BREEDING OF THE SIBERIAN STURGEON (*ACIPENSER BAERII BRANDT, 1869*), IN A RECIRCULATING AQUACULTURE SYSTEM, WITH DIFFERENT STOCKING DENSITIES

Corina Bădălan, M.G. Băcanu, M. Bărbulescu, D. Oprea, E. Bocioc, L. Oprea, V. Cristea, N. Patriche

Dunarea de Jos University, Galati
e-mail: bulgari_corina@yahoo.com

Abstract

The paper is presenting aspects regarding the influence of stocking density on the breeding of siberian sturgeon, in a recirculating aquaculture system (RAS). The experiment took place over 30 days, in four pilot breeding units type aquaria of 300 liters in volume. Two kind of variants were compared, with repetition V1 (B1, B2) and V2 (B3, B4) respectively. The stocking density was of 11 fish/unit in V1 (1,58 kg/ m^3) and 22 fish/unit in V2 (3,17 kg/m^3). The same feeding quantity of 20 g/kg. metabolic weight (3,7% from total biomass) was used in every unit. The technological indicators that showed up at the end of the experiment revealed the following:

- *The mean biomass gain in V1 was of 3,04 kg/m^3 compared to 5,62 kg/m^3 in V2. This was nearly perfectly correlated with the density variation. The growth rate (GR) variated in a similar way, from 27,33 to 33,03 g/day in V1 and 54,60-57,93 g/day in V2;*
- *The specific growth rate (SGR), calculated as a mean value on the two repetitions of each variant, was of 3,56 %/day in V1 and 3,39 %/day in V2. This showed a slightly better growth in V1, which is the variant with a lower stocking density;*
- *The food conversion ratio (FCR), calculated as the mean value of the two repetitions from the two variants, was of 0,91 in V1 and of 0,97 in V2. This indicated a better efficiency for the variant with a lower density.*

The parameters of fish breeding showed that doubling the stocking density from 1,58 kg/m^3 to 3,17 kg/m^3 does not negatively affect the organic load capacity of the system. This experiment showed that it is possible to obtain an increase of fish biomass of over 5,5 kg/month. Acipenser baerii, which is a sturgeon recently introduced in the Romanian farming systems, has a rapid growth rate. This is situating it in the second place, after the beluga, giving it very good perspectives for the Romanian aquaculture sector.

Key words: sturgeon, aquaria, different stocking densities

INTRODUCTION

According to statistics of the United Nations Food and Agriculture Organization (FAO) for the year 2007, total world production of aquatic organisms (fish, crustaceans, molluscs, algae, etc), has exceeded 155 million tons. Of this amount, yields from the catch in the natural environment was 90 million tonnes, while production aquaculture was 65 million tonnes, representing 42%. In the last decade, world aquaculture has evolved steadily, recording an annual increase of about 6.5%/year. At the top of the world aquaculture production is China, with about 62% of the total production, followed by India, Vietnam, Indonesia, and Thailand. The only European country which is present in this ranking is Norway at no. IX. In terms of value, the total world aquaculture production in 2007 reached USD 95 billion. The structure of the aquaculture production is formed by a high share (38%) of cyprinids (silver carp-*Hypophthalmichthys molitrix*, grass carp- *Ctenopharyngodon idellus*, common carp-*Cyprinus carpio*, bighead carp-*Hypophthalmichthys nobilis*), followed by salmonids (Atlantic salmon-*Salmo salar*, rainbow trout-*Oncorhynchus mykiss*) and molluscs (oyster-*Crassostrea gigas*).

Although they are not part of the world ranking, sturgeon form a group of highly valuable fish, because of the quality of their meat and eggs that give the famous black caviar. World's sturgeon catch has fallen dramatically in the last decade. If in 2001 the FAO statistics reported production of 2313 tons, in 2007 there were only 835 tonnes. The intense fishing beyond measure and poaching form the main cause that is leading to population decline. As demand for sturgeon is becoming greater, the only alternative is to grow them in intensive systems. Such systems are found in several European countries including France, Germany, Italy, Russia, Hungary and worthy to note, in recent years have opened in Romania.

