# AVOIDANCE OF ALGAE BLOOM, KEY FACTOR IN THE SUSTAINABLE DEVELOPMENT OF ECO-EFFECTIVE GROWTH TECHNIQUES OF CARP (*Cyprinus carpio*) WITH SILVER CARP( *Hypophthalmichthys molitrix*) AND BIGHEAD CARP (*Hypophthalmichthys nobilis*)

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***Abstract.*** *Water, nutrients, farmland and energy are the most important aspects of the ecological sustainability of aquaculture farms. With regard to water, both necessary quantity and quality are important . An important goal in all systems is to reduce the amount of water needed in order not to put additional pressure on the natural ecosystem. An equally important objective is to reduce wastewater and optimize discharges because in most cases aquaculture discharges contain many nutrients that could contaminate natural systems. Traditional carpiot fishponds only need water to replace the evaporated or infiltrated ponds; leakage is reduced until harvest. Under these conditions control of microscopic algae bloom is particularly important. Efficient use of the necessary nutrients is also essential for ecological sustainability. The first step is to reduce food losses through an advanced feed system and by selecting the right feed. Using polyculture technologies can increase the efficiency of nutrients due to various ecological niches of fish species. Thus, in the experiments necessary for the development of an eco-efficient fish species breeding technology, three experimental variants were applied, besides the conventional one, to the application of conventional technology, and the use of the growth in polyculture of the carp species, silver carp and big head carp. During the vegetative period of 2016 and 2017, the dynamics and structure of phytoplankton and zooplankton were monitored in the four experimental pools. The results showed that the phytoplankton structure was dominated by chlorophylls and diatoms, which did not pose problems in terms of the flowering phenomenon, with algal densities being small. In the semiintensive growth system practiced in ponds and small lakes, which has as a technological principle the intensification of production on the basis of stimulation of natural fish productivity and supplementary feeding, the carp benefits from the stimulation of the zoobenthos development, the silver carp as phytoplankton consumer, the big head carp from consuming zooplankton.*

***Key words*** *: carp, sustainable development, algal Bloom, polyculture*

## INTRODUCTION

Sustainability of aquaculture and fisheries is a medium- and long-term socio-economic need. About 75 percent of the most valuable marine resources are either exploited to the limit or even beyond. At the same time, world fish consumption has increased from 45 million tonnes in 1973 to more than 130 million in 2000 and FAO estimates that 40 million tonnes of seafood in addition will be needed by 2030 , just to keep current consumption levels.

In order to sustain this growing demand in the long run, sustainable alternatives need to be developed, and the aquaculture industry is the most promising. With a growth rate of 8% a year in the 1980s, aquaculture is probably the fastest growing food industry, accounting for almost half of the world's fish consumed today, from only 9% in 1980. The terms "sustainability" or " sustainable development "are concepts that guarantee an environment that can live for all people in the long term, comprising at least three fundamental components of sustainable development: maintaining a functional environment, economic well-being and social equality. Similarly, in aquaculture, the move towards sustainability means not only achieving environmental objectives but also providing clear economic benefits to long-term farmers in the field.

It is known that the overproduction of planktonic algae results in "flowering of water" - a phenomenon during which algae (especially cyanophytes and euglenophytes) become a source of pollution (adversely affect fish development and can induce population asphyxia), by enriching the ecosystem with organic substances. One of the major indicators of the degree of eutrophication of aquatic ecosystems is the biomass of planktonic algae (especially cyanophytes and euglenophytes). As the phytoplankton biomass increases, the degree of eutrophication of the aquatic ecosystems increases, so the prevention of the phenomenon is important.

## MATERIAL AND METHOD

The experiment was conducted in the years 2016 and 2017 in the Brateş Experimental Base of the Research and Development Institute for Aquatic Ecology, Fisheries and Aquaculture in Galati. The biological material that was the subject of the experiments was carp (Cyprinus carpio) in summer I, obtained in the experimental base Brateş, Galaţi and silver carp (Hypophthalmichthys molitrix) and big head carp (Hypophthalmichthys nobilis) of the same age. The experimental pools were grown in 4 experimental basins - B1, B2, B3, B4 each having a surface of 1 ha and an average depth of 1.8 m. The proposed general formula was: 50% carp (Cyprinus carpio); 25% silver carp (Hypophthalmichthys molitrix); 25% big head carp (Hypophthalmichthys nobilis). The dynamics, phytoplankton and zooplankton structure were monitored monthly in the four experimental pools.

