MORPHOMETRIC PARAMETERS OF LOCAL CARP WITH DIFFERENT TYPES OF SCALE PATTERNS REARED IN AUTOCHTHONOUS PRODUCTION ECOSYSTEMS

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MORFOMETRIJSKI PARAMETRI LOKALNOG ŠARANA RAZLIČITE LJUSKAVOSTI GAJENOG U AUTOHTONIM PROIZVODNIM EKOSISTEMIMA

Apstrakt

Istraživanje je sprovedeno na ribnjacima u okolini Plovdiva u južnoj Bugarskoj sa šaranima iz lokalnih populacija. Prilikom uzgoja šarana u uslovima monokulture koja se bazira na prirodnim izvorima hrane uz dodatak đubriva (3000 kg.ha^{-1}), dvogodišnje jedinke nisu dostigle konzumnu veličinu. Ljuskavi i goli šarani gajeni su na sličan način i na kraju uzgojnog perioda, nije bilo značajne razlike u težini žive ribe. Gajen u monokulturi, dvogodišnji ljuskavi i goli šarani iz lokalnih populacija, imali su izdužena tela `sazan` tipa, velike glave i nisku vrednost kondicionog indeksa. Vrednosti koje opisuju linearni rast riba i eksteriorne indekse se nalaze u značajnoj korelaciji sa tipom šarana. Goli šaran je imao višu vrednost kondicionog indeksa i kompaktnije telo u poređenju sa ljuskavim šaranom.

Ključne reči: šaran, morfometrijske mere, eksteriorni indeksi
Key words: carp; morphometric measures, exterior indices

Abbreviations: K_1 – 1-year old carp; K_0 – 0-year old carp; TW – total weight; SL – standard length; TL – total length; CL – carcass length; LHwg – head length; D – maximum body width; H – maximum body height; O – girth

INTRODUCTION

There are good opportunities for the introduction of ecological and organic production technologies in Bulgaria, including organic aquaculture in particular (Nikolova, 2013). Local plant varieties and animal breeds are given an advantage when introducing organic

farming. Carp species are very suitable for organic farms (Varadi, 2005). Common carp is a traditional species for Bulgarian aquaculture. In 2013 its production increased by almost 89% compared to the previous year and it represented about 35% of the total fish production in the country (MZH, 2014). At the same time there are not enough research studies on the characteristics of the local carp in Bulgaria, especially when reared in extensive and semi-intensive production ecosystems. Morphological characteristics and exterior indices were studied in different carp breeds and populations (Khosrow and Amirkolaie, 2010; Treer et al., 2000 etc.). Growth and body proportions in fish are determined by a complex of genetic and environmental factors (Kapusta et al., 2013; Kirpichnikov, 1979). That is why the individual breeds, local groups and populations should be characterized under the concrete rearing conditions.

The aim of the present study was to establish some morphometrical characteristics of scale and mirror carp of a local population in Bulgaria and the effect of some factors on those characteristics when fish is reared in autochthonous production ecosystem (based on natural nutrient sources in the pond).

MATERIAL AND METHODS

Studies were carried out in four carp ponds on the experimental site of the Institute of Fisheries and Aquaculture in Plovdiv (southern Bulgaria). The ponds were stocked with scale and mirror carps of local populations. Two variants of mixed monoculture were studied: I variant (n=2) – K_1 – 500 pcs.ha^{-1}; K_0 – 15000 pcs.ha^{-1}; II variant (n=2) – K_1 – 500 pcs. ha^{-1}; K_0 – 30000 pcs.ha^{-1}. The mean weight of fish at stocking was 0.045 kg for the one-year old scale carp and 0.048 kg for the mirror carp. In all the ponds the fish was fed only on natural food available in the pond (autochthonous monoculture (by Privezentsev, 1991)). The ponds were supplemented with cattle manure at rates permissible in organic aquaculture (3000 kg.ha^{-1}). During the period of vegetation, the water characteristics of each pond were monitored. Water temperature, pH and oxidability were within the technological limits for carp ponds.

At the end of the vegetation period the fishes were measured following the adopted methods (Kryukov et al., 2007, etc.). Measurements were made with a tape and a caliper with an accuracy of 0.05 mm.

The following parameters were calculated: CFF – Fulton's coefficient (TW*100/SL3); IC – condition index (TW*100/SL*H*O); IHB – high-backed index (SL/H); IBB – broad-backed index (D*100/SL); ILHwg – long-headed index (LHwg*100/SL); IH – hardness index (O*100/SL).

Analysis of variance was used for data processing. The linear equation model was of the following general type: **Yijklmn=μ+Vi+Pj+Tk+VTiκ+VTPijk+eijkl,**

where: Yijklmn – the index of the nth individual; μ – general average constant; Vi, Pj, Tk, - fixed effects of the ith variant (2); jth pond (4); kth types of scale patterns (2); VTij and VTPijk chance effect of kth scaling in ith variant; VTPijk chance effect of kth scaling in jth pond in ith variant; e (..) – residual variance.

RESULTS AND DISCUSSION

When reared in monoculture based on natural food available in the ponds, the two-summer old common carp of a local population cannot reach a consumable size (Table 1), the specific conditions in the pond having a significant effect on fish development (Table 2). The scale pattern type also has a significant effect on the linear fish growth ($P<0.05$), the differences not being dependent on the technological variant and on the pond within the same variant.

