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Morphometric characteristic of European perch (*Perca fluviatilis*) related to sex dimorphism

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Abstract. *The relationships among 15 morphometric measurements and carcass weight in European perch (Perca fluviatilis) were examined in connection with sexual dimorphism. The determinated sex ratio was 1:1.3 in the advantage of the male sex. The female perch were larger than male perch by 20,7%, but the carcass weight of the male specimens was by 4,7% better in comparison with the ones measured in female specimens. There were found five morphometric characters that differ between genders: ID1 (1-st dorsal fin lenght) ($p \leqslant 0.05$), lA (anal fin lenght)($p \leqslant 0.05$), hA (anal fin height) ($p \leqslant 0.05$), lp (pectoral fin lenght) ($p \leqslant 0.001$), lV (ventral fin lenght) ($p \leqslant 0.05$).*

Keywords: European perch, *Perca fluviatilis*, morphometric parameters, sexual dimorphism

Introduction

The European perch (*Perca fluviatilis* L.) is a widely distributed freshwater fish species in Europe and Asia. This fish prefers shallow and productive water and inhabits wide ranges of environmental conditions – from slow rivers to deep lakes. *Perca fluviatilis* was also introduced to South Africa, Australia and New Zealand (Craig, 2000). Eurasian perch was determined as one of the most perspective freshwater fish species for European aquaculture (Kucharczyk et al., 1998; Migaud et al., 2002; Szczerbowski et al., 2009). Most scientific efforts are directed to the questions connected with the reproduction of these valuable fish species (Kucharczyk et al., 1996, 1998; Kouril et al., 1997; Migaud et al., 2004, 2006; Szczerbowski et al., 2009; Ronyai and Lengyel, 2010) as well as the initial rearing (Mandiki et al., 2004; Blanchard et al., 2008).

Sexual growth dimorphism is widely interceded in teleost fish. A series of studies observed that at adult age males are found to be larger than females in the following species: salmonids (Bonnet et al., 1999), silurids (Haffray et al., 1998) and tilapias (Toguyeni et al., 1997). Conversely for other fish species, it was found that females are larger than males at the same ages: dab *Limanda limanda* (Lozan, 1992), turbot *Scophtalmus maximus* (Imsland et al., 1997) and some cyprinids including *Cyprinus carpio* (Hollebecq and Haffray, 1994). The European perch displays sexual growth dimorphism in which females grow significantly faster than males (Fontaine et al., 1997). For this reason the possibility to distinguish the sex of these fish species before they reach sexual maturity is a valuable information for the cultivation of these fish species as well as for its artificial reproduction.

One possible solution for the problem of earlier sex determination in European perch before these fish reach sexual maturity is to study and compare the morphometric characteristics for both sexes. Morphometric studies in European perch were conducted in the past, but they are connected with morphological adaptations related to ontogenic niche shifts in Eurasian perch (Hjelm et al., 2000) or with the influence of different environmental conditions (predator density, competition and prey abundance) on morphology of these fish species (Kekäläinen et al., 2010). Up to this moment no specific studies dealing with morphometric characteristics of European perch in relation with sex dimorphism has been carried out.

The aim of our study was to analyze external morphometric parameters of European perch (*Perca fluviatilis*) and to determine, if they could be used to distinguish the sex of these fish species.

Material and methods

For the purpose of our study 38 European perch specimens were sampled from one Bulgarian aquaculture farm. The samples consisted of 22 males and 16 females. An overdose of clove oils was used for killing the fish. The fish were weighed with technical balance and 16 morphometric characters were measured. Morphometric characters were measured according to the scheme used by Pravdin (1966) (Table 1, Figure 1).

To examine differences in both sexes, the received value from measured morphometric characters was plotted against SL and a statistical comparison was made on calculated proportion value.

For the sex determination of the experimental fish gonads were dissected, observed and weighed and the gonadosomatic index (GSI) was calculated :

$$GSI = \frac{(gonad\ weight\ (g^{-1}))}{(body\ weight\ (g^{-1}))} \cdot 100$$

The relative weight of the heads were measured and calculated:

$$Weight\ of\ head = \frac{(weight\ of\ head)}{(weight\ of\ body)} \cdot 100$$

The relative value of carcass weight of fish were measured and calculated by the formula:

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$$Caracas\ weight() = \frac{(weight\ of\ fish\ (g^{-1}) - weight\ of\ head\ (g^{-1}) + weight\ of\ internal\ organs\ (g^{-1}))}{(weight\ of\ fish^{-1})} \cdot 100$$