For the study of phytoplankton, sampling was performed in 300 ml glass vials. and preserved with Lugol fixative and sodium acetate (Utermöhl), 0.15-0.25 ml solution at 100 ml / sample. In order to determine the structure of planktonic zoocenosis, samples from the same horizons were collected from where samples of phytoplankton were taken. After collection, the sample volume (10 liters) was concentrated by filtration, using the planktonic mesh made of silk screen No. 25 (the size of the eye being 40-50 μm). The zooplankton concentrate was transferred to 100-150 ml glass vials. The sample was preserved with 4% formol.

In the laboratory, phyto and zooplankton samples were concentrated by slow sedimentation for three weeks, after which the supernatant was removed by siphoning without shaking the sample. From the measured sediment, 5 ml were taken for the study, from which 1 ml of the sample was analyzed by microscope. The total phytoplankton biomass was calculated using the Utermöhl method. For the expression of biomass results cell volumes were used (after NOUWERCK, 1963; DUSSART, 1966; WETZEL, 1975). The zooplankton from the processed samples was analyzed qualitatively and quantitatively on stereomicroscope and Kolkwitz cell microscope. Following the determination of the main taxonomic groups: Rotatoria, Cladocera, Copepoda (after RUDESCU L., 1960; DUSSART, 1966; V.A.IASNOV, 1952), the faunistic consciousness of component taxa was formed. Planktonic biomass was expressed in g / m3 wet matter.

## RESULTS AND DISCUSSION

In 2016, from the qualitative analysis, the same frequency scale was used to highlight the frequency of encounters of phytoplankton and zooplankton species: very frequent forms

(+++) - species with a frequency greater than 50%; frequent forms (++) - species with a frequency between 25% and 50%; rare forms (+) - species with a frequency of less than 25%.
Regarding the quantitative structure of phytoplankton, algal biomass in basin B1 recorded values between 1.387 and 8.17 g / cm3 during the vegetative period. Chlorophylls and cyanophils, isolated diatoms (table no. 1), predominated. In the experimental basin B2, algal biomass recorded values ranging from 2.88 to 11.22 g / cm3, with a peak in July, due to the decrease in the number of zooplanktons. The number of zooplanktons decreased as a result of their consumption by carp specimens because they are part of their feed spectrum. In experimental basin B3, algal biomass ranged from 1.51 to 7.03 g / m 3, with a maximum in July. In experimental basin B4, algal biomass recorded values between 1.38 and 8.02 g / cm3, with a peak in July.

*Table* 1

Phytoplankton structure in experimental basins

| Experimental basins | Total Biomass, From which: | Chlorophyta | Bacillariophyta | Cyanophyta |
|---|---|---|---|---|
| | g/mc | | | |
| B1 | 4.799 | 2.092 | 0.893 | 1.815 |
| B2 | 6.790 | 5.216 | 1.091 | 0.483 |
| B3 | 4.535 | 2.240 | 1.149 | 1.145 |
| B4 | 4.938 | 2.851 | 0.826 | 1.261 |

Table no 2 shows the frequency of the phytoplankton forms in the experimental basins. After the microscopic analysis of the water samples in the ponds, the phytoplankton, represented by the following groups of algae: chlorophylls, cyanopites, diatoms, euglenophytes, pyrophites. The species found in the analyzed samples belong to the genres: *Cosmarium*, *Closterium*, *Chlamidomonas*, *Chlorella*, *Crucigenia*, *Ankistrodesmus*, *Lagerheimia*, *Pediastrum*, *Scenedesmus*, *Tetraedron*, *Tetrastrum*, (*Chlorophyceae)*, *Aphanizomenon*, *Anabaena*, *Merismopedia*, *Oscillatoria Phormidium*, (*Cyanophyceae*), *Cymbella*, *Cyclotella*, *Diatoma*, *Navicula*, *Synedra*, *Surirella*, *Fragillaria*, *Nitzschia*, *Stephanodiscus*, (*Bacillariophyceae*), *Lepocinclis*, *Euglena*, *Trachelomonas*, *Phacus*, (*Euglenophceae*), *Cryptomonas* (*Pyrrophyceae*).

