Correlations among the Main Body Measurements in Pikeperch Larvae from 10 to 25 Days Post-Hatch, Obtained Out-Of-Season

Adrian Grozea, Eliza Simiz, Ioan Bănăţean-Dunea, Petru Szilagyi, Andrei Osman

Affiliation: Banat's University of Agricultural Sciences and Veterinary Medicine from Timisoara, Address –300645-Timisoara, Calea Aradului, 119, Romania

Abstract
The pikeperch (*Sander lucioperca*) is one of the most valuable carnivorous fish species in Europe, and in Romania as well. In the literature there are no relevant data on growth dynamic and correlation among the main body measurements in pikeperch larvae obtained out-of-season and reared in recirculated aquaculture system (RAS). The aim of this study was to bring information for clarifying some of these aspects. Our results emphasized that correlation coefficient between maximum body high (H) and total length (TL) together with standard length (SL) decrease linear from 10 to 25 DPH. The correlation coefficients between the main length measurements (TL and SL) reveal a very high correlation between the two traits in pikeperch larvae. High correlations between body weight (BW) and the other length measurements were observed.

Keywords: correlations, growth, larvae, out-of-season, pikeperch, RAS.

1. Introduction

The pikeperch (*Sander lucioperca*) is one of the most valuable carnivorous fish species in Europe [1] being generally reared in ponds, in extensive and semi-intensive systems based on polyculture with common carp [2]. It is a new and promising species for European intensive aquaculture. The possibility of juvenile pikeperch weaning to formulated feed has been proven [3, 4], this fact leading to the increasing of the interest in intensive rearing of this species. Feeding has a great impact in growth dynamic of the pikeperch larvae. There are authors [5] indicating that between 13 and 19 DPH (days post-hatch) is a crucial period when significant changes occur in the larvae that determine their growth and development. Others [4] indicated that the best growth with the lowest mortality and lowest deformity rate are registered when the weaning starts at 19 DPH.

There are some reports regarding the out-of season spawning of pikeperch [6, 7, 8, 9]. The first Romanian success in out-of-season spawning of pikeperch was reported by Grozea et al. in 2010 [10]. There are few data regarding correlation among some traits in pikeperch [11] but there are no relevant data on growth dynamic and correlation among the main body measurements in pikeperch larvae obtained out-of-season and reared in recirculated aquaculture system (RAS). The aim of this study was to bring information for clarifying some of these aspects.

2. Materials and methods

Our study was carried out between 10 and 25 of February 2010, at Aquaculture Research Laboratory from Banat's University of Agricultural Sciences and Veterinary Medicine from Timisoara. The breeders used to obtain the larvae for the study spawned in 26th of January,

* Corresponding author: Adrian Grozea, grozea@animalsci-tm.ro

after photo-thermal and hormonal treatments. Their preparation starts in 21st of September 2009 when they were captured from the earthen ponds (0.40 ha) from university's Aquaculture Facility. After weighting they were bathed in saline solution (2%) for 2 minutes and then introduced in 8 m^3 fiberglass tank, indoor, at natural photo-thermal regime. The breeders were maintained in these conditions for 35 days. They were fed ad libitum with live roach (*Rutilus rutilus*) common rudd (*Scardinius erytrophtalmus*) and bleak (*Alburnus alburnus*). The temperature was daily monitored, varying from 19.5°C to 7°C. In 26th of October the breeders were weighted again, bathed in saline solution (2%) for 2 minutes, and then transferred into a small recirculated aquaculture system (RAS) (2.5 m^3), in 1 m^3 fiberglass tank. The RAS was equipped with a cooling unit (Clint CHA/CL25, G.I. Holding S.p.A., Italy). The thermal treatment was shared in 3 main periods:

-cooling (until 19th of November, from 10°C decreased to 7°C);

- cold (until 25th of December, constant 6°- 7°C)

- heating (until 19th of January, from 7°C increased to 12°C).

The duration of illumination was adjusted to 14:10 (L:D) when heating period starts (40-50 lx at the tank water surface). Otherwise the fish were maintained at ambient photoperiod.

