

# Correlations and Interdependencies of the Main Morphological Traits in 6 to 7.5-Months-old Pikeperch (*Sander lucioperca*), Reared in Recirculating Aquaculture System

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## Abstract

The pikeperch (*Sander lucioperca*) is one of the main freshwater fish species recently introduced in intensive aquaculture in Romania, with good perspective for next years. Monitoring of the growth dynamic of the pikeperch reared in controlled conditions has a high importance in fish farm management. The aim of this study is to test if there are linear correlations and functional dependencies between total length, standard length, maximum body depth and body weight in pikeperch fingerlings reared into recirculating aquaculture system (RAS). Our results clearly revealed that any of the 4 measurements could be monitored in pikeperch fingerlings, to accurately evaluate the growth dynamic, the correlations among these being very high (between 0.970329 and 0.998856). The dependencies of the evaluated traits are very high, and with our equations detailed in the paper, 3 of measurements could be calculated based on pikeperch's body weight.

**Keywords:** body development, correlations, interdependencies, morphological traits, pikeperch, *Sander lucioperca*

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## 1. Introduction

The pikeperch (*Sander lucioperca*) is a freshwater fish species with very good market potential due to its meat quality and high demand from consumers. The intensive aquaculture of this species in Romania has a short history, but the perspectives are optimistic [1]. Monitoring of the growth dynamic of the pikeperch reared in controlled conditions has a high importance in fish farm management. This has to be done to evaluate and correlate the growth performance with other technological parameters. The feeding management also has to be adjusted according with fish growth dynamic. The pikeperch difficulty accepts dry feed [2] and many changes of feed characteristics could influence the fish

growth [3]. This could directly influence the dynamics of some morphological traits, and the knowledge of the degree of correlation and their interdependencies could have a good impact on pikeperch aquaculture. The information in this respect are sparse [4].

The aim of this study is to test if there are linear correlations and functional dependencies between total length, standard length, maximum body depth and body weight in pikeperch fingerlings reared into recirculating aquaculture system (RAS).

## 2. Materials and methods

The study was carried out in the year 2017, between October 18<sup>th</sup> and November 15<sup>th</sup> at the Aquaculture Research Laboratory from Banat's University of Agricultural Sciences and

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The pikeperch larvae were obtained in April 2017 using controlled reproduction, according with the method described by Grozea et al., 2010 [5]. The weaned juveniles were fed according with fish size with different types and sizes of dry food (Advance, Star Alevin and Supreme–10) and were kept in monoculture until the age of 6 months, and then, including the experimental period, in polyculture with sterlet juveniles (21% from pikeperch biomass). The fish were fed during the experimental period with 3 mm dry food Supreme–10, distributed with belt feeders (FIAP, Germany). The quantity was adjusted once per week at 2% of pikeperch biomass.

The fiberglass tanks where the fish were reared during experimental period had rectangular shape with round corners and 1m<sup>3</sup> utile volume, being part of a recirculating aquaculture system (RAS) with a total volume of 8 m<sup>3</sup>.

The total biomass per tank was 13.135 kg when the first measurement was done and reach to 17.77 at the last measurement.

The SC1000 controller and Spectrophotometer DR3900 (Hach Lange, Germany) were used to measure the main physical-chemical parameters. The registered values during experimental period were as follow: water temperature 21.5-23.5°C, turbidity<4 NTU, pH 7-8, dissolved oxygen>5

mg/L, nitrates<120 mg/L, ammonium<0.2 and nitrites<1.5 mg/L. In order to maintain a good water quality, 10% of the water from RAS was replaced daily with fresh water.

Total length (L), standard length (Sl), maximum body depth (H), and body weight (BW) were measured according with the methods described by BURA and GROZEA, 1997 [6]. Sixty pikeperch from 2 tanks (30 pikeperch/tank), were randomly measured each time at every 14 days, starting when the pikeperch were 6-month-old and ending at the age of 7.5-months-old. To avoid the fish movement during biometrical study, they were anesthetized with clove oil.

The data were statistically analyzed by the Statistica 10 package. The linear regression tries to model the relationship between two variables using a function of the form  $y=ax+b$ . The graph of such function is a straight line that will fit the analyzed data. In order to find the line that best fits the data, it was used the least squares approach. The regression coefficients were tested by the analysis of variance.

### 3. Results and discussion

The correlations among the studied traits are revealed in Table no. 1.