Favored by the neighborhood of 1075 km of the Danube, Romania seems to be privileged, because the river still has beluga (*Huso huso*), Russian sturgeon (*Acipenser gueldenstaedti*), stellate sturgeon (*Acipenser stellatus*), sterlet (*Acipenser ruthenus*) that can be caught and reproduced. Moreover, the recent years have also brought two species of sturgeon, *Polyodon spathula* and *Acipenser baerii*, with high growth potential, easily adaptable in terms of growth.

The paper presents some aspects of the growth of Siberian sturgeon, *Acipenser baerii*, in a pilot recyrculating system. Mainly, we aimed to see the influence of stocking densities on growth, in terms of identical feeding level.

MATERIALS AND METHODS

Experiments were conducted in September 2009, in the pilot laboratory of the Department of Aquaculture of the Faculty of Food Science and Engineering, Galati. The recirculating aquaculture system (RAS) was formed by four aquaria-type units with a volume of 300 liters and a size of 100x80x40 cm. The system is equipped with a mechanical and biological filtration unit, an UV sterilization unit (equipment Quiet Tetra UV-C 35000, power 36 W) and an aeration equipment (compressor RESUN Quiet LP-100 100W, 0.045 MPa pressure and flow air 150 l / min.) (Fig. 1). The temperature and the dissolved oxygen which are the main physico-chemical water parameters, were measured daily with equipment Hach-Lange Sc 1000.

The biological material that was used consisted in juvenile Siberian sturgeon aged 4 months, with average body weight of 43 g/fish. This was provided by the Institute for Research and Development for Aquatic Ecology, Fishing and Aquaculture Galati. There were tested two variants of stocking density, each with one repetition: V1 (aquariums B1, B2), with density of 11 fish /aquarium and V2 (aquariums B3, B4), with density of 22 fish / aquarium.

The same food was distributed in the four aquaria, over 30 days. This consisted in pellets of 2 mm, with the same feeding level of 20 g/kg of metabolic weight (3.7% of total biomass). The chemical composition of pellets is shown in Table 1. Initial elements of computing technology and daily feed quantities distributed are presented in Table 2.

