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## **CARP FISH REARING IN AUTOCHTHONOUS POLY CULTURE OF ONE AND THE SAME AGE (CYPRINUS CARPIO L., ARISTICHTHYS NOBILIS RICH. AND CTENOPHARYNGODON IDELLA VAL.)**

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### **Abstract**

NIKOLOVA, L., L. HADJINIKOLOVA, K. DOCHIN, D. TERZIYSKI, R. ATANASOVA, A. STOEVA, G. GROZEV and E. PASKALEVA, 2008. Carp fish rearing in autochthonous polyculture of one and the same age (*Cyprinus carpio* L., *Aristichthys nobilis* Rich. and *Ctenopharyngodon idella* Val.). *Bulg. J. Agric. Sci.*, 14: 133-138

For the needs of organic fish farming at the Institute of Fisheries and Aquaculture-Plovdiv, the levels of natural fish productivity of carp fish, bred in polyculture, based on a natural nutritive basis (an "autochthonous polyculture") have been investigated. The experiment has been carried out in six fish ponds with a total area of 1.59 ha: three fish ponds – with organic manure applied (3000 kg.ha<sup>-1</sup> of cattle manure), three fish ponds (no organic manure applied). Before flooding the ponds with water, 300 kg.ha<sup>-1</sup> of quicklime has been applied, and during the vegetation period – an additional quantity of 150 kg.ha<sup>-1</sup>. The quantity of the organic manure and quicklime used has been conformed with the requirements for organic fish farming. The polyculture structure has been the following: one-year old carp-500 pcs.ha<sup>-1</sup>; one-year old bighead carp - 300 pcs.ha<sup>-1</sup> and one-year old grass carp-100 pcs.ha<sup>-1</sup>, with an average single fish weight (ASFW) in the fish-stocking of ponds, respectively – 0.031; 0.021 and 0.038 kg. During the vegetation period the quality of water has been within the technological standards. The ponds have ensured a good natural nutritive basis. The organic manure applied has not contributed to fish productivity increase. From the experimental ponds max 720 kg.ha<sup>-1</sup> of total yield and 693 kg.ha<sup>-1</sup> of total gain have been obtained. The carp gain has reached up to 368 kg.ha<sup>-1</sup> (final ASFW of 0.768 kg); of the bighead carp–345 kg.ha<sup>-1</sup> (final ASFW of 1.171 kg); of the grass carp – 118 kg.ha<sup>-1</sup> (final ASFW of 1.300 kg).

*Key words:* organic fish farming; natural fish production; fish pond; organic manure; polyculture

*Abbreviations:* ASFW – average single fish weight; K<sub>1+</sub> - two-summer old carp; T<sub>1+</sub> - two-summer old bighead carp; A<sub>1+</sub> - two-summer old grass carp

### **Introduction**

The main tendencies for growing a stable aquaculture in Europe nowadays are concerned with guaran-

teeing possibilities for the production of safe and high quality products, for ensuring good conditions for rearing animals and for preserving their health and for organizing ecologically safe production (Vamvakas,

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2003). All of these purposes in practice can be achieved after introducing the organic production.

The carp fish as species, which occupy a low position in the food chain are ideal objects for the needs of organic fish farming (Varadi, 2005). The organic carp growing, to a great extent is based on a natural nutritive basis in the ponds without application of mineral fertilizers. The standards give the admissible ratios between the fish production, obtained by using a natural food and by the fodder used, and because of that the basic levels of natural productivity should be known. The problems concerning the natural fish productivity in growing carp fish in polyculture have not been cleared up in our country.

For the needs of organic fish farming, we have set the purpose to make a complex investigation of ponds ecosystem and to establish the levels of fish productivity, in rearing fish in an autochthonous polyculture of one and the same age (carp (*Cyprinus carpio* L.), bighead carp (*Aristichthys nobilis* Rich.) and grass carp (*Ctenopharyngodon idella* Val.)).

