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ORIGINAL ARTICLE

THE DYNAMICS OF THE PLANKTON FOR THE SECOND SUMMER OF CARP POLYCULTURE WITH PHYTOPLANKTON CONSUMER SPECIES*

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The biologic processes in water are strictly dependent on physical-chemical factors. By maintaining the balances of the environmental factors, it can ensures the micro and macro fauna development with direct implication on breeding and developing the fishy material.
The aim of this article was to monitor and register the plankton dynamics in six rearing ponds for the polyculture of carp (*Cyprinus carpio*) with Asian complex species: silver carp (*H. molitrix*), grass carp (*Ct. idella*) and bighead carp (*A. nobilis*). The experiment took place in six ponds of C.C.D.P. Nucet, during a period of 120 days.
At the end of the experiment one determined that the evolution of both phytoplankton and zooplankton was in a close correlation with both the variation of physical-chemical factors as well as with the technology of the fishy material in these ponds.

Keywords: dynamics, plankton, carp (*Cyprinus carpio*), polyculture

1. Introduction

By the nature of the energy used and by the intervention way, fish breeding was and still is an ecological occupation in many countries, but one aimed at transforming it from a subsisteme activity into a profitable one which imposed the intervention intensification by: increasing the energy entries, increasing the flux speed and making the use of energy efficient (Medina-Sachez *et al*., 1999).

Rearing in the second summer of cultured cyprinids on the base of natural feed, product stimulated by mineral and organic fertilization is efficient by production, but especially by quality. The trophic base care to be able to sustain increasingly densities of species from biocenose structure, species that also have a satisfactory growth rhythm (Wedemeyer, 1996).

2. Material and methods

The breeding experiment for the 2nd summer of carp in polyculture with Asian cyprinids was realized in six experimental ponds belonging to the experimental centre Cazaci-Marata.

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The ponds were prepared following the technological regulations in traditional fish breeding. In winter time, when the tank is still dry, quick lime was used in the amount of 500 kg/pond. The supply and evacuation networks of each tank were verified and repaired. To avoid wild juvenile fish from penetrating the ponds, the flooding was made through nytal sieves of 1 mm loops.

The population material resource has come from CCDP Nucet,, and it had been obtained by artificial reproduction of species and their breeding in the 1st summer in the ponds of Cazaci River. The juvenile fish were introduced for winter time in ponds belonging to CCDP Nucet, and during this period they were closely surveyed, while providing optimum conditions for the winter period.

3-4 days before the flooding, organic fertilizer will be administered and the doses are established according to the level of the biogene elements in the water.

The population of the experimental ponds took place at a water temperature of 20°C on 10th May 2008.

On the 2nd summer the fish were fed on mixed fodder having a protein content of 25%.

The fodder mixture is made up of: sunflower 25%, soy 25%; cereals 30%, wheat bran 10%, meat flour 9%, fish flour 1%.

The biochemical composition of the fodder used while breeding in the 2nd summer consisted of proteins 25%, fats 4.5-5.6%, carbon hydrates 27-33%.

The initial fodder ratio established for fish breeding in this experiment was of 2.5% of the body mass/day. On the first day of the experiment the fish were left to adapt to their new life environment without receiving any food. Starting with the second day we began administering 25% of the calculated fodder ratio to adapt them to the feeding intensity, and in the following days we continued by 50-75% and in the end by 100% in the fourth day. The total quantity of fodder/day was administrated in 2 equal portions for meals set at a fixed time. We controlled daily the fodder meals to note if the fish were consuming the fodder or not. During the experiment, according to the results t of the control catchesg, the fodder ratio was diminished to 2%, respectively 1%, towards the end of the experiment.

The survey of the environmental conditions was made by means of the field equipment and of the scientific experiment laboratory of CCDP Nucet.

The quality parameters surveyed during the experiment are represented by: temperature, oxygen, nitrites, nitrates, ammonium, phosphates, pH, calcium, alkalinity, hardness, CCO and chlorides.

Their determination was made by using the following equipment: oxygen concentration and saturation percentage determined on the WTW Oxi 315 apparatus, pH determined by the pH-meter WTW.

For the other survey parameters we used standard determination methods (APHA, 1985). The water transparency was measured by means of the Secchi disk.

CCO was determined weekly in all the experimental ponds, in the laboratory. The variation of this ion was registered weekly, being considered one of the determining parameters in establishing the organic fodder doses and the control of water quality.

