ASSESSMENT OF SOME BIOMETRIC TRAITS FOR DIFFERENT LINES OF STELLATE STURGEON IN EARLY LARVAL DEVELOPMENT PERIOD

Lorena Dediu[1*], Angelica Docan[1], V. Cristea[1], Marilena Maereanu[1], Iulia Grecu[1]

[1]Aquaculture, Environmental Sciences and Cadastre Department, "Dunarea de Jos" University of Galati, Romania

Abstract

The study aims to evaluate growth pattern during early larval development of sturgeons obtained from crossbreeding of genitors with different origins (wild and aquaculture), from the time of hatching until the yolk sac resorption. To characterize the growth of larvae for the first 7 days post hatch (dph) following biometric characters were evaluated: total length (L), preanal length (PAL), yolk sac length (YSL), the maximum height of the yolk sac (YSH) and height –length report HL = YSH/YSL (for characterizing yolk sac shape). Study of the morphometric traits revealed slightly differences between tested groups.

Key words: sturgeon aquaculture, morphometry, growth pattern

INTRODUCTION

Early development of sturgeon larvae is accompanied by very complex morphological changes. It is known that, during this period, the growth of the various parts of the body is characterized by algometric mathematical models [1]. The changes in body shape are directly related to the completion of various organs functions, such as respiration, feeding and swimming [2,3]. Characterization of morphogenesis processes and developing models for the early stages of growth may lead to a better understanding of the early stages of development and offers new perspectives in understanding the biological, behavioral and ecological aspects of the species [4]. *The study follows growth process of sturgeon larvae obtained from crossbreeding of genitors with different origins (wild and aquaculture), from the time of hatching until the yolk sac resorption.*

MATERIALS AND METHODS

The experimental groups consisted in four larvae populations obtained from crossbreeding of wild and farmed *Acipenser stellatus* (each of the two wild females was crossed with two different males, respectively from aquaculture and from Danube) as is shown in table 1.

The eggs were incubated in Zug-Weiss incubators at 20.5°C. After 3 days of incubation, 800 newly hatch larvae for each breeding combination were introduced into 500 L fiberglass tanks connected to a flow-through freshwater system. During the trial the water temperature was kept around 21±0,5°C. Average dissolved oxygen concentration in the water was 7±0,3 mg/l, and average pH was 7.50 ±0,2. Fish were reared under natural photoperiod. Fish larvae samples were collected every day at 9.00 am and 9.00 pm with the exception of the first day, when the samples ware taken at hatching. The samples were kept in 10% formalin. Because biometric measurements were performed on formalinized material a correction factor of 8% was applied in order to offset the effect of dehydration and thus reducing biometric characters [5].

To characterize the growth of larvae for the first 7 days post hatch (dph) following biometric characters were evaluated: total length (L), preanal length (PAL), yolk sac length (YSL) and the maximum height of the yolk sac (HYS). In addition, the yolk sac shape was characterizated by calculating height – length ratio HL = HYS/YSL. Mean, standard deviation and the minimum / maximum of these indicators are summarized in Table 1.

*Corresponding author: lorena.dediu@ugal.ro
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RESULTS AND DISCUSSIONS

During the incubation, by the time of the second division of the animal pole, approx. 4:00 post fertilization (pf), fertilization rate (%) was determined. The analysis was carried out on a sample of approx. 100 eggs / batch with stereo magnifying glass. As a result, it was appreciated that fertilization rate was between 72 -85%.

Biometric evaluation of sturgeon larvae obtained from different combinations of wild and aquaculture sturgeons breeders has shown that, in terms of length, the dynamics were similar for all tested groups, revealing insignificant differences when all tested variables were compared (ANOVA, $p > 0.05$).

It may be noted, however, that there are notable differences in the rate of length growth for the larvae form V4 variant, those recording average 21.50 mm on the last day of the study, compared with the other groups, where the total length did not exceed 20 mm, reaching only 19.98 (V3), 19 (V2) and 18.88 (V1), respectively.