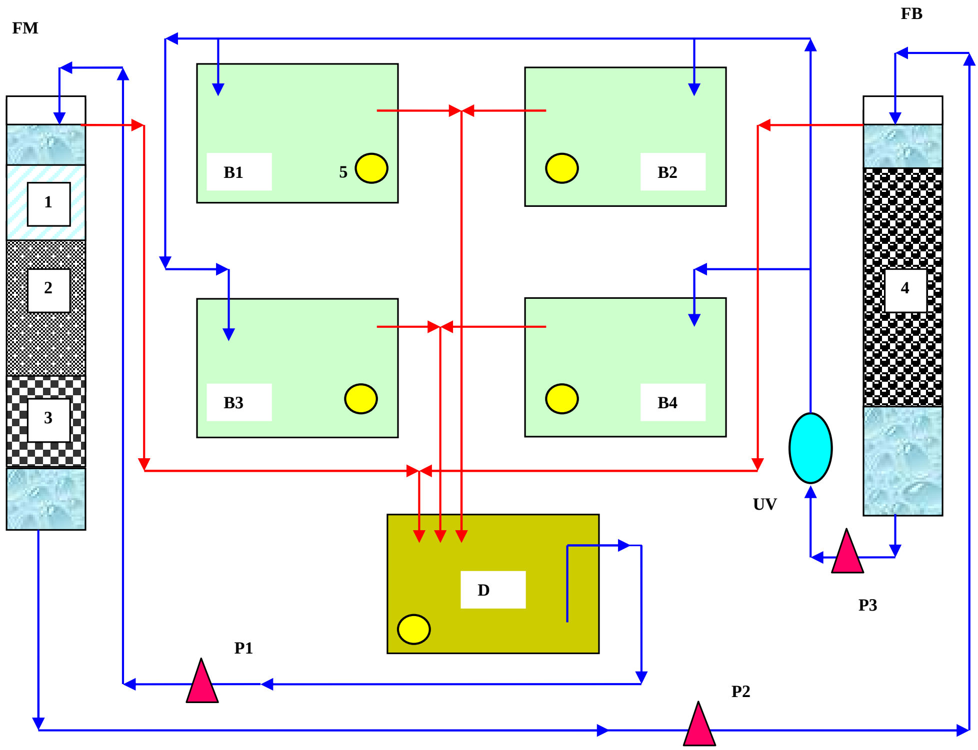

Fig. 1. Scheme of the recycling system
(B1-B4)-aquariums, D-settling, (P1-P3)-pumps, UV-lamp sterilization, FM-mechanical filter, FB-biological filter, 1-sponge, 2 sand, 3 gravel, 4-bactobolt, 5-nozzle aeration.

Table 1

Chemical composition of the pellets

Nutrients	Quantity
Crude protein	46 %
Fat	20 %
Ash	6,8 %
Crude fiber	2,8 %
Phosphorus	0,9 %
Vitamin A	9.500 U.I./kg
Vitamin D3	1500 U.I./kg
Vitamin E	150 mg/kg
Copper	9 mg/ kg
Ingredients: products and sub-products from oilseeds, cereals and cereal sub-products, fish products, hemoglobin, oil, wheat gluten, BHT. **Granulation:** 2mm	

Table 2
The initial elements of calculation and daily quantities of food distributed

VARIANT	**V1**		**V2**	
CALCULATION ITEMS	**B1**	**B2**	**B3**	**B4**
Initial number of fish	**11**	**11**	**22**	**22**
Initial fish biomass (g)	**476**	**476**	**952**	**952**
Mean body weight (g/fish)	**43**	**43**	**43**	**43**
Feeding level (% biomass)	**3,7**	**3,7**	**3,7**	**3,7**
Feeding level (g/kg met.)	**20**	**20**	**20**	**20**
FCR (g/g)	**1**	**1**	**1**	**1**
01-sep	17,8	17,8	35,7	35,7
02-sep	18,4	18,4	36,7	36,7
03-sep	18,9	18,9	37,8	37,8
04-sep	19,5	19,5	38,9	38,9
05-sep	20,0	20,0	40,1	40,1
06-sep	20,6	20,6	41,3	41,3
07-sep	21,2	21,2	42,4	42,4
08-sep	21,8	21,8	43,7	43,7
09-sep	22,4	22,4	44,9	44,9
10-sep	23,1	23,1	46,2	46,2
11-sep	23,7	23,7	47,5	47,5
12-sep	24,4	24,4	48,8	48,8
13-sep	25,1	25,1	50,1	50,1
14-sep	25,7	25,7	51,5	51,5
15-sep	26,5	26,5	52,9	52,9
16-sep	27,2	27,2	54,3	54,3
17-sep	27,9	27,9	55,8	55,8
18-sep	28,6	28,6	57,3	57,3
19-sep	29,4	29,4	58,8	58,8
20-sep	30,2	30,2	60,4	60,4
21-sep	31,0	31,0	61,9	61,9
22-sep	31,8	31,8	63,6	63,6
23-sep	32,6	32,6	65,2	65,2
24-sep	33,4	33,4	66,9	66,9
25-sep	34,3	34,3	68,6	68,6
26-sep	35,2	35,2	70,3	70,3
27-sep	36,0	36,0	72,1	72,1
28-sep	37,0	37,0	73,9	73,9
29-sep	37,9	37,9	75,7	75,7
30-sep	38,8	38,8	77,6	77,6
Total food distributed (g)	**820**	**820**	**1641**	**1641**

RESULTS AND DISCUSSIONS

The technological growth indicators of the juvenile Siberian sturgeon *Acipenser baerii* are presented in table 3, fig. 2 and fig. 3. Figure 4 shows the variation of the water temperature and of the dissolved oxygen.

