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The influence of the structure of the common carp and grass carp population on the growth and cyprinid polyculture production indexes

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Abstract:

The experiment is done in cultivation plant of cyprinid fish family in Klos, Elbasan, during March 2012-May 2013. Two ponds are used to do the test, each with a surface of 0.3ha. Stocking was done with one year olds. We have applied two structures of ponds population with five species of cyprinid family, the control polyculture and the test polyculture. The analysis of data for grass carp showed that in the control polyculture the "b" intercept value was 2.9778, thus a negative allometric. In the test polyculture the value of this index was b=3.2106 (r = 0.928), thus a positive allometric. In the two polyculture variants applied in this study, the “b” values coefficient in the length-weight relation for “common carp population” resulted to be negative allometric. For the control polyculture the value “b” calculated was 2.6762 (r = 0.981), whereas in the test polyculture this index had the value 2.924 (r = 0.984). The value of this index for the bighead carp grown in control polyculture was 3.0914 (r = 0.978). This number is found in the interval between the isometric value (b = 3.0) and allometric positive values (b>3.0 up to 3.5). For the population of bighead carp grown in test polyculture the value of “b” was 3.3708 (r = 0.987), thus a positive allometric. For the population of silver carp cultivated in control polyculture the “b” value was 3.0554 (r = 0.960), whereas for the silver carp grown in the test polyculture the “b” value was 3.1037 (r = 0.974). The final medium weight of common carp in the test polyculture was 141g greater compared with the polyculture. The difference of medium weight between two variants for bighead carp was 257g, for silver carp 204g and for grass carp 149g, always in favor of the populations included in the test polyculture.

Keywords: common carp, bighead carp, silver carp, grass carp, control polyculture, test polyculture

Introduction:

Carp does not fully exploits the useful food stocks which is present in the breeding pools. This is the main reason why this species is grown in polyculture with other species of fish. The need for the application fish polyculture is based on the concept of total utilization of all the living space and the trophic basin potentials, with the purpose to ensure the maximum level of fish production per unit of water surface. According to [2] the purpose of the introduction of Chinese cyprinid herbivorous and plankton eaters in polyculture along with common carp, is the increase of production through the use of phytoplankton, zooplankton and macrophytes. Interactions between fish and other species that serve as food have special importance for the polyculture systems [9]. Those species that have different habits of nutrition can positively affect the availability of natural food, e.g. by liberating nutrients deposited in the bottom of the basin, or negatively, by consuming various components of the food reserve [11, 14]. According to [6, 11]the displacement of sediment from common carp increases the availability of the natural food enriching the nutrient flux that passes through the food chain. It should be recognized that for several reasons mainly related to trophic flexibility and the opportunistic nature of feeding of the omnivore and phytophagous species, in many cases it is difficult to predict the interconnection between the structure of the polyculture and the production generated from this cultivation practice [20, 19, 1]. The selection of fish species is of paramount importance to ensure the success of the production, both in terms of quantity and quality [22]. Population densities and species that combine in a polyculture vary from one country to another depending on the cultivation practices, as well as on the environmental conditions and practices of the market needs [21]. Considering the problem in terms of natural food consumption [7] claimed that the level of efficient use of food depends on the combination of the species that would constitute a polyculture and their relative densities.

Material and methods of the study:

Tests have been conducted in the private business of Shermadhi family in Klos (Elbasan)

(Figure 1), during the period 14 March 2012 - 19 May 2013 (a total of 14 full months).

In order to carry out the tests two ponds were exploited, each holding 0.3 ha area. Depth of water in ponds, during all the cultivation, is held at 1.50-1.80 m (average 1.65 m). The total volume of water in a pond was about 5000 m³. Restocking was not conducted with fingerlings of standard size (10g), but one year-old ones. Different from fry and fingerlings, one-year-olds (age 8.5-9.5 months, depending on the species) have overcome the stabilization stage of the typical nutrition manner. According to the species that were included in the polyculture, the individual average weight (M ± SD) of the restocking material is given in table 1:

Figure 1 The cultivation plant of Cyprinidae family fishes in Klos (Elbasan)

Table 1 Individual average weight (M ± SD) of five species of fish

Silver carp	564.266 ± 41.931 g
Bighead carp	**611.467 ± 42.435 g**
Grass carp	**704.933 ± 52.939 g**
Common carp	**495.333 ± 34.439 g**
Bream	**86.866 ± 12.982 g**

Table 2 The polyculture of "control"