In 21st of January a male and a female being at the first reproduction, were hormonally stimulated with hCG (Chorulon, Intervet) 400 UI/kg, intraperitoneal in one dose. They were maintained 72 hours in RAS at 17°C and then were moved into a 500 l tank in pair, for spawning on artificial nest. They spawned in 26th of January. The larvae were maintained in the hatching tank 4 days and then were moved into RAS special designed for pikeperch rearing. Total volume of RAS was 8 m^3, having 7 tanks, drum filter, bio-filter, UV sterilization unit, aerators, pumps and spraying unit. Into the tank (1 m^3 capacity), dedicated to our study, a cage with 4 compartments was introduced, each compartment having 80 liters net capacity. Each cage compartment was connected to spraying unit which provided a flow rate in each compartment of 0.6 L min^{-1}.

Permanent lighting (24 hours per day) was used until 15 DPH, and then was adjusted to 15:9 (L:D). Light intensity above the water of the rearing compartment was 10-15 lx.

The most important physical and chemical parameters were continuously monitored, using SC 1000 controller (Hach Lange, Germany): water temperature 20.42±0.015°C, turbidity 0.28±0.001 NTU, pH 7.89±0.01, dissolved oxygen 8.52±0.007 mg L^{-1}, nitrates 34.53±0.037. Total ammonia and nitrites were maintained below 0.02 mg L^{-1} and 0.2 mg L^{-1}, respectively.

In two of the cage-compartments 6000 pikeperch larvae were stocked, with a mean of 37.5 individuals per liter (3000 individuals per compartment). From the 5th DPH larvae were fed ad libitum with newly-hatched Artemia nauplii (Coppens International, Holland). The weaning starts at 21 DPH using the dry feed Noblesse 300 µm (Coppens International, Holland) that replaced Artemia naupli in 5 days.

Dead fish, faeces and unconsumed food were removed two times per day by siphoning the bottom of the cage-compartments. The growth dynamic was established at 10, 16, 18, 21, 22, 23, 24 and 25 days post-hatch using each time 30 individuals randomly sampled from the two cage-compartments. They were anesthetized with MS_{222} (ethyl 3-aminobenzoate methansulfonate 98%, Sigma-Aldrich, Germany) 0.1 g l^{-1}, measured using binocular microscopy with micrometer and weighted using electronic balance (Kern ABJ 220-4M, Germany). Even the larvae were anesthetized they didn't survive at manipulation process.

The dynamics of total body length (TL), standard length (SL), head length (HL), maximum body height (H), have been taken from 10th to 25th DPH. Body weight (BW) have been taken from 23rd to 25th DPH, when fish grown enough to be individually weighted.

The experimental data were analyzed using SPSS 17.0. software. The Pearson correlations between two variables were performed using the same software. Graphs and mathematically adjustment of the correlation coefficients were realized in the program Excel, version 2007.

3. Results and discussion

Correlation coefficients (r) among 4 main measurements (TL, SL, HL and H) are shown in table 1. These data indicates that $r_{H\ TL}$ decrease continuously from 10 to 25 DPH, $r_{H\ TL}$ = 0.932 and $r_{H\ TL}$ = 0.315, respectively. Even if the last value is not significant ($p \geq 0.05$) the trend is

evident having in mind the value of $r_{H\ TL}$ at 24 DPH (0.505; p≤0.001). Graphical representation of this trend (fig. 1) is very suggestive. The correlation coefficient between H and SL has generally the same trend (fig. 2) starting from 0.901 (p≤0.05) and decreasing to 0.260 (p≥0.05) (table 1). At 24 DPH, $r_{H\ SL}$ is statistically assured (0.488; p≤0.001). It is not a distinctive trend of $r_{H\ HL}$, this being revealed by its fluctuation. These data are hard to be explained, but anyway it can be seen that measurements of H and HL are positively correlated between medium and high *r* values. The same observations could be formulated for $r_{HL\ TL}$ and $r_{HL\ SL}$.

