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GROWTH AND SURVIVAL OF PIKE LARVAE *ESOX LUCIUS* L. FED ON BRINE SHRIMP *(ARTEMIA SALINA* L.) NAUPLII

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Abstract

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The purpose of this investigation is to establish the effect of using live *Artemia* nauplii on the survival and growth of juvenile pike (*Esox lucius* L.). The experiment was carried out at laboratory conditions in 20 l tanks in the course of 20 days. The experimental fish were obtained by means of semi artificial reproduction of pike spawners in tank (4 m^3). On the 12^{fth} day after hatching larvae were transferred to the laboratory and stocked in the experimental tanks at three densities - 10, 20 and 30 pike larvae.l^{-1}. The larvae from the different variants have been fed *ad libitum* on *Artemia* nauplii. The results have shown that *Artemia* nauplii can be used successfully to feed pike larvae obtained from the artificial and semi-artificial reproduction, when because of the low water temperature the zooplankton collection from ponds and lakes has been difficult. The highest growth rate was achieved at stocking density of 30 larvae.l^{-1}, which has been probably due to the relatively higher density of the *Armemia* nauplii given in the tanks at that variant. The survival rate of pike larvae in all variants was good and within the limits of 64-68%, in the third variant being little less because of cannibalism, which have occurred more often during the last 3-4 days of rearing.

Key words: pike *Esox lucius*, larvae, feeding, *Artemia salina*, nauplii

Introduction

One of the most important stages in the artificial and semi-artificial reproduction of pike (*Esox lucius* L.) is the initial larvae rearing after their hatching. The feeding on suitable feed is of a decisive importance for their growth and survival (Anwand, 1978).

The pike larvae are produced in a period (February) when the natural food quantity (zooplankton) in the ponds and lakes is minimal and it is practically impossible to be collected and use for their feeding. On the other side, instead of some positive outcomes, the use of commercial starters has still been problematic and controversial (Wolnicki and Myszkowski, 1998). One of the means for solving the problem with larvae feeding is to use brine shrimp (*Artemia salina*) nauplii. It is a common practice worldwide to use *Artemia* as food for fish larvae in the aquaculture (Piasecki at al., 2004, Howell and Bengson, 1991). Rearing fish larvae with live *Artemia* nauplii or decapsulated dried *Artemia* cysts have been successful as a sole food or as a supplement to dry diets (Timmermans, 1979; Wolnicki, 2003; Ehrlich at al., 2007).

The purpose of this investigation is to establish the effect of using live *Artemia* nauplii on the survival and growth of juvenile pike (*Esox lucius* L.)

Materials and Methods

The experiment was carried out at laboratory conditions in 20 l tanks in the course of 20 days. The water in the tanks was aerated by using micro compressors, and it was completely changed every 3 days. The tanks were cleaned of faeces and uneaten food twice a day - at 9 a.m. and at 4 p.m. before feeding the pike larvae. When dead animals were observed, they were immediately removed from the tanks.

During the experiment the water hydrochemical parameters were within the normal limits, and the separate indices values were within the technological requirements for normal growth and development of pike larvae (Table 1).

The experimental fish were obtained by means of semi artificial reproduction of pike spawners in tank (4 m^3). From 12 days after hatching larvae were transferred to the laboratory and stocked in the experimental tanks.

Larvae were stocked at three densities - 10, 20 and 30 pike larvae.l^{-1}. All experiments were in duplicate groups (two tanks per density). Before the experiment the body weight and length of the larvae were measured und the animals were counted.

The pike larvae from the different variants have been fed *ad libitum* on *Artemia* nauplii. Live freshly-hatched *Artemia* nauplii (cysts of Advanced Hatchery Technology" Inc., Salt Lake City, Utah, USA) were used as sole food for the larvae. The quantity of feed has been supplied proportionally by variants depending on stocking density, 4 times a day.