Silver carp	1600 individual/ha	(903 kg/ha)
Bighead carp	800 individual/ha	(490 kg/ha)
Grass carp	1200 individual/ha	(845 kg/ha)
Common carp	1200 individual/ha	(595 kg/ha)
Bream	200 individual/ha	(17.4 kg/ha)
Total	5000 individual/ha	(5.789 kg/m³)

Table 3 The polyculture of “test”

Silver carp	1600 individual/ha	(903 kg/ha)
Bighead carp	800 individual/ha	(490 kg/ha)
Grass carp	900 individual/ha	(634.5 kg/ha)
Common carp	1500 individual/ha	(742.5 kg/ha)
Bream	200 individual/ha	(17.4 kg/ha)
Total	5000 individual/ha (5.919 kg/m³)	

We applied two structures of pond population with five species of fish of the carp family (Cyprinidae): the polyculture of “control” (table 2) and the polyculture of “test” (table 3).

In the polyculture of "test" we have changed the ration between grass carp and common carp due to the two following motives:

First**:** The results obtained in the study on the level of diets coverage among adults of these two species.

Secondly**:** the most expressed preferences of the current market for common carp compared to grass carp.

The structure of the “test” polyculture, which due to the fact that has taken into account the needs of the market, can be considered as an "economic" polyculture, has had the following composition:

The content of dissolved oxygen in the water and water temperature were measured with electronic device YSI - Oxy - thermometer 85. Measurements were carried out twice a day, at 10:00 and 16:00. The depth of the measurements in the water column was 30-60 cm. Each day we established minimum, maximum and average values for the water temperature (°C) and concentration of the dissolved oxygen in water (mgO_2/l).

For the measurement of the scale of transparency of the water Secchi disk was used [5]. Measurement of transparency with the disc provides quick assessment of the scale of distribution of the solar radiation in the water column.

Results:

Length-weight relationship:

Analysis of the data for grass carp showed that in the polyculture of control the value of the intercept " b " was 2.9778 (r = 0922), thus a negative allometric. In the polyculture of “test” the value of this indicator was b = 3.2106 (r = 0928), thus a positive allometric. In the two variations of the polyculture that were applied in this study, the values of the coefficient "b" in the length - weight relationship for "populations" of common carp it resulted to be negative allometric. For the version of the polyculture of control the value calculated for "b" was 2.6762 (r = 0.981), while for the version of the polyculture of “test” the indicator value was 2.924 (r = 0.984). Based on the interpretation made by [17], the negative allometric values of intercept "b" show that the cultivation environment or specific elements of technology implemented do not fully responded to the physiological requirements of the two populations of common carp . The value of this indicator for the bighead carp that grew in the polyculture of control was b = 3.0914 (r = 0978). This figure is in the range between isometric value (b = 3.0) and the positive allometric values (b> 3.0 to 3.5). For the population of bighead carp that grew in the polyculture of “test” the value of "b" was 3.3708 (r = 0.987), thus a positive allometric. In the two populations of bighead carp in no case we have calculated the negative allometric value (b <3.0 to 2.5). For the silver carp populations that were cultivated in the polyculture of control the value of "b" was 3.0554 (r = 0.960). For the population of this species that grew in the polyculture of “test” the value of "b" was 3.1037 (r = 0.974). In the case of the bighead carp as well as in that of the silver carp, in no case, did the values of intercept "b" result to be within the range of the negative allometric values. In the typology structure of the polyculture that we have experimented the bighead carp and silver carp are the cyprinids that, for the age groups included in the study, compete less for food, between themselves as well as with the other three species. Lack of alimentary competition with the grass carp, common carp and bream as well as the application of other intensifying technical elements the application of technical elements have created favorable environment for the fulfillment of physiological requirements of the bighead carp and silver carp in the two variants of the polyculture, a fact proved by the positive allometric values of coefficient "b" in the length - weight relationship.

Final weight (Wg) , Condition coefficient according to Fullton (K) and specific growth index (SGR).

Comparing the figures, for the same indicators and for specific species, proves that, with the exception of the coefficient of variability of the final weight (CV %) values are systematically higher in the version of the polyculture of “test”.