Table 1. Correlations and their significance threshold among 4 measurements in the pikeperch larvae

Specification	Days post-hatch (DPH)	Total body length (TL)	Standard length (SL)	Head length (HL)
Maximum body height (H)	10	0.932 (p=0.021)	0.901 (p=0.037)	0.781 (p=0.119)
	16	0.899 (p=0.038)	0.885 (p=0.046)	0.639 (p=0.246)
	18	0.872 (p=0.054)	0.687 (p=0.200)	0.534 (p=0.353)
	21	0.843 (p=0.002)	0.824 (p=0.003)	0.913 (p=0.000)
	22	0.707 (p=0.000)	0.604 (p=0.002)	0.718 (p=0.000)
	23	0.889 (p=0.000)	0.834 (p=0.000)	0.858 (p=0.000)
	24	0.505 (p=0.000)	0.488 (p=0.000)	0.480 (p=0.001)
	25	0.315 (p=0.409)	0.260 (p=0.499)	0.603 (p=0.085)
Head length (HL)	10	0.823 (p=0.087)	0.764 (p=0.123)	
	16	0.758 (p=0.138)	0.761 (p=0.135)	
	18	0.746 (p=0.147)	0.896 (p=0.040)	
	21	0.929 (p=0.000)	0.938 (p=0.000)	
	22	0.915 (p=0.000)	0.876 (p=0.000)	
	23	0.850 (p=0.000)	0.813 (p=0.000)	
	24	0.691 (p=0.000)	0.672 (p=0.000)	
	25	0.661 (p=0.052)	0.572 (p=0.107)	
Standard length (SL)	10	0.990 (p=0.001)		
	16	0.999 (p=0.000)		
	18	0.939 (p=0.018)		
	21	0.991 (p=0.000)		
	22	0.917 (p=0.000)		
	23	0.970 (p=0.000)		
	24	0.939 (p=0.000)		
	25	0.840 (p=0.005)		

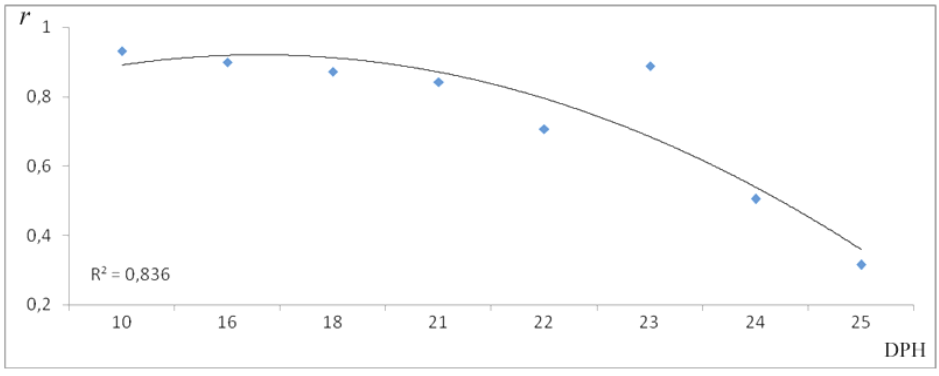

Figure 1. The trend of $r_{H\ TL}$ in the pikeperch larvae between 10 and 25 DPH, mathematically adjusted with the second degree polynomial regression

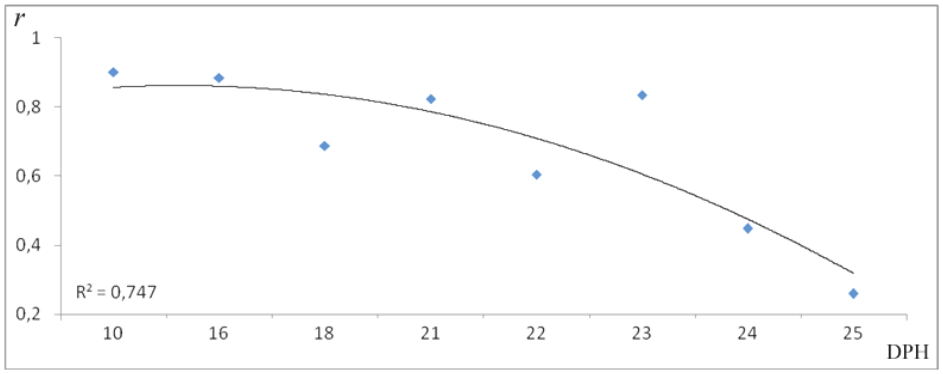

Figure 2. The trend of $r_{H\ SL}$ in the pikeperch larvae between 10 and 25 DPH, mathematically adjusted with the second degree polynomial regression