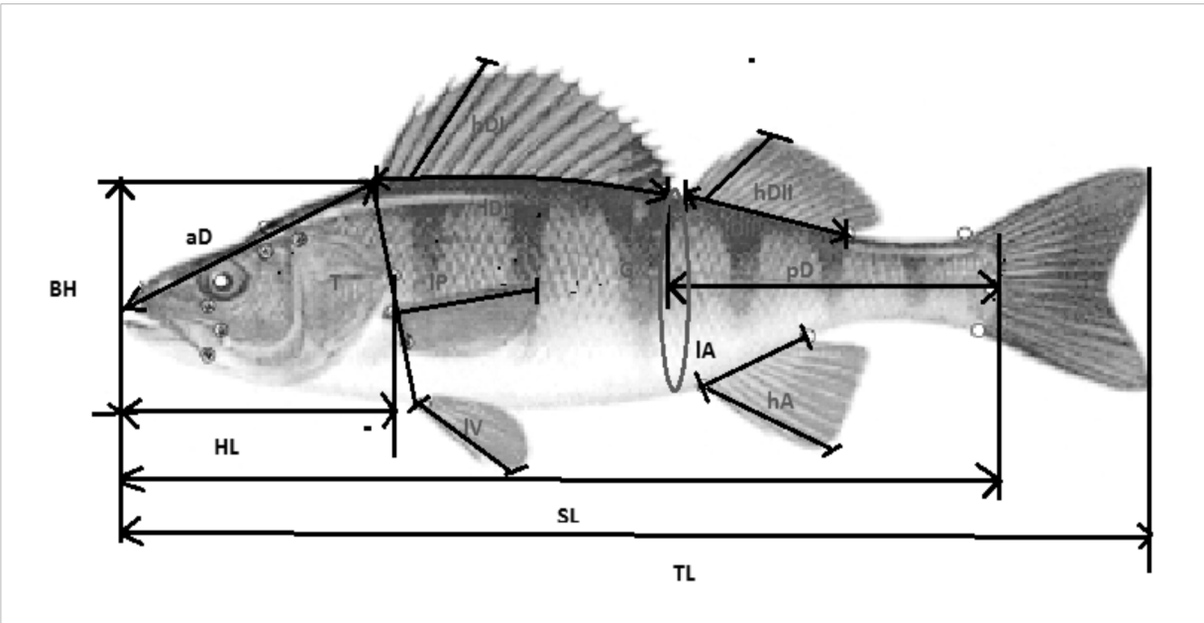

Figure 1. Morphometric measurement taken on European perch (*Perca fluviatilis*)

Table 1. Description of measured morphometric character of European perch (Perca fluviatilis)

Abbreviations	Character
TL	Total length
SL	Standard length
HL	Head length
BH	Body height
T	Thickness
aD	Antidorsal distance
pD	Postdorsal distance
lDI	1-st dorsal fin length
lDII	2-nd dorsal fin length
hDI	Height of 1-st dorsal fin
lA	Anal fin length
hA	Anal fin height
lP	Pectoral fin length
lV	Ventral fin length
G	Grid of fish

The received data from the measurements was statistically analyzed using ANOVA (Microsoft office, 2010).

Results and discussion

Data from the measurement of the morphometric character of Eurasian perch (*Perca fluviatilis*) can be seen in Table 2. The determinated sex ratio was 1:1.3 in advantage of the male sex. Gonadosomatic indices (%) of European perch were estimated for females (16.5) and males (14.3). The female specimens of European perch are larger than male perch at the same age as reported by Fontaine et al. (1997). Our study confirms this conclusion, because the measured body weight of female perch on average was 20.7% higher than those measured on male individuals. Conversely of body weight carcass, the weight of male perch was 4.7% higher than measured on female perch, but the difference between both sexes in this aspect was not statisticaly proved. The female head weight was 15.3 % of the total body weight compared to the male head weight, which was 10.6% of the total body weight. The value is 4.7 % lower than on female perch, but the difference was not significant ($P \geqslant 0.05$).

The analysis of the received data showed that five morphometric characters – lDI, lA, hA, lp and lV were found to have significant differences between individuals from both sexes. The average value of lDI to SL ratio was 34.1% (min = 31.4% and max = 37.7%) for females and 35.4% (min = 31.5% and max = 37.7%) for males. The calculated lA to SL and hA to SL ratios were respectively on average 11.4% (min = 10, max = 13.4) for females and 12.07% (min = 10.16, max = 14.5) for males and 13.9% for females and 14.9% for males for the second character's ratio. The average values of lp to SL ratio for male perch were 18.06% and 16.2% for female fish ($P \leqslant 0.001$). Similar results were found for lV to SL ratio (Table 3).

Some of the conducted studies in the past related to sexual dimorphism have focused on sexual size dimorphism (Ji et al., 2006) or/and on sex allometric growth (Minos et al., 2008). Other important aspects in this research have been connected with the determination of physiological changes occurring in the spawning season with experimental fish.