Table 1 Descriptive statistics for biometric characters quantified for sturgeon larvae after 7 days posthach

Variant	Descriptive statistics	L (mm)	PAL (mm)	YSL (mm)	HYS (mm)	HL (mm)
V1/ ♀D x ♂D1	Media	13.82	8.37	3.01 [a]	1.67 [a]	0.56 [a]
	Dev. Std.	3.44	1.31	0.77	0.43	0.05
	Minim	9.34	6.50	1.38	0.88	0.45
	Maxim	18.88	10.55	3.74	2.12	0.64
V2/ ♀D x ♂A1	Media	14.07	8.55	2.72 [ab]	1.60 [ab]	0.58 [ab]
	Dev. Std.	3.70	1.58	0.72	0.47	0.05
	Minim	9.19	6.55	1.44	0.98	0.50
	Maxim	19.00	10.83	3.59	2.27	0.68
V3/ ♀D x ♂A2	Media	14.90	8.55	2.38 [ab]	1.51 [ab]	0.54 [ab]
	Dev. Std.	3.85	1.39	1.21	0.78	0.23
	Minim	9.63	6.48	1.51	0.98	0.59
	Maxim	19.98	10.19	3.59	2.30 [a]	0.66 [a]
V4/ ♀D x ♂D2	Media	14.62	8.92	2.99 [a]	1.66 [a]	0.56 [a]
	Dev. Std.	3.98	1.59	0.89	0.50	0.06
	Minim	9.36	6.85	1.31	0.85	0.43
	Maxim	21.50	11.56	3.76	2.19	0.65

a,b –significant differences (t student, $p<0,05$) for variables with different letters; insignificant differences (t student, $p>0,05$) for variables with the same letter.

For highlighting more eloquent these differences, length growth regression models were developed for all four tested groups (Table 2). To correct outliers, before running statistical procedure, independent variable values of L (total length) were transformed by logarithmic approach.

Table 2 Regression coefficients and statistical significance (T - Student Testing)

Variant	Model	Unstandardized coefficient		Standardized coefficient	t	Sig.
		B	Std. error	Beta		
V1	Time (Days)	0.115	0.004	0.992	27.405	0.000
	Constant	8.623	0.159		54.294	0.000
V2	Time (Days)	0.121	0.006	0.983	18.729	0.000
	Constant	8.521	0.243		35.042	0.000
V3	Time (Days)	0.132	0.007	0.987	19.673	0.000
	Constant	8.139	0.259		31.394	0.000
V4	Time (Days)	0.124	0.006	0.986	20.446	0.000
	Constant	8.758	0.234		37.506	0.000

Thus, the regression equations are developed as:

V1: Ln L = 8.62 *e0.115t
V 2: Ln L = 8.52 *e0.121t
V 3: Ln L = 8.13 *e0.132t
V 4: Ln L = 8.75 *e0.124t

In order to identify ontogenetic allometry and, therefore, the relationships between the various biometric characters that could characterize sturgeon early development stages, a multiple regression model was developed for each variant; the purpose of these models is to be able to predict / estimate the total length as a function of preanal length and the length of the yolk sac. After transforming the studied variables, the matrix of correlations was generated in order to establish the relationship and dependence between different variables (Table 3). It can thus be seen the strong positive correlation relationship between L and PAL (Pearson coefficient 0.98) and the strong negative correlation relationship between L and YSL (Pearson coefficient 0.91).

Table 3 Correlation matrix (Pearson) between different caracters

		L	La	LSV
Correlation Pearson	L	1.000	.975	-.909
	Lpa	.975	1.000	-.891
	LSV	-.909	-.891	1.000
Sig. (1-tailed)	L	.	.000	.000
	Lpa	.000	.	.000
	LSV	.000	.000	.
N	L	54	54	54
	Lpa	54	54	54
	LSV	54	54	54

To validate the developed models a series of statistical indicators and coefficients (multiple correlation coefficient R, the coefficient of determination R2, Durbin-Watson (DW) statistic criterion, the value of probability associated with Fisher and Fisher test were analyzed (Table 4).

Table 4 Regression equations and regression significance and coefficients

Variant	Regresion equations	Regression coefficients		DW	F	Sig.
		R	R2			
V1	L = 2.294 x Lpa – 0. 575 YSL - 3.633	0.987	0.973	1.708	437.8	0.000
V2	L = 2.424 x Lpa – 0. 214 YSL – 7.221	0.993	0.985	1.750	793.81	0.000
V3	L = 2.080 x Lpa – 0. 283 YSL - 3.667	0.980	0.961	1.888	246.62	0.000
V4	L = 2.169 x Lpa – 0. 560 YSL - 3.054	0.977	0.954	1.741	246.58	0.000

The value of R, the correlation coefficient may be considered to be the measure of the prediction quality of the dependent variable, in this case L. The R values ranged between 0.977 and 0.993 indicating a high level of prediction. To characterize the relationship between the total length of larvae, L and preanal length, PAL has developed a linear regression model with a high degree of predictability, given that the total length variation is explained in a proportion of 95.1% of the variation in yolk sac length (Figure 1).