The values of the following parameters have been traced: initial body weight and length of pike larvae; body weight and length, growth rate and survival on the 10-th day; final body weight and length, growth rate and survival on the 20-th day; daily growth rate (DGR, g/day^{-1}) by the formula: $DGR = (Wf-Wi).t^{-1}$ where Wf and Wi are the final and the initial body weight, and t is the duration of the experimental period, equal to 20 days; specific growth rate (SGR, %/day^{-1}) by the formula: $SGR = \{[\exp(\ln Wf-\ln Wi)-1].t^{-1}\}.100$.

Results and Discussion

Day 10th from experiment beginning

The initial body weight and body length of pike larvae on the day 1st of the experiment (12 days after hatching) was 12.53 mg and 13.03 mm (Table 2).

On the day 10-th from the experiment beginning the body weight and body length in the different variants of stocking density was as follows: 24.62 mg and 16.56 mm for the first variant; 26.65 mg and 16.29 mm for the second variant and 28.22 mg and 16.81 mm for the third variant.Significant differences in BW (mg) and SL (mm) were found only between the first and the third group and that at $p<0.05$.

Relative growth rate of 48.99% at the first variant, 52.71% at the second and 55.02% at the third variant have been achieved. DGR (mg) was 1.21 mg for the first variant, 1.41 mg for the second and 1.57 mg for the third variant. SGR (%) was 9.64 for the first variant, 11.27 for the second and 12.52 for the third variant.

The survival of pike larvae for the 10 days' rearing period had close values at the different variants: 78.3% for the first, 77.3% for the second and 73.9% for the third variant.

Day 20th from experiment beginning

The final body weight and length of pike larvae at the end of the second 10 days' rearing period (20 days after experiment beginning) was 37.89 mg and 19.2 mm at the first variant, 44.74 mg and 19.72 mm at the second variant, and 49.95 mg and 20.0 mm at the third variant (Table 2).

Significant differences in body weight and body length have been observed among all 3 variants, the level of significance between the first and third variant and between the first and second variant being at $p<0.001$, while between the second and third variant has been at $p<0.05$.

The relative growth rate for the second decade

Table 1

Hydrochemical parameters of the water in the experimental tanks

Variant	Parameters	T°C	O2 , mg.l-1	O2, %	pH	NH4+ , $mg.l^{-1}$	NO3- , $mg.l^{-1}$	Total N mg.l-1	NH3 $mg.l^{-1}$	Saturation mg O_2.l-1	Phosphorus, $mg.l^{-1}$
I	x±SD	10.45±0.57	6.58±0.34	60±2.76	8.32±0.1	0.18±0.054	10.28±0.4	10.45±0.39	0.003±0.001	3.30±0.75	0.58±0.4
	Cv, %	5.44	5.12	4.59	1.24	30.8	3.87	3.71	40.51	22.62	70.1
	lim	9.7÷11.1	6÷6.9	55÷62	8.17÷8.4	0.1÷0.23	9.6÷10.8	9.82÷11	0.0015÷0.004	1.91÷3.8	0.37÷1.4
II	x±SD	10.25±0.49	6.75±0.18	61.33±1.5	8.35±0.07	0.392±0.18	10.84±0.52	11.23±0.37	0.007±0.003	3.30±0.78	0.59±0.045
	Cv, %	4.77	2.61	2.45	0.81	45.77	4.78	3.32	49.1	23.76	7.63
	lim	9.6÷10.8	6.6÷7	60÷63	8.26÷8.43	0.11÷0.59	10.3÷11.8	10.84÷11.91	0.0016÷0.0108	2.29÷3.81	0.51÷0.65
III	x±SD	10.42±0.53	6.47±0.28	58.5±2.17	8.3±0.03	1.28±0.18	10.59±0.54	11.87±0.65	0.022±0.0041	3.57±0.75	0.78±0.13
	Cv, %	5.06	4.34	3.71	0.4	13.86	5.1	5.51	18.39	21.06	16.21
	lim	9.7÷10.9	6.2÷6.8	56÷61	8.27÷8.34	1.02÷1.43	9.85÷11.2	11.02÷12.63	0.0161÷0.0262	2.67÷4.57	0.65÷0.98