3. Results and Discussions

Survey of the water quality parameters

Temperature, the determining factor in the technology progress (the fodder was administrated according to its evolution) varied between the values of 20°C for population and 15.5°C by the end of the experiment, recording a maximum of 28.8°C, in August. The temperature determined values corresponding to the carp and Asian cyprinids growth.

The temperature evolution all over the experimental period is presented in Figure1. Its variation was within optimum limits for the fish growth and development, reaching a maximum in July. This was mainly due to the high temperature of this period.

One must consider the variation of this parameter when examining the health status of the fishy material.

The ammonium ion registered relatively high variations during the experiment in the experimental tanks where we administered rother soil (Figure 3).

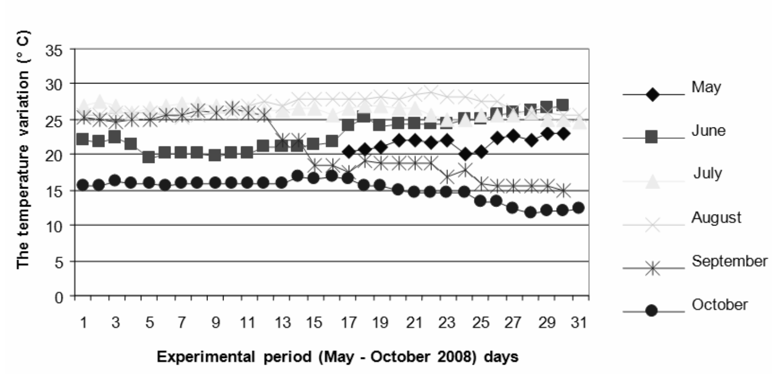

Figure 1. The temperature variation during the growth period

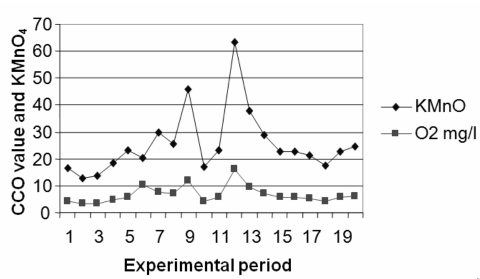

Figure 2. The CCO variation and that of oxidizability to $KMnO_4$ (mg/l)

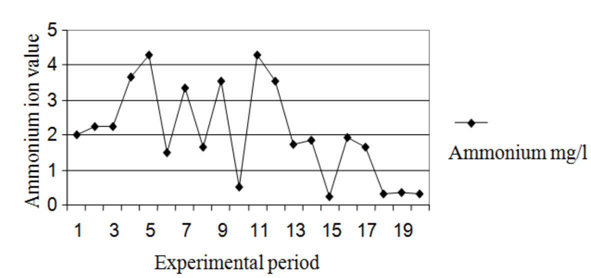

Figure 3. The variation of the ammonium ion during the experiment development

The variation of the phosphate ion was influenced by the natural biological productivity and the amount of super-phosphate administrated (Manca and Comoli, 1999; Pugnetti and Bettinetti, 1999). In the ponds where we administrated super-phosphate one noted a real growth of the content in this ion, and in those where we also administrated rother soil one noted that because of the tank natural productivity growth, the phosphates level recorded a significant growth, too (Figure 4).

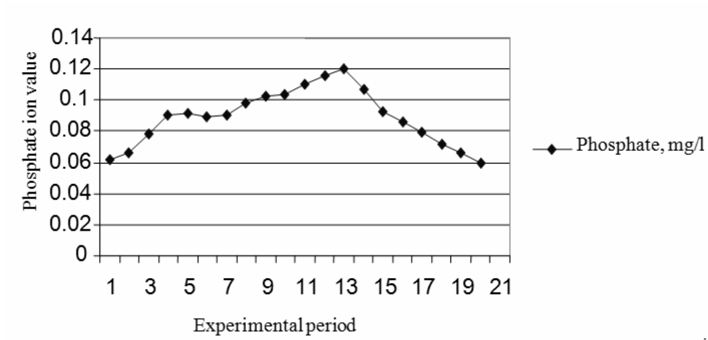

Figure 4. The variation of the phosphate ion

Survey of the biological factors

Production realized by mineral fertilization on 50 kg superphosphat and 100 kg ammonium nitrogen/ha and organic fertilization on 10000 kg/ha.
The average phytoplankton biomass 450 kg/ha, the total phytoplankton biomass kg/cycle of production 18000 kg.
The average biomass of the zooplankton 72 kg/ha, total zooplankton biomass kg/per cycle of production 1440 total production of plankton 19440 kg/ha.
The ecological efficiency of the energy entries 1289/19440=6.6%. Fishy productivity of pond no.1 is 0.89.