*Table* 2

The composition of phytoplankton in the experimental basins

| Systematic group | Representatives from groups | B1 | B2 | B3 | B4 |
|---|---|---|---|---|---|
| Euglenophyta | *Phacus* | + | + | | |
| | *Euglena* | + | + | + | + |
| Cyanophyta | *Anabaena* | + | ++ | | ++ |
| | *Merismopedia* | + | ++ | | ++ |
| | *Oscillatoria* | + | + | ++ | |
| | *Nostoc* | + | ++ | ++ | ++ |

| | | | | | |
|---|---|---|---|---|---|
| Chlorophyta | *Ankistrodermus* | + | + | | ++ |
| | *Cosmarium* | + | ++ | +++ | +++ |
| | *Closterium* | + | ++ | ++ | +++ |
| | *Pediastrum* | ++ | +++ | +++ | +++ |
| | *Scenedesmus* | +++ | ++ | ++ | +++ |
| Bacillariophyta | *Asterionella* | + | + | ++ | ++ |
| | *Diatoma* | +++ | ++ | ++ | ++ |
| | *Fragilaria* | + | ++ | ++ | ++ |
| | *Navicula* | ++ | ++ | ++ | ++ |
| | *Nitzschia* | + | + | | |
| | *Pleurosigma* | ++ | ++ | | |

The qualitative structure of phytoplankton in the 4 experimental pools is presented in the graphs below (*graphs* 1, 2, 3, 4).

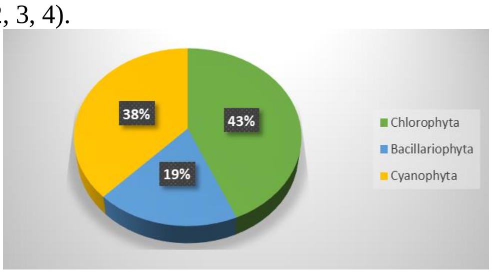


Fig. 1 – Qualitative structure of phytoplankton in basin B1

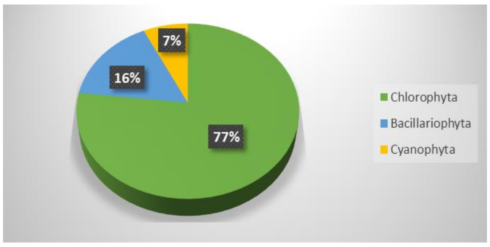


Fig. 2 – Qualitative structure of phytoplankton in basin B2

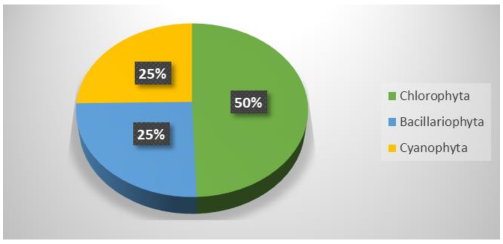


Fig. 3 – Qualitative structure of phytoplankton in basin B3

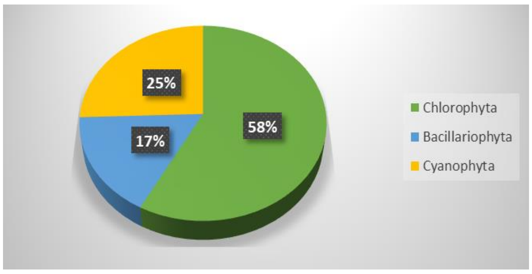


Fig. 4 – Qualitative structure of phytoplankton in basin B4

Zooplankton biomass recorded values ranging from 0.97-12.70 g / cm3 in basin B1, with a peak in July. In B2 zooplankton biomass registered values ranging from 0.488-12.50 g / m3, the highest value being registered in August. In B3 zooplankton biomass registered values between 0.011-3.59 g / m 3, the highest value being registered in August. In B4 zooplankton biomass registered values between 0.065 and 12.79 g / m3, the highest value being registered in August (*table no*.3).

*Tabel 3*

Quantitative structure of zooplankton in experimental basins

| Experimental basins | Total biomass, from which: | Rotatoria | Copepoda | Cladocera |
|---|---|---|---|---|
| | g/mc | | | |
| B1 | 4.885 | 0.130 | 1.516 | 3.239 |
| B2 | 5.015 | 0.453 | 1.727 | 2.834 |
| B3 | 2.178 | 0.856 | 0.460 | 0.862 |
| B4 | 4.664 | 0.147 | 1.233 | 3.284 |

The zooplankton analysis shows a quantitative increase in cows in August in experimental chambers. Rotifers are poorly represented at the beginning of the vegetative period, their weight being increased towards the end of the vegetative period. Copepods are for the entire vegetative period, except for basin B3, where they are no longer present in October in the analyzed sample.