**Table 1.** Correlations among the studied traits in 6 to 7.5-months-old pikeperch

Traits <sup>1</sup>	L	H	BW
Sl	0.997170	0.992435	0.992673
L	-	0.998856	0.980781
H	0.998856	-	0.970329
BW	0.980781	0.970329	-

<sup>1</sup>Sl–standard length, L–total length, H–maximum body depth, BW–body weight

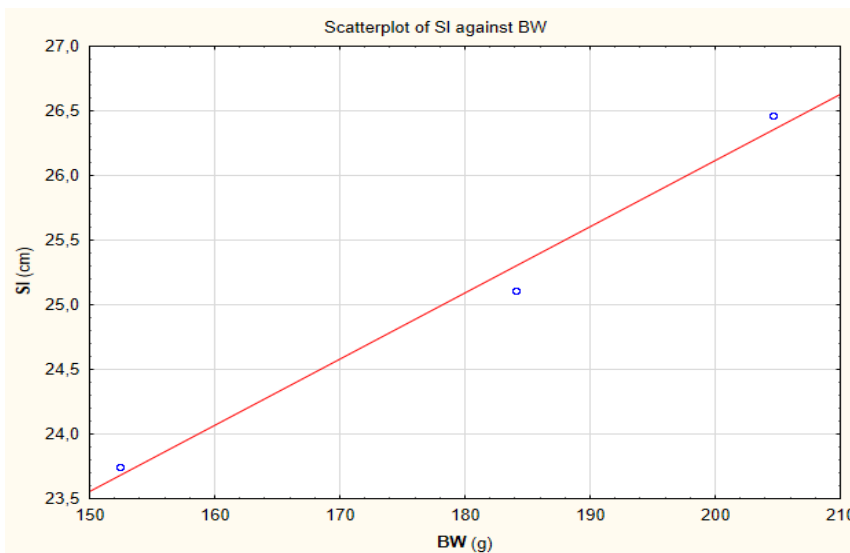
The data indicate very high correlations among all studied traits, varying between 0.970329 and 0.998856. A linear regression analysis of the standard length (Sl) based on the body weight (BW) was performed (Table 2). It was determined that the proportion of variance in Sl was 3.61 for

$F=67.4941$  and  $df=1$ , where the F ratio provided the test of statistically significance. The regression line  $y=b_0+b_1x$  is the linear equation used to fit the best straight line to the data (Figure 1). The dependent variable Sl was expressed as the equation:  $Sl=15.873+0.5119*BW$

**Table 2.** Linear regression analysis of the standard length (SI) based on the body weight (BW) in pikeperch fingerlings

Effect	SS	Degr. of freedom	MS	F	p
Intercept	10.54329	1	10.54329	196.6613	0.045320
BW	3.61846	1	3.61846	67.4941	0.077111
Error	0.05361	1	0.05361		

BW–body weight, SS–sum of squares, MS–mean sum of squares, –F–statistic, p–P-value



**Figure 1.** The regression line of the standard length (SI) based on the body weight (BW), in pikeperch fingerlings

The 95% confidence interval for the slope 0.5119 was (-0.02, 0.13) and the 95% confidence interval for the intercept 15.873 was (1.49, 30.25) which provides the lower and upper bounds for the unstandardized regression coefficients. We noted also the strong positive linear correlation which was reported by the Pearson linear correlation

coefficient  $r=0.99$  and determination coefficient  $r^2=0.98$ . A linear regression analysis of the total length (L) based on the BW was also performed (Table 3). It was determined that the proportion of variance in the L was 3.47 for  $F=25.2684$  and  $df=1$ , where the F ratio provided the test of statistical significance.

**Table 3.** Linear regression analysis of the total length (L) based on the body weight (BW) in pikeperch fingerlings

Effect	SS	Degr. of freedom	MS	F	p
Intercept	15.42168	1	15.42168	112.2023	0.059923
BW	3.47302	1	3.47302	25.2684	0.125014
Error	0.13745	1	0.13745		

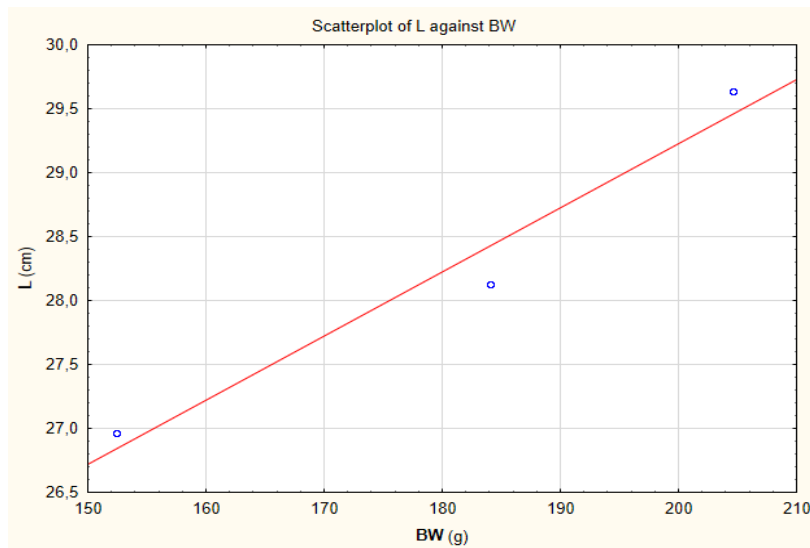
BW–body weight, SS–sum of squares, MS- mean sum of squares, F–F-statistic, p–P-value