Table 1. Exterior measurements and indexes

Indices	I				II			
	Scale		Mirror		Scale		Mirror	
	LS-means	±Se	LS-means	±Se	LS-means	±Se	LS-means	±Se
TW, kg	0.238	13.102	0.287	17.807	0.315	23.614	0.343	34.218
TL, cm	25.61	0.425	27.18	0.577	28.22	0.765	28.54	1.109
SL, cm	20.99	0.348	22.26	0.473	23.11	0.627	23.38	0.909
CL, cm	15.15	0.273	15.87	0.372	16.56	0.493	16.86	0.714
LH, cm	5.84	0.084	6.39	0.114	6.55	0.152	6.52	0.220
D, cm	3.11	0.064	3.48	0.087	3.41	0.115	3.57	0.167
H, cm	6.71	0.115	7.13	0.156	7.22	0.207	7.44	0.300
O, cm	17.49	0.266	18.54	0.361	18.84	0.479	19.27	0.694
IHB	3.14	0.023	3.13	0.031	3.21	0.041	3.13	0.060
IBB	14.82	0.123	15.62	0.168	14.69	0.222	15.26	0.322
ILHwg	27.93	0.186	28.79	0.253	28.41	0.335	28.06	0.486
IH	83.54	0.462	83.41	0.628	81.59	0.833	82.97	1.207
CFF	2.45	0.026	2.56	0.035	2.43	0.047	2.57	0.068
IC	9.17	0.067	9.55	0.091	9.58	0.121	9.71	0.175

Table 2. Effect of the studied characteristics on the body parameters and indices (F-test)

Indices	Variant (V)	Types of scale patterns (Tsp)	Pond (P)	V * Tsp	V*Tsp*P
TW	1.810	2.709	2.185	0.857	0.528
SL	1.308	2.848*	5.079*	0.308	0.458
TL	1.249	2.785*	4.801*	0.289	0.435
CL	0.821	2.212	5.082*	0.214	0.291
LH	3.199*	4.623*	4.002*	0.630	1.118
D	5.108*	2.540	1.592	2.175	1.370
H	0.758	1.623	1.251	0.742	0.423
O	0.834	1.464	4.069*	0.684	0.397
IHB	0.192	0.758	5.837*	0.524	0.791
IBB	8.749**	0.058	2.430	5.088*	2.279*
ILHwg	1.169	0.066	3.285*	0.075	0.317
IH	0.711	3.065*	1.841	0.402	1.596
CFF	0.208	0.121	3.056*	0.273	1.261
IC	0.169	2.933*	1.890	0.189	0.443

* - ($P<0.05$); **- ($P<0.01$)

As a whole, it is considered that scale carp has better total productivity compared to mirror carp, however, Katasonov and Gomelskiy (1991) mentioned that mirror carp practically does not fall behind scale carp under favourable rearing conditions.

In a detailed study on pond-reared common carp in Bulgaria, Tsekov (1985) did not establish a significant difference in growth of carp breeds and groups at the age of two summers. No significant difference in growth of local Ukrainian scale and mirror carp fishes was also established by Tovstik (1979). Data about the live weight and the body length, obtained in the present experiment, were close to those published by the author for the two-summer old scale and mirror carp fishes fed only on natural food available in the pond.

Referring to body shape, fishes in our experiment have an elongated body shape (Bogeruk et al., 1997). The established IHB is significantly higher than the indices published for scale carp of Hungarian breeds (Spaho et al., 2012). The index is higher than the established by Tsekov (1985) for two-summer old mirror carp reared under intensive conditions in Bulgaria, the values being close to those defined by the author for Amur carp of the same age. Data obtained in the present study were also similar to IHB established by Tarazevich et al. (2012) for two-summer old mirror and scale Tremlyansky carp.

Hardness index has higher values in the fishes of the I variant (Table 1), however, the effect of the stocking structure is insignificant (Table 2). The scale pattern type has a significant effect on IH, the mirror carp having a more compact body. IH and IBB values established by Pishtenko and Belousov (2003) for two-summer old Altay mirror carp are similar to our results.

The mean ILHwg values in the present study vary from 27.9 to 28.8 but no relationship with the scale pattern was found. The individuals with a long-headed index bigger than 26 belong to the large-headed fishes (Bogeruk et al., 1997). Katasonov and Gomelskiy (1991) mentioned a long headed index of 27 for two-year old scale Ukrainian carp and an index of 31 for mirror carp.

In the present experiment, we established higher values of CFF and IC for mirror carp (Table 1), the scale pattern being a significant source of variation of IC, but not affecting significantly CFF (Table 2). Tsekov (1985) established obvious differences in the carp breeds referring to CFF. CFF is an important index in studies on fish, despite its disadvantages. McPherson et al. (2011) established in their study that the relationship between CFF and mesenteric fat was inconsistent and often non-existent, while CFF was significantly correlated with fatmeter values for the aggregate field dataset and significantly correlated with total muscle fatty acid for the experimental dataset. Kolisnyk et al. (2014) mentioned that CFF is an indicator of the level of nutrition and the natural food quality, as well as an indicator of the ability to absorb available food.

CONCLUSION

When rearing carp of a local population under the conditions of monoculture based on natural nutrient sources in the pond, loaded with manure, the two- summer old fishes cannot reach a consumable size. Carp fishes of different scale patterns grow in a similar way and there is not a significant difference in their live weight at the end of the rearing period. Reared in autochthonous monoculture, the two- summer old scale and mirror carp fishes of a local population have an elongated body of a 'sazan' type, a large head and low IC values. The values characterizing linear fish growth and exterior indices are significantly correlated with the scale pattern type. Mirror carp has a higher IC value and a more compact body compared to scale carp.

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