was 34 % for the first variant, 40 % for the second and 43% for the third variant. DGR (mg) for the second decade had the following values: 1.33 mg for the first variant, 1.81 mg for the second and 2.17 mg for the third, respectively. SGR, % was 5.40 for the first variant, 6.88 for the second and 7.84 for the third variant, respectively. In general, during the second decade a growth rate decrease of pike larvae at all variants has been observed, as compared to the first decade of growing.

The larvae survival for the second 10 days‘ period of rearing was higher as compared to the first decade and had also similar values at the different variants: 87%for the first variant, 86.9% for the second and 87% for the third variant, respectively.

Concerning the whole 20 days‘ long rearing period, pike larvae have achieved a relative growth rate of 67% at the first variant, 72% at the second and 75% at the third variant. DGR (mg) had values, as follows: 1.27 mg for the first variant, 1.61 mg for the second and 1.87 mg for the third variant, respectively. SGR (%) was as follows: 10.11 for the first variant, 12.85 for the second and 14.93 for the third variant.

Within the stocking density investigated, no negative effect of the greater fish larvae per unit volume upon the growth rate has been determined. The higher growth rate of pike larvae at the third variant (30 $ind.l^{-1}$) is probably in connection with the relatively higher density of *Artemia* nauplii given for pike larvae in that variant.

The survival rate was the highest at the first variant 68.3%, followed by that at the second variant 67.2%. The lowest survival rate has been reported at the third variant – 64.4%, i.e., in the tanks where the stocking density was 3 times higher than the first variant and 1.5 time than the second one. The difference concerning the survival at the different variants, though small, shows clearly its dependence from the stocking density.

The appearance of cannibalism, which has been observed for the first time on the 12th day of larvae rearing in the tanks, had an effect upon the survival rate, as well, and that has continued till the end of the experiment. In the tanks, where demonstrations of

Table 2

Body weight (mg) and length (mm), relative growth rate (RGR,%), daily growth rate (DGR, mg), specific growth rate (SGR, %) and survival (%) of the pike larvae during the experiment

Parameters	Body weight, mg	Body length, mm	RGR, %	DGR, mg	SGR, %	Survival, %
Day first from the experiment	12.53	13.03				
Day 10 from experiment beginning						
I variant	24.62	16.56	48.99	1.21	9.64	78.3
II variant	26.65	16.29	52.71	1.41	11.27	77.3
III variant	28.22	16.81	55.02	1.57	12.52	73.9
Day 20 from experiment beginning						
I variant	37.89	19.2	34.00	1.33	5.40	87
II variant	44.74	19.72	40.00	1.81	6.88	86.9
III variant	49.95	20.00	43.00	2.17	7.84	87
For the whole 20 days rearing reriod						
I variant			67	1.27	10.11	68.3
II variant			72	1.61	12.85	67.2
III variant			75	1.871	14.93	64.4

cannibalism have been observed most often, pike larvae density has been the greatest.

Conclusions

The recent study shows that *Artemia* nauplii are good food for pike larvae in the first days of their exogenous feeding. The results have shown that stocking densities of 10, 20 and 30 larvae.l^{-1} allowed the achievement of a satisfactory growth rate when fed larvae *ad libitum* on *Artemia* nauplii.

The highest growth rate was achieved at stocking density of 30 larvae.l^{-1}, which has been probably due to the relatively higher density of the *Armemia* nauplii given in the tanks at that variant. The survival rate of pike larvae in all variants was good and within the limits of 64-68%, in the third variant being little less because of cannibalism, which have occurred more often during the last 3-4 days of rearing.

The *Artemia* nauplii can be used successfully to feed pike larvae obtained from the artificial and semi-artificial reproduction, when because of the low water temperature the zooplankton collection from ponds and lakes has been difficult.

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