Corroborating these data it is very relevant that HL in the studied pikeperch population has a higher variability coefficient, contrasting with the other measurements. Statistical processing of all measurements sustains this supposition. The correlation coefficient between the main length measurements $r_{TL\ SL}$ reveal a very high correlation between the two traits ($r_{TL\ SL}$ between 0.999 and 0.840). All values are statistically assured, being at least significant ($p \leq 0.05$).

Measurements of H and head length (HL) are medium and high positively correlated. All the other measurements have the same characteristics when they are correlated with HL.

The correlation coefficient between the main length measurements (TL and SL) reveal a very high correlation between these ($r_{TL\ SL}$ varying between 0.840 at 25 DPH and 0.999 at 16 DPH) (table 1 and fig. 3).

Correlation coefficients (r) between BW and the other main measurements (TL, SL, HL and H) are shown in table 2. These data generally indicate high correlations between traits, with a minim between BW and H ($r_{BW\ H} = 0.716$) and a maxim between BW and TL ($r_{BW\ TL} = 0.899$).

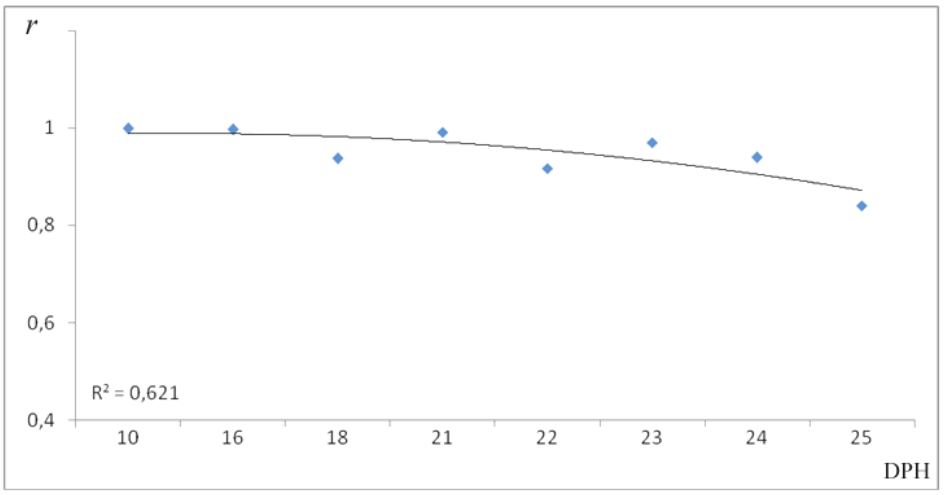

Figure 3. The trend of $r_{TL\ SL}$ in the pikeperch larvae between 10 and 25 DPH, mathematically adjusted with the second degree polynomial regression

Table 2. Correlation coefficients (r) and their significance threshold (p) among body weight (BW) and other 4 measurements in the pikeperch larvae at 23-25 DPH

	Days post-hatch (DPH)	Total body length (TL)	Standard length (SL)	Head length (HL)	Maximum body height (H)
Body weight (BW)	23 - 25	0.899 ($p \leq 0.001$)	0.884 ($p \leq 0.001$)	0.743($p \leq 0.001$)	0.716 ($p \leq 0.001$)

4. Conclusions

The correlation coefficient between maximum body high (H) and total length (TL) decrease linear from 10 to 25 DPH (from 0.932 to 0.315).
The correlation coefficient between H and standard length (SL) has generally the same trend as between H and TL.
Measurements of H and head length (HL) are medium and highly positive correlated. All the other measurements have the same characteristics when they are correlated with HL.
The correlation coefficients between the main length measurements (TL and SL) of pikeperch larvae at different days post-hatch reveal a very high correlation between the two traits.
High correlations between body weight (BW) and the other length measurements were observed, being from 0.716 ($r_{BW\,H}$) to 0.899 ($r_{BW\,TL}$).

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