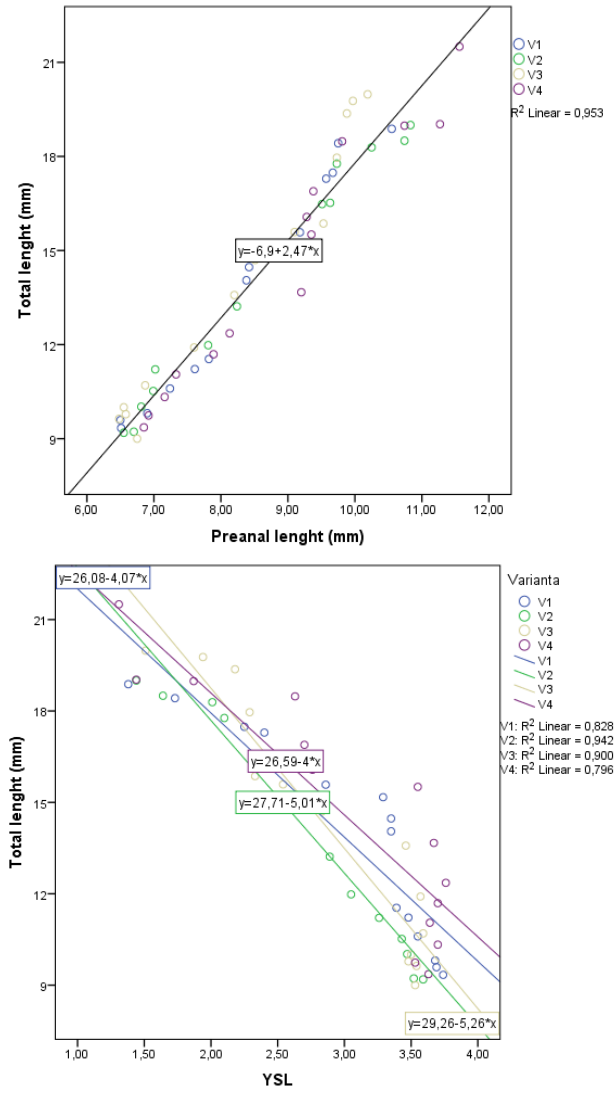

Fig. 1 Linear Regression Models to describe the growth of sturgeon larvae within 7 days after hatching

Regarding the relationship between total length and the yolk sac length, it can be described globally through a linear regression equation surprised in Figure 2. In this case L variation can be explained in a proportion of 82.6% of YSL variation.

In aquaculture, assessing the size and shape of the yolk sac has great practical significance since decreased of yolk reserves may adversely affect larval growth until transition to the exogenous food, sometimes leading to significant losses in this period. Also, the presence of large yolk reserves may indicate serious osmoregulation problems that can occur during embryogenesis, negatively affecting both the transition to exogenous feeding and excretory function. Evaluation of the deformation of the yolk sac can be done through height - length ratio, HL which normally oscillates between 0.55 -0.69 [6].

HL ratio in this study varied between 0.45 and 0.64 for V1, between 0.50 and 0.68 for V2, between 0.59 and 0.66 for V3 and 0.43 and 0.65 for V4. Statistical analysis

revealed significant differences among mean values of HL ratio calculated for experimental larvae obtained from the same female and different males, with slightly higher values for V1 and V4 groups (derived from wild females and wild males).

However, during the first four days after hatching HL ratio values were more homogeneous among groups comparing with last three days when a more pronounced variation between tested variants was recorded. This variation of HL values recorded in the latter part of the prelarval period highlights the quickly change of the yolk sac shape, this oscillating between oval and spherical form within 12 hours.

CONCLUSIONS

The study of the morphometric traits revealed slightly differences, among tested groups, regarding the form and dimensions of the yolk sac during endogen feeding. Thus, regardless egg dimension, the larvae obtained from wild genitors had slightly higher and longer yolk sac comparing with those obtained from wild female and domestic male.

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