Table 1. Breeding pond no.1 Marata 0.4 ha

Species	Ex/ha	Wi, g	kg/ha	%S	Wf, g	ex./ basin	Result Biomass	Prod kg/basin
C. carpio	1500	42	63	92	436	600	601	240
H. molitrix	1200	50	48	94	500	480	564	225
A. nobilis	500	50	25	100	400	200	200	80
Ct. idella	300	50	15	100	250	120	75	30
Total	3500		151			1400	1440	575

Structurally, the plankton presents a diversity of phyto and zooplankton species specific for the state of average eutrophy, where all the groups are represented by a light dominance of cyanophyceae in the phytoplankton and the cyclopidae in the zooplankton.

In the ihtiocenosis, carp and silver carp have the biggest biomass multiplication rate but the contribution to the production percentage show that the silver carp participates by a percentage which exceeds the participation ratio in the population norma which can be explained by trophic specialization of silver carp and its position in the trophic chain, because of the inability to efficiently value the plankton. The grass carp has the lowest biomass multiplication rate. Production realized by mineral fertilization with 30 kg/ha. Phosphorus and 50 kg/ha azoth, organic 5000 kg/ha and use of fodder 5625 kg/ha mixed fodder with a protein content of 25%.

Table 2. Breeding pond 2 Marata – 0.4 ha

Species	Ex/ ha	Wi, g	kg / ha	%S	Wf , g	Ex./basin	Result Biomass	Prod kg/basin
C. carpio	1500	45	67.5	90	945	600	1275	510
H. molitrix	1200	50	60	90	990	480	1069	455
Anobilis	500	55	27.5	95	948	200	450	180
Ct. idella	300	50	15	100	708	120	212	85
total	3500		170			1400	3006	1230

Average phytoplankton biomass 560 kg/ha, total phytoplankton biomass / production cycle 22400 kg/ha.
Average zooplankton biomass 82 kg/ha, total zooplankton biomass / production cycle 1640 kg/ha, total phytoplankton biomass 24040 kg/ha. The biomass values express weight when the biological material is fresh. Ecological efficiency is 9.7%. Fishy productivity of pond no.2 is 0.94.
The phytoplankton made up of chlorophyceae and diatoms in the first part of the breeding interval suffered structure modifications. In the second part of the interval by the cyaniphyceae appearance which had a maximum of biomass in the second decade of August. The zooplankton had a monotonous structure represented by rotifers and cyclopidae. All through the production cycle the biomass multiplication rhythms were closed to the biotic potential of the species. The trophic support of the ihtiomass was optimally realized, the carp and the silver carp excelled, the first benefited by the fodder, which it valued efficiently in the presence of a satisfactory natural trophic base, both

quantitativelly and qualitative all over the breeding season. Bighead carp, in spite of a high biomass multiplication rhythm does not reach the performances of carp and silver carp.

Table 3. Breeding pond no. 3 Marata – 0.4 ha

Species	Ex/ ha	Wi, g	kg/ha	%S	Wf, g	Ex./basin	Result Biomass	Prod kg/basin
C. carpio	1500	50	75	92	836	600	1153	460
H. molitrix	1200	50	60	94	734	480	847	330
A. nobilis	500	50	25	95	763	200	362	145
Ct. idella	300	50	15	92	682	120	188	75
Total	3500		175				2550	1010

Production realized by using fodder-mixed fodder with 25% protein - 5000 kg/ha.
Average phytoplankton biomass 232 kg/ha, phytoplankton biomass per production cycle of 9280 kg/ha.
Average zooplankton biomass 32 kg/ha, total zooplankton biomass 640 kg/ha, total phytoplankton biomass 9920 kg/ha, total energy entries 14920, the ecological efficiency of using energy =15.9. Fishy productivity of pond no.3 is 0.93.
The phytoplankton is diversely represented, in the first part of the breeding interval, chlorophyceae and diatoms dominate its biomass and in the second part cyanophyceae appear too, but without a representation ratio that could give them dominance.
In the second part, in the zooplankton besides rotifera and cyclopidae, cladoceres appear, too for a short period.

The carp production is the undoubted beneficiary of the activity of using fodder and it participated to the production percentage with a higher rate than the participation ratio in the population formula. The other species in the population norm structure the bighead carp has a relatively equal participation, followed in performance by the silver carp, and the grass carp ranging last place.