Table 4 Some indexes of fish growth in control polyculture

Species	*W±SD*	*CV(%)*	*K*	*SGR(%)*
Silver carp	**2308.733±151.987**	**6.58**	**1.53**	**0.355**
Bighead carp	**2753.667±133.581**	**4.52**	**1.55**	**0.371**
Grass carp	**2814.247±454.046**	**15.58**	**1.51**	**0.347**
Common carp	**2104.347±213.262**	**10.134**	**1.50**	**0.344**

Table 5 Some indexes of fish growth in test polyculture

Species	*W±SD*	*CV(%)*	*K*	*SGR(%)*
Silver carp	**2512.267±163.728**	**6.51**	**1.59**	**0.361**
Bighead carp	**3010.733±147.192**	**4.89**	**1.62**	**0.381**
Grass carp	**2963.780±417.482**	**14.09**	**1.54**	**0.351**
Common carp	**2245.067±217.152**	**9.67**	**1.52**	**0.347**

The final average weight of common carp in the version of the "test" polyculture has been 141g larger compared to the polyculture of "control". For the bighead carp the average weight difference between the two variants was 257g, for the silver carp it was 204g and for the grass carp it was 149g, always in favor of the populations included in polyculture of "test". The high values of the coefficient of variability of the final body weight (CV %) for populations of common carp and grass carp may be indicative of the existence of competition within the same species and inter species for the same components of the food reserve. We believe that the reduction of the value of this indicator for all types that were included in the polyculture of "test" may be indicative of the improved conditions of nutrition and of the reduction of the pressure of the competition for food. Data on the average final weight (Wg) and analysis of the values of the coefficient of condition according to Fullton (K) and the specific growth index (SGR %) indicated that the change of quantitative ratios between the two competing species in the cyprinid polyculture was followed by improvement of the overall growth indicators. We have proved that the rate of improvement has been different for specific species. We believe that the position that ichthyic species occupy in the food pyramids present in the basin has had a significant impact on the rate of improvement of the indicators of growth after the quantitative modification of the polyculture.

Discussion*:*

Fish production results that were achieved in this study point to a technology which ensures very good economic profits. In reality, semi-intensive system of the cultivation system uses a combination of natural foods with the concentrated food. Complementary foods are always natural food complements [10]. It is exactly this assertion that guarantees economic efficiency of the semi-intensive system. The efficient use of the natural food resources, the stimulation of their development through the organic and mineral fertilization and the complementary and limited use of the concentrated foods (which being expensive result in the increase of the production costs) are the basic elements of semi-intensive technology of production.

The polyculture was found as a technical solution which aims precisely to increase the efficiency and maximize the utilization of trophic opportunities that the natural aquatic ecosystems offer. It is important to exploit knowledge on the quantitative interactions "fish–fish" and "fish-environment" in order to select the right combination of fish species, population densities, types of inputs and their level of engagement as well as any type of management decision-making in accordance with the local conditions: climate, the quality of the supply water, the basin fertility, the availability of fingerlings, food and fertilizers, and including the market demand and needs [10, 8]. Common carp combinations with grass carp and other Chinese cyprinid are typical to the polyculture applied in Albania [15, 16], Poland [13], Bulgaria [4, 12] and Hungary [18]. The two compared polycultures had identical typological composition but different numerical ratios between species. The most evident difference between was manifested in the polymorphism of the size of the fish at the end of the period of cultivation. This phenomenon was evaluated by us by calculating the coefficient of the variability of weight (CV %). According to our calculations, in the polyculture of "test" the value of CV for the grass carp was 14.9 %, where as for the common carp it was 9.67 %. Based on figures presented by [16], for the polyculture realized in the business of Laknas family, the values of this indicator for the white grass carp result to be 2-3 times higher. Densities that are applied in two polycultures we are analyzing, were typical for the half intensive aquaculture. In the "biological" polyculture it was operated with a density of 9,700 individuals/ha while the ratio between the grass carp fingerlings and common carp was approximately 1.5:1.0. Altogether, the density of individuals of these two species was 0.84 individuals/m². This level of the density of the population is practiced for the polyculture of cyprinid in Bulgaria, but the ratio between grass carp and common carp was 0.025:1.0 [3]. The density of population with common carp and grass carp was 0.80 individuals/m². In the polyculture of "test", which was applied in this study, the overall population density was 5,000 individuals/ha. Relationship between fingerlings of grass carp and common carp was 0.6:1.0. The density of individuals of these two species, altogether, was 12:24 individuals/m². The figures presented show that the densities of restocking with the grass carp and common carp that were applied in our test were 3.3 to 3.5 times smaller than the structures of the polyculture that we used for comparison. It is likely that this difference be one of the factors that has guaranteed a higher homogeneity of the size of fish in our test compared with the polyculture that operated with high density. The evaluation of the dynamics of the average weight and of the levels of variability of this indicator in different stages of the production cycle would point out moments of the display and reinforcement of polymorphism and would help to determine the causes of the phenomenon. Although the calibration, or selection based on the size, is not an element of the semi-intensive technologies of the ichthyic cultivation, this practice could be realized if the cultivation was carried out in ponds with limited surface. The calibration would ensure the uniformity of size and a better growth as a result of the avoidance of the phenomena of competition and social stress.