## Materials and Methods

The investigation has been carried out at the Institute of Fisheries and Aquaculture-Plovdiv, within the framework of the project "Investigating the Possibilities for Introducing Biological Production in the Warm Water Fish Farming at the Conditions in Bulgaria" (2004-2006), financed by the NCAS. For the purposes of the experiment, six carp ponds have been used, with a total area of 1.59 ha, divided into two groups: I group (three fish ponds) – in which organic manure has been applied (3000 kg.ha<sup>-1</sup> of cattle manure); II group (three fish ponds) – in which no organic manure has been applied. Before flooding the experimental ponds from the two groups with water, 300 kg.ha<sup>-1</sup> of quicklime each has been applied. During the vegetation period, 150 kg.ha<sup>-1</sup> have been additionally applied. The quantity of organic manure and quicklime applied has been in conformation with the requirements of organic fish farming standards. For the purposes of the experiment, polyculture based on

the natural nutritive basis of the pond has been formed – "autochthonous polyculture" (Privezencev, 1991). One and the same structure has been used in all experimental ponds: one-year old: carp - 500 pcs.ha<sup>-1</sup>; bighead carp - 300 pcs.ha<sup>-1</sup> and grass carp - 100 pcs.ha<sup>-1</sup>, with an ASFW in the fish-stocking of ponds, as follows: 0.031; 0.021 and 0.038 kg. The samples for the physical and chemical investigations of water have been taken once per week to measure: temperature (T<sup>0</sup>C), oxygen dissolved in water (O<sub>2</sub>, mg.l<sup>-1</sup>; O<sub>2</sub>, %) and through a 14 days interval to determine: oxidability and biogenic elements level. The temperature and the oxygen dissolved in water have been measured by using a microprocessor oxymeter, OXI 96 type; the hydrogen index – by means of pH meter, MV 88 type; the permanganate oxidability – by using the analytical method (Bulgarian State Standard (BSS) – 3413-77); ammonium nitrogen (mg.l<sup>-1</sup>) – spectrophotometrically by Nessler's reagent (BSS 3587-79, ISO); nitrate nitrogen (mg.l<sup>-1</sup>) spectrophotometrically; phosphate phosphorus (mg.l<sup>-1</sup>) – spectrophotometrically by molybden reagent (BSS 7210-838). For investigating the sanitary and hygienic parameters of water samples have been taken once per month. The following has been recorded: the total microbial count (microbial number), by Koch's method; coliform test (by Ginchev's medium) – by using standard methods (Kapeljan et al., 1990). As regards the hydrobiological investigations, the samples have been taken through a 14 days' interval. The growth of phytoplankton and zooplankton has been determined by recording the numbers, biomass and the species composition: measuring of chlorophyll a colorimetrically at  $\lambda = 750-665$  nm (ISO-1/1980; ISO-5667-2/1991); benthos – by determining the total biomass; ponds overgrowing – in % of the total area.

In order to determine the fish health status at the moment of fish-stocking during the vegetation period and during fishing, prophylactic check-ups have been done, by using methods, generally accepted in ichthyopathology. At the end of the vegetation period, the main fish productive indices have been reported by using routine for the fish farming methods.

**Table 1**

**Physical and chemical, sanitary and hygienic and hydro-biological parameters of experimental ponds (average seasonal values; coliform test limiting values)**

Parameters	Ponds, №					
	Manured			Without Manure		
	1	2	3	4	5	6
Pond area, ha	0.17	0.39	0.16	0.31	0.18	0.38
Physicochemical and sanitary-hygienic qualities of water						
Temperature, °C	22.60	23.22	21.93	22.52	21.80	23.60
Water transparency, cm	48	23	66	26	54	21
O <sub>2</sub> , mg.l <sup>-1</sup>	4.51	11.36	7.59	12.77	4.44	9.89
O <sub>2</sub> , %	53	138	90	152	51	120
pH	7.55	8.16	7.85	8.17	7.8	8.33
N(NH <sub>4</sub> )', mg.l <sup>-1</sup>	0.072	0.097	0.068	0.11	0.067	0.145
N(NO <sub>3</sub> )', mg.l <sup>-1</sup>	0.339	0.642	0.55	1.042	0.599	0.709
N-total, mg.l <sup>-1</sup>	0.411	0.739	0.618	1.152	0.666	0.854
NH <sub>3</sub> , mg.l <sup>-1</sup>	0.066	0.011	0.01	0.017	0.01	0.017
P-PO <sub>4</sub> , mg.l <sup>-1</sup>	0.285	0.607	0.185	0.198	0.156	0.535
Oxidability, mg.l <sup>-1</sup>	8.98	16.23	9.07	8.94	9.85	13.3
Total number of microorganisms, cm <sup>-3</sup>	20220	20200	3560	11600	5400	6440
Coli-titer, cm <sup>-3</sup>	0.001-0.1			0.001-0.1		
Hydro-biological parameters						
Phytoplankton, mg.l <sup>-1</sup>	1.807	2.005	1.859	1.467	1.213	1.679
Chlorophyll a, mg.l <sup>-1</sup>	22.21	112.07	20.09	52.22	14.02	52.56
Zooplankton, g.m <sup>-3</sup>	0.401	0.853	0.321	0.415	0.723	1.272
Zoobentos, g.m <sup>-2</sup>	17.63			6.48		
Macrophyte, % of pond area	49	1.5	57	6.3	59.5	0.4

## Results and Discussion

In Table 1 are shown some parameters, which characterize the ecosystem of the experimental ponds during the vegetation periods.