Minos et al. 2008 reported that six morphometric characters

Table 2. Morphometric measurement in Eurasian perch (*Perca fluviatilis*). Morphometric abbreviations are listed in Table 1

Characters	Sex	Mean (mm)	Min (mm)	Max (mm)	SD
SL	F	207	185	226	1.25
	M	190	170	228	1.53
TL	F	241	217	260	1.32
	M	223	198	265	1.61
HL	F	59.7	53	66	0.38
	M	55.3	48	68	0.44
BH	F	63.3	58	71	0.39
	M	59.2	53	68	0.4
T	F	35	31	43	0.31
	M	31.7	28	38	0.25
aD	F	65.8	60	72	0.35
	M	61.4	55	75	0.47
pD	F	36.8	32	49	0.43
	M	33.8	28	42	0.39
lDI	F	70.8	63	82	0.53
	M	67.5	61	78	0.46
lDII	F	37.5	20	43	0.54
	M	35.3	27	41	0.42
hDI	F	29.4	26	35	0.26
	M	27.7	23	34	0.27
hDII	F	25.6	21	29	0.19
	M	23.2	21	28	0.19
lA	F	23.6	21	28	0.22
	M	23	20	29	0.25
hA	F	29.4	26	37	0.27
	M	28.5	24	36	0.29
lP	F	33.6	26	39	0.35
	M	34.5	28	38	0.27
lV	F	38	31	44	0.3
	M	36.8	34	41	0.21
G	F	155.7	140	170	0.9
	M	146.4	125	170	1.11

(fork length, pre-orbital distance, postorbital distance, standard length, head length, trunk length) have been significantly different for males and females. For *Alburnoides bipunctatus* Syriova (2004) reported that 22 of 43 measured morphometric charatcters were found to be different between genders. Summer et al. (2005) observed similar results in *Lipomis gibbosus,* where the distance was different for both sexes. The conducted research with European seabass (*Dicentrarchus labrax*) (Çoban et al., 2011) showed that 3 morphometric characters are significantly different for both sexes – pre AFL, post AFL and post DEF indices – and they could be used for the determination of sexual dimorphism of this fish species.

A series of research showed that the grown of female perch are significantly better than those of male individuals. Some studies (Stejskal et al., 2009) showed that if monosex, all females culture showed better results (higher growth and better feed conversion ratio) than mixed. The observed morphological characters will give the opportunity to distinguish earlier the sex of farmed fish. They could be separated by their sex belonging which is a good basis for developing a monosex female culture in these fish species which are characterized by better biological and economic parameters.

Conclusion

The data obtained from our research shows that morphological differences between individuals from both sexes in European perch (*Perca fluviatilis*) existed according to lDI, lA, hA, lp and lV characters and they could be used for the determination of sexual dimorphism. This information will be valuable for the aquaculture of this fish species because of two general reasons: selection of strains carrying valuable genetic traits like high survival, disease resistance,

Table 3. Proportion of the measured morphometric character in female and male European perch (*Perca fluviatilis*). Morphometric abbreviations are listed in Table 1.

Characters	Sex	Mean ± SEM	Min	Max	p≤
TL	F	116.2 ± 1.56	113.6	119.5	ns
	M	117 ± 2.63	111.6	121.1	
HL	F	28.8 ± 0.68	27.8	30.4	ns
	M	29.0 ± 1.24	26.9	30.8	
BH	F	30.57 ± 1.34	28.1	32.7	ns
	M	31.1 ± 1.21	29.2	33.8	
T	F	17.0 ± 1.19	14.7	19.03	ns
	M	16.6 ± 1.18	14.8	19.4	
aD	F	31.8 ± 1.40	29.1	33.6	ns
	M	32.2 ± 1.57	28.8	34.9	
pD	F	17.8 ± 2.26	15.2	24.7	ns
	M	17.8 ± 2.07	13.03	23.6	
lDI	F	34.1 ± 1.69	31.4	37.7	*
	M	35.4 ± 1.81	31.5	39.2	
lDII	F	18.08 ± 2.36	10.1	20.5	ns
	M	18.5 ± 1.65	15.4	21.1	
hDI	F	14.3 ± 0.86	13.3	16.06	ns
	M	14.8 ± 1.32	12.9	17.7	
hDII	F	12.3 ± 1.02	9.55	13.93	ns
	M	12.23 ± 0.85	10.7	13.6	
lA	F	11.4 ± 0.81	10	13.4	*
	M	12.07 ± 1.05	10.16	14.52	
hA	F	13.9 ± 1.43	11.9	16.8	*
	M	14.9 ± 1.39	12.5	17.06	
lP	F	16.2 ± 1.90	12.3	19.1	**
	M	18.06 ± 1.39	16	22.1	
lV	F	18.3 ± 1.34	15.6	20.2	*
	M	19.4 ± 1.24	16.9	22.1	
G	F	75.2 ± 3.59	68.1	80.8	ns
	M	76.8 ± 3.41	71.07	84.3	

accelerated growth rate, etc. and possibility for developing all female culture in European perch.

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