References*:*

1. Billard R, Jacqueline M: **Aquaculture of cyprinids**.INRA Paris; 1986
2. Cremer MC, Smitherman OR: **Food habits and growth of silver and bighead carp in cages and ponds.** Aquaculture, 1980, 20: 57-64.
3. Dimitrov M: **Intensive polyculture of common carp (*Cyprinus carpio L.*) and herbivorous fish [silver carp *Hypophthalmichthys molitrix* (Val) and grass carp *Ctenopharyngodon idella* (Val)].** Acquaqulture, 1984, 38: 241-253.
4. Dimitrov M: **Intensive polyculture of common carp *Cyprinus carpio* L,silver carp *Hypophthalmichthys molitrix* (Val) and black buffalo *Ictiobus niger* (Raf).** Aquaculture, 1987, 65(2): 119-125.
5. Gregorio D: **Water clarity (transparency) and Color Using a Secchi Disc**. The Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment. State Water Resources Control Board 3151.doc.; 2010
6. Hepher B, Milstein A, Leventer H, Teltsch B: **The effect of fish density and species combination on growth and utilization of natural food in ponds.** Aquac.Fish. Manage., 1989, 20: 59-71.
7. Kumar SMThTh, Binh S, Burgess N, Luu LTh: **Evaluation of optimal species ratio to maximize fish polyculture production.** Journal of Applied Aquaculture, 2005 17(1): 35-49.
8. Lin Hao Ren: **Polycultural System of Freshwater Fish in China.** Canadian Journal of Fisheries and Aquatic Sciences, 2011 39(1): 143-150.
9. Milstein A, Hepher B, Teltch B: **The effect of fish species combination in fish ponds on plankton composition.** Aquac. Fish. Manage., 1988, 19: 127-137.
10. Milstein A: **Ecological aspects of fish species interactions in polyculture ponds.** Hydrobiologia, 1992, 231(3): 177-186.
11. Milsten A, Svirsky F: **Effect of fish species combinations on water chemistry and plankton composition in earthen fish ponds**. Aquac. Res., 1996, 27: 79-90.
12. Nikolova L, Hadjinikolova L, Dochin K, Terziyski D, Atanasova R, Stoeva A, Grozev G, Paskaleva E: **Carp fish rearing in autochthonous mixed polyculture (*Cyprinus carpio* L.,*Aristichthys nobilis* Rich. and *Ctenopharyngodon idella* Val.).** Bulgarian Journal of Agricultural Science, 2008, 14 (2): 139-144.
13. Opuszynski K: **Comparison of the usefulness of the silver carp and the bighead carp as additional fish in carp ponds.** Aquaculture, 1981, 25: 223-233.
14. Pearl HW, Tucker CS: **Ecology of blue-green algae in aquaculture ponds**. J. Aquac. Soc. 2007, 26: 109-131.
15. Rakaj N: 1977 **Rritja e dendur e peshqve bar e planktongrenes ne polikulture.** Teknologjia e shtimit dhe e rritjes se peshqve bar e planktongrenes. Stac.Kerk.Shkenc.Peshk. Durres 1977: F.61-121.
16. Rakaj N: **Shtimi dhe rritja e drejtuar e peshqve permiresues biologjike.** Albuena.Tirane 2003:F.250.
17. Ricker WE: **Computation and interpretation of biological statistics of fish populations.** Bulletin of the Fisheries Research Board of Canada 1975, 191: 1-382.
18. Ruttkay A: Ivadek-utoneveles polikulturaban. *Halaszat,* 24: 16-17. (in Hungarian) [**Rearing of two summer old fish in polycultural systems**] 1978, 24: 16-17.
19. Sandhu Jaswindher S, Toor HS: 1983 **Preliminary studies on dietary overlap of fishes**

in a polyculture. Indian J.Ecol. 1983, 10: 322-326.

20. Schroeder GL: **The breakdown of feeding niches in fish ponds under conditions of severe competition.** Bamidgeh 198032 1980: 20-24.
21. Singh T: **Common culture practices for cyprinids in Asia.** INFOFISH, 50728 Kuala Lumpur, Malaysia 1997: 73-76.
22. Ur-Rehman MH, Ahmed I, Javid A, Naeem Akhtar HM: **Comparative growth and yield of exotic Chinese and indigenous major carps under polyculture system.** Journal of Agriculture and Social Sciences; 2006, 2(4): 256-259.