Table 4. Breeding pond no. 4 Marata- 0.4 ha

Species	Ex/ ha	Wi, g	kg/ha	%S	Wf, g	Ex./basin	Result Biomass	Prod kg/basin
C. carpio	1500	50	75	88	872	600	1151	462
H. molitrix	1200	46	55	90	977	480	1055	420
A. nobilis	500	50	25	100	790	200	263	158
Ct. idella	300	50	15	83	700	120	174	70
Total	3500		170			1400	2643	1110

Production realized by mineral fertilization - 30 kg phosphorus and 50 kg azoth/ha and administration of combined fodder with 25% protein in the amount of 5000 kg/ha. Average phytoplankton biomass 365 kg/ha, phytoplankton biomass per production cycle 14600kg/ha, average zooplankton biomass 60 kg/ha, total zooplankton biomass 1200 kg/ha, plankton biomass =15800 kg/ha.
The ecological efficiency 2473/20800=11.8. Fish productivity of pond no.4 is 0.93.
The phytoplankton is dominated in the first half of the breeding interval by the diatoms followed by the chlorophyceae, which persist until the end of July when cyanophyceae appear, without being dominated by biomass. In the zooplankton the rotifers have dominated for a longer period, cyclopidae appear toward the end of July, and they share their dominance until the end of the period.

The mineral fertilization determines a qualitative structure of the trophic base, which favors silver carp, this efficiently valuing the phytoplankton biomass and realizing a growth rhythm close to its biotic potential, its participation to the accomplishment of the production percentage exceeding the participation quota in the population formula. Carp, the second in performance, though disposing of resources compared to the expectations, cannot reach the performance accomplished by silver carp.

The bighead carp occupies the third place of the hierarchy, because it seems that the trophic support is not qualitatively proper for its demands (Urbaniec-Brozda, 1995).

Table 5. Breeding pond no. 5 Marata-0.4 ha

Species	Ex/ha	Wi, g	kg/ha	%S	Wf, g	Ex./basin	Result Biomass	Prod kg/basin
C. carpio	1500	46	69	92	909	600	1254	500
H. molitrix	1200	50	60	96	874	480	1006	402
A. nobilis	500	55	27	90	945	200	425	170
Ct. idella	300	50	15	92	709	120	195	78
Total	3500		171			1400	2880	1150

The fish production is accomplished by administering 5450 kg/ha, of combined fodder with 25% protein and organic fertilization with 6000 kg/ha rother soil.
The average phytoplankton biomass in breeding pond 5 was of 445 kg/ha, and the total phytoplankton biomass of 17827 kg/ha.
The average zooplankton 56 kg/ha, and the total biomass of 1120 kg/ha.
The total phytoplankton biomass 18947 kg/ha, the energy entries by fodder 5450 kg/ha and rother soil 6000 kg/ha.

The ecological efficiency of 2709/23277=11.6. The fish productivity in pond 5 growth=0.94 phytoplanhkton reveals the influence of the fertilization type, the euglenophyceae presence and dominance, the permanence of chlorophyceae and the weak representation of the other groups: diatoms and cyanophyceae. The zooplankton is dominated by rotifers in the first part of the interval and cyclopidae in the second part. The fish production realized by this type of intervention is satisfactory for the growth rhythms of the populations in the structure and participation quota. For the growth percentage one can notice an equilibrium between the participation quota of the first three species in the population formula and the production percentage, the highest growth rhythm being that of carp, which, in its competition for resources, estimating the fodder has a net advantage compared to other consumers.

Tabel 6. The breeding pond no.6 Marata-0.4 ha

Species	Ex/ ha	Wi, g	kg/ha	%S	Wf, g	Ex./ basin	Result Biomass	Prod kg/basin
C.carpio	1500	50	75	90	963	600	1300	520
H. molitrix	1200	50	60	94	990	480	1116	445
Polyodon sp	200	312	62	100	2250	80	450	180
Ct. idella	300	50	15	83	700	120	174	70
Total	3200	0	212			1280	3040	1215

The fish production is accomplished by administrating of organic fertilization 2000 kg/ha, mineral 30 kg/ha phosphorus and 50 kg/ha azoth of combined fodder with a 25% protein rate.
The average phytoplankton biomass of 328 kg/ha, phytoplankton biomass per production cycle of 13120 kg/ha.