The frequency of zooplanktonic species in the experimental basins is shown in Table 4. After the zooplankton analysis, during the whole study period, it was well represented by the species Brachionus calyciflorus, Brachionus forficula, Brachionus urceolaris, Brachionus diversicornis, Polyarthra vulgahs, Keratella quadrata, Keratella cochleahs of the Rotatoria class. The copepods were represented by the species: Cyclops strennus and Macrocyclops albidus, and the cladocele of the species: Bosmina longirostris, and Moina brachiata.

*Table 4*

The composition of zooplankton in experimental basins

| Systematic group | Representatives of the groups | B1 | B2 | B3 | B4 |
|---|---|---|---|---|---|
| Rotifera | *Brachionus* | + | + | + | + |
| | *Polyarthra* | + | + | + | + |

| | | | | | |
|---|---|---|---|---|---|
| | *Keratella* | + | + | + | + |
| | *Synchaeta* | + | + | + | + |
| Copepoda | *Cyclops* | ++ | + | + | + |
| | *Eudiaptomus* | + | + | + | + |
| | *Nauplius* | +++ | ++ | ++ | ++ |
| | *Metanauplius* | ++ | + | ++ | ++ |
| Cladocera | *Moina* | +++ | +++ | +++ | +++ |
| | *Bosmina* | +++ | +++ | +++ | +++ |

In the year 2017, the phytoplankton from a quantitative point of view shows that due to the high water temperatures at the beginning of June and July, the quantity of phytoplankton in stations 1 and 2 was high. (graph no. 5)

**Quantitative variation of phytoplankton in experimental basins**

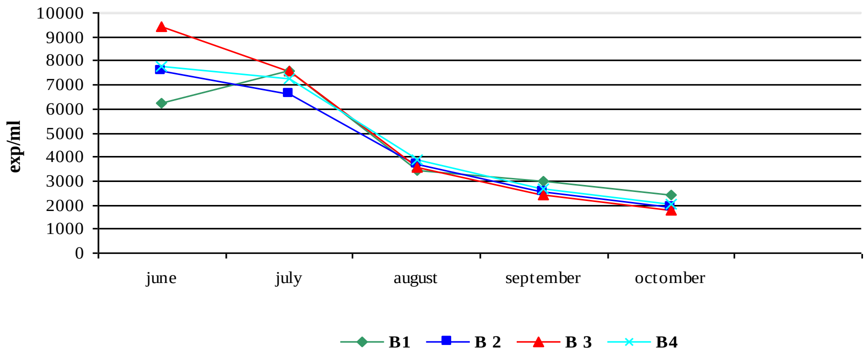


Fig. 5 – Quantitative variation of phytoplankton in experimental basins

Analyzing the groups of phytoplankton we can observe the dominance of diatoms, followed by chlorophylls, cyanophiles and euglenophiles. The cyanophytes prevailed in June and August at all the stations where samples were taken due to the high water temperature during this period. Phytoplankton biomass peaked in July (8.657 g / m3) in basin B2. The smallest values were also recorded in August in the B2 basin (graph no. 6)

