phytoplankton abundance in some fish-raising reservoirs of the Institut of freshwater fisheries in Plovdiv. - Hidrobiologiya (Sofia) 22: 39-50 (In Bulgarian, Russian and English summ.).

Paskaleva E. 1975. Phytoplankton development in carp ponds at polycultutral rearing. Institout po ribna promishlenost, Izvestiya na filiala po sladkovodno ribarstvo, Plovdiv 11: 17-28 (In Bulgarian, Russian and English summ.).

PipALOVA I. 2006. A review of grass carp use for aquatic weed control and its impact on water bodies. - J. Aquat. Plant Manage. 44: 1-12.

Radojicic M. & Kopp R. 2016. Dynamic of the phytoplankton community in eutrophic fishponds. - MendelNet 2016: 352-357.

Richard D. I., Small J. W. & Osborne J. A. 1984. Phytoplankton responses to reduction and elimination of submerged vegetation by herbicides and grass carp in four Florida lakes. - Aquat. Bot. 20: 307-319.

Rott E. 1981. Some result from phytoplankton intercalibration. - Schweis. Z. Hydrol. 43: 34-62.

Sevrin-Reyssac J. & M. Pletikosic. 1990. Cyanobacteria in fishponds. - Aquaculture 88 (1): 1-20.

Stoyneva-Gartner M. P., Descy J.-P., Latli A., Uzunov B., Pavlova V., Bratanova ZL., Babica P., Marsalek B, Meriluoto J. & Spoof L. 2017. Assessment of cyanoprokaryote blooms and of cyanotoxins in Bulgaria in a 15-years period (2000-2015). - Advances in Oceanography and Limnology 8 (1): 131-152.

Vodenicharov D. I. Kiriakov & Russeva J. 1974. Composition and dynamics of the phytoplankton in the ponds with polycultural rearing of carp and mineral fertilization. - Izvestiya na tsentura za naouchnoizsledovatelska razvoina i proektantska deynost po ribno stopanstvo, Filial po promishleno ribovudstvo, Plovdiv 10: 17-34 (In Bulgarian).

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