The average zooplankton biomass per season per 38 kg /ha, total zooplankton biomass is of 760 kg/ha.
Total phytoplankton biomass 13880 kg/ha, anthropic energy entries: 2000kg/ha rother soil and 5500kg/ha fodder, ecologic efficiency of 2828/19380=14.5%. Quantitatively, the phytoplankton biomass characterizes water with an average level of trophicity, also confirmed by the presence of euglenophyceae in the structure together with chlorophyceae. The zooplankton is dominated by cyclopidae, by Diaptomus and Cyclops. The presence of polyodon in the population structure positively influenced carp and silver carp growth which participate in the production percentage by 80%. The biomass multiplication rhythms are close to the biotic potential of the respective species in the second year of life. Fishy productivity of pond no.6 is 0.93.

Indicators of technological performance

After 120 days, the fish were caught and studied, observed from the point of view of their ichthyopathologic estimation numbered and weighted and the growth result was calculated by different means.

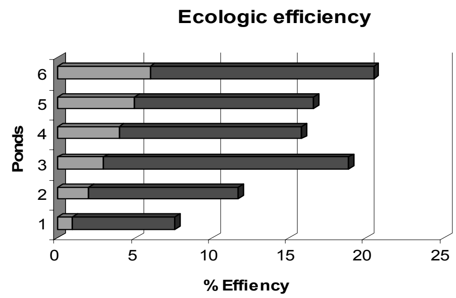

Figure 5. The variation of the ecologic efficiency

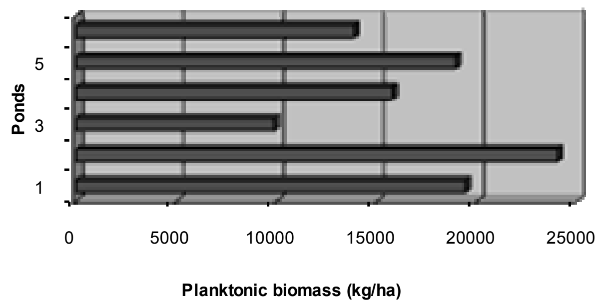

Figure 6. The variation of the planktonic biomass

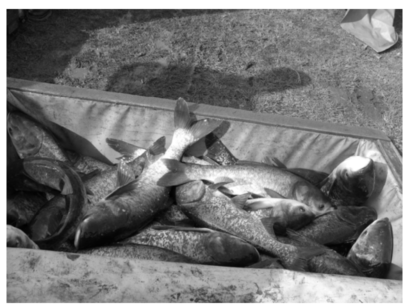

Figure 7. Aristichthys nobilis fished at the end of the experimental period

4. Conclusions

Increase of the available stock of nutrients is made by mineral and organic fertilization, intervention which also accelerates the mineralization processes.

The accrued values of plankton biomass provide a gradual increase perspective, registering the highest peaks in the months of July and August. This was determined by the biomass supporting fertilizer addition tight examination requirements and maintenance of rearing parameters between optimal limits:

- constantly monitoring the physico-chemical factors;
- keeping the input and recirculation debts within a values limits, entailing in this way the progress of biogenic evolution. In this type of polyculture, carp experiments have an essential role especially because of its feeding spectrum. It determines the acceleration of nutrient turn-over by stimulation of organic matter mineralization and recirculation of nutrients accumulated in sediments.
- carp breeding in polyculture with *Asian cyprinides* determines the qualitative and quantitative growth of the organic substance and its maintenance at a superior level.
- the plankton index has a superior level in the BR2 Marata. This richness of organic substance and plankton, appeared as a consequence of the aquatic vegetation in the pond consumption by the

species *Ctenopharyngodon idella* (including the terrestrial vegetation distributed in ponds), of enhancing this way, the mineralization process, from the vegetation stage to the nitrates stage and the growth rate of biogenic substance amount;

- using the species *Ctenopharyngodon idella* upon populating the experimental basins, the growth rate of the trophic base (plankton and bentos) is positively influenced by consumption of macrofita emersa vegetation, thus reaching superior values;
- the species *Hypophthalmichthys molitrix* populated in polyculture with carp also determines an improvement of the pond plankton quality and quantity. Fish stocking caused a considerable increase in phytoplankton density and cyclopid biomass, as well as a decrease in the biomass of large cladocerans.

Natural food, stimulated both by mineral and organic fertilization, makes cyprinid breeding, in 2nd summer polyculture, most efficient in terms of production as well as standard quality.

The trophic base proves capital in sustaining trophically the species in the ichthyocenosis structure, species which have satisfactory growth rhythms, being included.

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