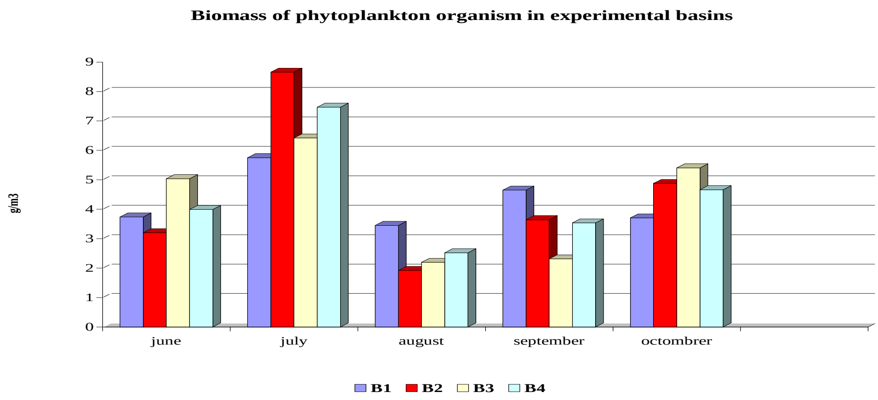


Fig. 6- Biomass of phytoplankton organisms in experimental basins

Zooplankton is represented by a small number of species grouped into three systematic groups: *Rotatoria*, *Copepoda and Cladocera*. Analyzing the zooplankton's components, rotifers dominate in both stations, being represented by species belonging to the genus: *Brachionus and Polyarthra*. The group of copepods is represented by specimens of the Macrocyclops genus of juvenile specimens (nauples) at different stages of development. Copepods are larger than rotifers , in terms of number of copies.

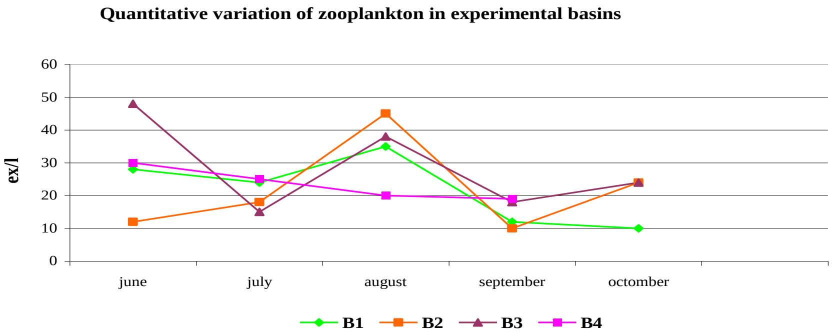


Fig.7 - Quantitative variation of zooplankton in experimental basins

In B3 there was a peak in June (48 ex./l) and a minimum in September (10 ex./l) in basin B2. The zooplankton was poor in terms of the number of species throughout the study period. Referring to biomass, it is noted that the highest values were in August (0.363g / m3) in basin B3, and the highest value small in June (0.0051 g / m3) in pool B2. In general, the copepods are smaller than the rotifers not only in terms of number of copies. Cladocereas appear less frequently, generally present during periods of high temperature.

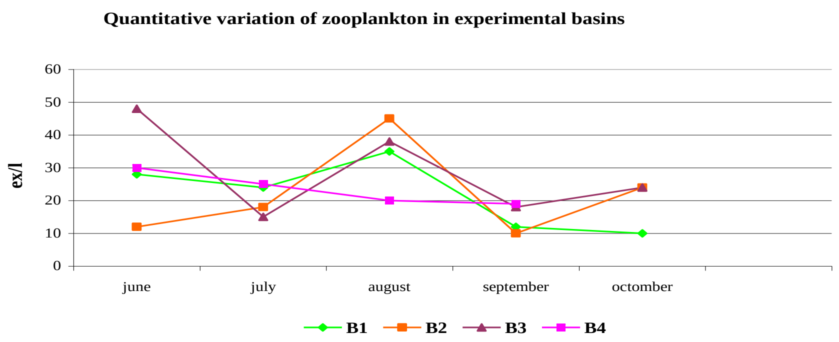


fig.8 – Biomass of zooplanktonic organisms in experimental basins

As in the case of copepods, cladocean adults are found especially in summer and autumn.

## CONCLUSIONS

Analyzing the structure and dynamics of micro flora and micro fauna remaining in the experimental basins, there is a low level of diversity at each trophic level. The decrease in the density of the remaining plankton was a clear indicator of the pressure on these trophic levels of consumers (the use in the popular formula of phytoplanktonophagi)

Due to remarkable differences between the size of the alfoflora species and the zooplankton, as well as their dividing rate, there is no consistency between density and biomass. That is why high biomass corresponds to low densities, which reflects the predominance of large-scale species and slowed by divisions and vice versa.

In the phytoplankton structure the chlorophylls and diatoms predominated, which did not pose problems in terms of the flowering phenomenon, the algal densities being small.

Zooplankton is well represented by cladocers, which had high densities in the shore area, especially in August, appearing the hunting phenomenon.

Density of algal species records high values before the introduction of biological material into all experimental basins.

Reducing the nutrient intake in aquatic ecosystems and preventing the "Blooming of water" is influenced by ensuring a habitat that meets the biological requirements of fish species (1.5 m minimum depth, independent water supply and evacuation facilities, basins to provide a complete vents, basins not to be invaded by vegetation)

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