The physical and chemical parameters have shown that the quality of water has corresponded to the carp ponds technological standards. The average seasonal temperature of water has been within the range of 21.7–23.6°C with recorded morning temperature

maximums of 26.4–29.3°C. The average seasonal values of hydrogen index have been within the range of 7.55–8.29, at minimum ones of 7.29–7.3. The level of the oxygen dissolved in the water has been within the optimum limits during the whole period of fish breeding, with the exception of some single samples in the middle of the period. The contents of the remaining quantities of total nitrogen have been below that considered as the optimum, which has been the result mainly of the low contents of ammonium nitro-

gen. The quantity of phosphorus dissolved in water has been within wide limits, but in total phosphorus level has been below the optimum limits.

In general, the average seasonal values of permanganate oxidability have been within the technological standards for carp ponds (8.94–16.23 mg. l<sup>-1</sup>). The increase of oxidability up to 22.4 mg. l<sup>-1</sup>, recorded in some single samples, has not influenced upon the total background of pond redundancy with organic matter and has been within the admissible limits for this index for the summer months.

The sanitary and hygienic parameters have been an important water quality index. The quantitative counts of mezophyllic microbes have shown a low pond redundancy with organic matter. The total microorganisms count for the variants with no organic manure application has varied within 5400 to 11600 number.cm<sup>-3</sup>, and for those with organic manure application within 3560 to 20220 numbers.cm<sup>-3</sup> (Table 1). The coliform test of water from the ponds investigated has varied mainly within 0.1 to 0.01. An increase of 0.001 has been observed only once during August. The assessment for the ponds status has shown a low level of bacteriological contamination. The water has corresponded totally to the sanitary and hygienic requirements for the quality of waters from the II category from a general ecological point of view, to which those for fish farming purposes belong.

Within the phytoplankton composition phytoplankters from four main groups have been established: Bacillariophyta, Chlorophyta, Cyanomycota and Euglenophyta. A characteristic feature for all experimental ponds is the highest frequency and the dominating growth of the group of the green algae. That has created favorable trophic conditions for the zooplankton and for the fish species grown. The average seasonal biomass of phytoplankton in the ponds has varied from 1.213 mg. l<sup>-1</sup> to 2.005 mg. l<sup>-1</sup>. In general, the total average seasonal biomass of phytoplankton has been at the average level of 1.426 mg. l<sup>-1</sup> in the ponds without organic manure fertilization. The ponds with organic manure application have had also average levels from the phytoplankton growth, but their

values have been higher 1.891 mg. l<sup>-1</sup>. As regards the average seasonal levels of chlorophyll a in the phytoplankton, the difference of 30.2% (Table 1) has been in favor of the ponds with organic manure application. The ponds rank depending on the average phytoplankton biomass, has not been preserved as regards zooplankton biomass. The average biomass in the ponds with organic manure application has been by 34.6% higher as compared to that in the ponds with organic manure application.

The benthos growth has been typical for the carp ponds – at the beginning of the vegetation period the supply has been very good, but at the end of the summer and at the beginning of the autumn it has decreased sharply till its complete run out. The difference according to the index of the ponds from the various groups has been 59% in favor of the ponds with organic manure application (Table 1). A difference in the qualitative composition of benthos has not been established. The main species this is the chironomous larva *Chironomus plumosus*, and in some separate samples, single representatives of Oligochaeta have been found.

In the experimental ponds the level of overgrowing with aquatic vegetation has varied considerably (Table 1). Concerning hard vegetation, it is mainly *Typha* sp., *Phalaris australis*, *Sparganium erectum*, which can be found in the coastal area and have a constant character of growth during the vegetation period (3-6%). The main soft vegetation species, this is *Trapa natans*, while in some ponds *Ceratophyllum demersum* can be observed. *Lemna minor*, *Potamogeton* sp. has a more limited growth.

The ecosystem parameters established have shown that the ponds can ensure good conditions for the fish species grown. During the whole period of vegetation the fish have been in good health status.