The regression line  $y=b_0+b_1x$  is the linear equation used to fit the best straight line to the data (Figure 2). The dependent variable L was expressed as the equation:

$$L=19.197+0.05015 \cdot BW$$

The 95% confidence interval for the slope + 0.05015 was (-0.07, 0.17) and the 95%

confidence interval for the intercept 19.197 was (-3.3, 42.22) which provides the lower and upper bounds for the unstandardized regression coefficients. We noted also the strong positive linear correlation which was reported by the Pearson linear correlation coefficient  $r=0.98$  and determination coefficient  $r^2=0.96$ .



**Figure 2.** The regression line of the total length (L) based on the body weight (BW), in pikeperch fingerlings

A linear regression analysis of the maximum body depth (H) based on the BW was also performed (Table 4). It was determined that the proportion of

variance in the H was 0.06 for  $F=16.1050$  and  $df=1$ , where the F ratio provided the test of statistically significance.

**Table 4.** Linear regression analysis of the maximum body depth (H) based on the body weight (BW) in pikeperch fingerlings

Effect	SS	Degr. of freedom	MS	F	p
Intercept	0.630542	1	0.630542	147.2079	0.052352
BW	0.068983	1	0.068983	16.1050	0.155469
Error	0.004283	1	0.004283		

BW–body weight, SS–sum of squares, MS- mean sum of squares, F–F-statistic, p–P-value

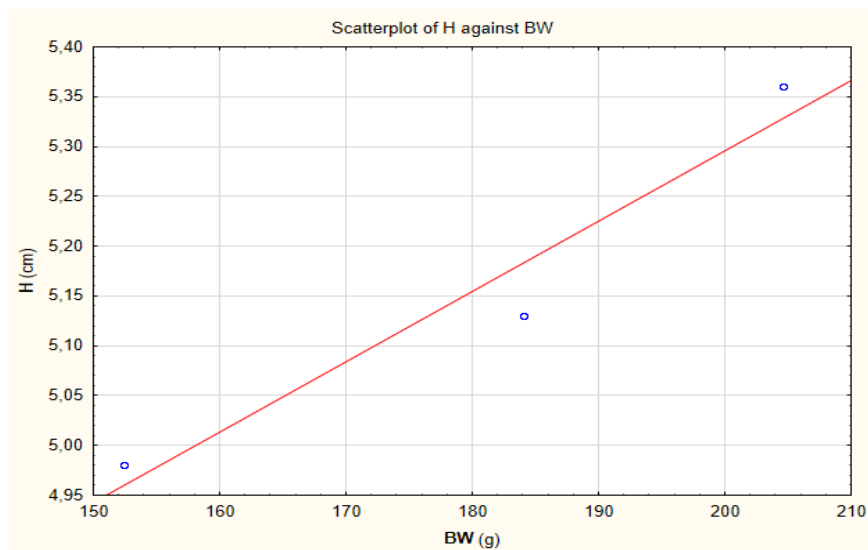
The regression line  $y=b_0+b_1x$  is the linear equation used to fit the best straight line to the data (Figure 3). The dependent variable H was expressed as the equation:

$$H=3.8817+0.00707*BW$$

The 95% confidence interval for the slope 0.00707 was (-0.01, 0.02) and the 95% confidence interval for the intercept 3.8817 was (-0.18, 7.94) which provides the lower and upper bounds for the unstandardized regression coefficients. We noted also the strong positive

linear correlation which was reported by the Pearson linear correlation coefficient  $r=0.97$  and determination coefficient  $r^2=0.94$ .

The results clearly revealed that any of the 4 measurements (total length, standard length and maximum body depth and body weight) could be monitored in pikeperch fingerlings, to accurately evaluate the growth dynamic, the correlations among these being very high. Furthermore, the dependencies of the evaluated traits are very high, and with our equations, 3 of measurements could be calculated based on pikeperch’s body weight.



**Figure 3.** The regression line of the maximum body depth (H) based on the body weight (BW), in pikeperch fingerlings

#### 4. Conclusions

1. The results indicate very high correlations among all the studied traits (total length, standard length, maximum body depth, and body weight), varying between 0.970329 and 0.998856.
2. The dependencies of the evaluated traits are very high, and with our equations, 3 of measurements could be calculated based on pikeperch's body weight.

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