The limits of total fish productivity, obtained in the experimental conditions have been presented in Table 2. The maximum total yield has been 720 kg. ha<sup>-1</sup>, and the total gain – 693 kg. ha<sup>-1</sup>. The maximum and the minimum total fish gain in a given pond have been recorded in the ponds without organic manure application. The difference according to the maximum total

**Table 2**

**Limits of the total fish productivity in growing of one-year old carp, bighead carp and grass carp in polyculture, based on a natural nutritive basis**

Parameters	Manured		Without Manure	
	Ponds, № ***			
	2*	3**	4*	5**
Yield, kg.ha <sup>-1</sup>				
Total (Without <i>C. gibelio</i> )	636	462	697	363
Total	636	462	720	363
K <sub>1+</sub>	210	234	384	144
T <sub>1+</sub>	35	106	239	150
A <sub>1+</sub>	76	122	74	69
<i>Carassius gibelio</i>	-	-	23	-
Gain, kg.ha <sup>-1</sup>				
Total (Without <i>C. gibelio</i> )	612	437	670	339
Total	612	437	693	339
K <sub>1+</sub>	195	219	368	129
T <sub>1+</sub>	345	100	232	144
A <sub>1+</sub>	72	118	70	66
<i>Carassius gibelio</i>	-	-	23	-
Final Weight, kg				
K <sub>1+</sub>	0.471	0.568	0.768	0.366
T <sub>1+</sub>	1.171	0.378	0.796	0.500
A <sub>1+</sub>	0.776	1.300	0.742	0.781
Survival, %				
K <sub>1+</sub>	89.2	82.5	100	78.9
T <sub>1+</sub>	100	93.8	100	100
A <sub>1+</sub>	97.4	93.8	100	88.9

\* The maximum total fish yield and gain

\*\* The minimum total fish yield and gain

\*\*\* It corresponds to the enumeration in Table 1

fish gain between the ponds without and with organic manure application has amounted to 11.7%.

The maximum total fish productivity obtained at our conditions, in growing of carp and herbivorous fish in a autochthonous polyculture has been higher as compared to the maximum levels given by Vovk (1976) for the Ukraine. The statement made above concerns carp gain, which for our country is 368 kg.ha<sup>-1</sup>, at final weight of 0.768 kg. The difference between the maximum levels of the index between the separate

groups of ponds has amounted to 40.5%. When investigating the natural fish productivity in a monoculture (K<sub>1</sub>-530 pcs.ha<sup>-1</sup>; K<sub>0</sub>-4000 pcs.ha<sup>-1</sup>) at our conditions yield without mineral fertilizers application of 240 kg.ha<sup>-1</sup> have been obtained, and with mineral fertilizers application from 380 to 480 kg.ha<sup>-1</sup> (Dimitrov, 1969; Ljudskanova, 1969).

In contrast to the carp, maximum gain levels and final weight of bighead carp have been obtained in the ponds where organic manure has been applied. The

maximum gain has amounted to 345 kg.ha<sup>-1</sup> at the final ASFW of 1.171 kg. The difference between the maximum gain levels between the separate pond groups has amounted to 32.8%.

The grass carp gain in the variants presented has reached 118 kg.ha<sup>-1</sup>, at the final ASFW of 1.300 kg. The maximum indices have been registered in ponds with a high level of overgrowing during the vegetation period. The grass carp productivity in our experiment has reached the maximum species productivity at optimum conditions indicated by Chernomashencev and Miljshtein (1983) – 120-150 kg.ha<sup>-1</sup>.

The fish productivity of herbivorous fish has been in close connection with fish-stocking density (Bondarenko, 1997), intensity of nutrition and mineral fertilizers application (Bondarenko and Chajka, 1995).

Tjutjunik (1972) has stated that plant-eating fish yield has not been less than 500 kg.ha<sup>-1</sup> when grown in polyculture with the carp. At our conditions, at a single carp stocking, nutrition only with natural food, and lack of mineral fertilizer application, the maximum level of plant-eating fish yield has amounted to 426, and the gain 417 kg.ha<sup>-1</sup>.

## Conclusions

The parameters characterizing pond ecosystem in fish farming in the so formed autochthonous polyculture of one and the same age have shown that the fish have been ensured good growing conditions. The physical and chemical characteristics of water have been within the technological standards. The ponds have ensured a good natural nutritive basis. During the whole period of vegetation, the fish have been in good health status. At the experimental conditions, max 720 kg.ha<sup>-1</sup> of total yield and 693 kg.ha<sup>-1</sup> of total gain have been obtained, and the fertilizers applications have not contributed to these indices increase. The carp gain has reached 368 kg.ha<sup>-1</sup> (final ASFW of 0.768 kg); the bighead carp – 345 kg.ha<sup>-1</sup> (final ASFW of 1.171 kg); the grass carp – 118 kg.ha<sup>-1</sup> (final ASFW of 1.300 kg).

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