Table 3
Technological Indicators of growth

Experimental variant	**V1**			**V2**		
Indicator / aquarium	**B1**	**B2**	**Media**	**B3**	**B4**	**Media**
initial biomass (g / aquarium)	476	476	476	952	952	952
initial biomass (kg/m^3)	1,58	1,58	1,58	3,17	3,17	3,17
final biomass (g/aquarium)	1308	1467	1387,5	2590	2690	2640
final biomass (kg/m^3)	4,36	4,88	4,62	8,62	8,96	8,79
biomass growth gain (g/aquarium)	832	991	911,5	1638	1738	1688
biomass growth gain (kg/m^3)	2,78	3,30	3,04	5,45	5,79	5,62
initial number of fish	11	11	11	22	22	22
final number of fish	11	11	11	22	22	22
survival (%)	100	100	100	100	100	100
initial average weight (g /fish)	43	43	43	43	43	43
final average weight (g /fish)	119	133	126	118	122	120
days growth	30	30	30	30	30	30
individual growth gain (g)	76	90	83	74	79	76,5
food distributed (g)	820	820	820	1641	1641	1641
GR (g/day)	27,73	33,03	30,38	54,60	57,93	56,26
SGR (g%/day)	3,37	3,75	3,56	3,34	3,46	3,40
FCR (g feed/g biomass)	0,99	0,83	0,91	1,00	0,94	0,97
feeding level (g/kg met weight)	20	20	20	20	20	20
feeding level (% biomass)	3,70	3,70	3,70	3,70	3,70	3,70

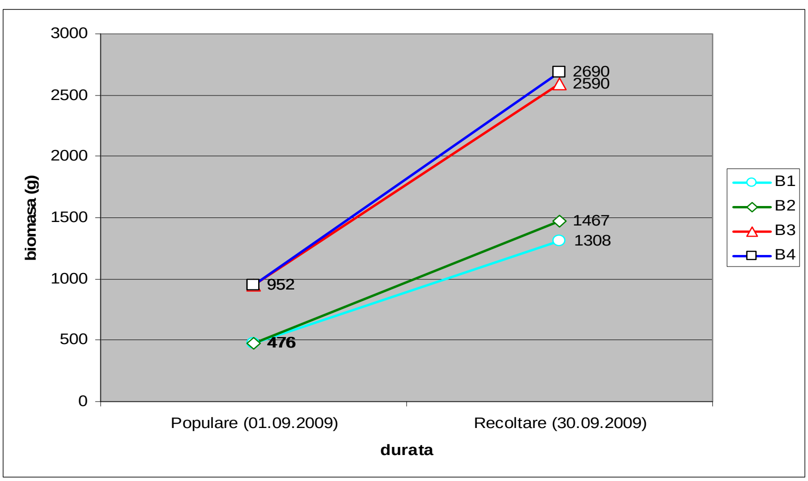

Fig.2-Evolution of growth rate

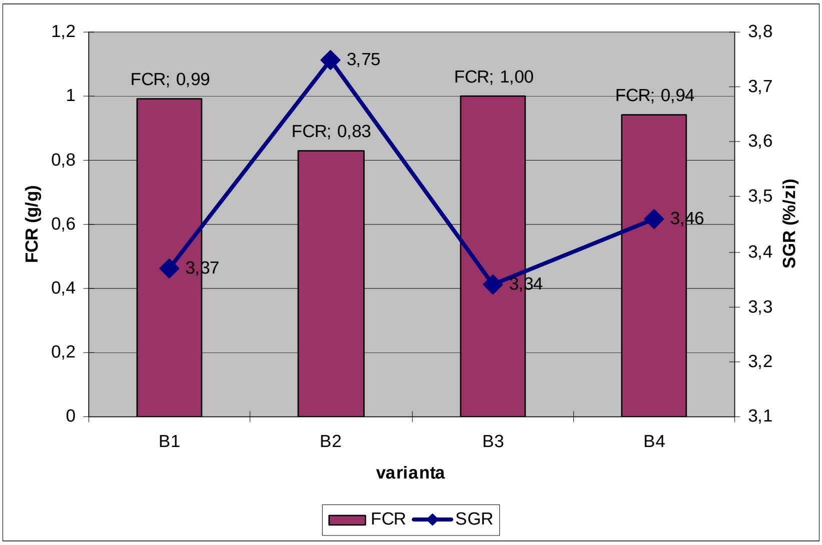

Fig. 3-Variation of feed conversion ratio (FCR) and specific growth rate (SGR)

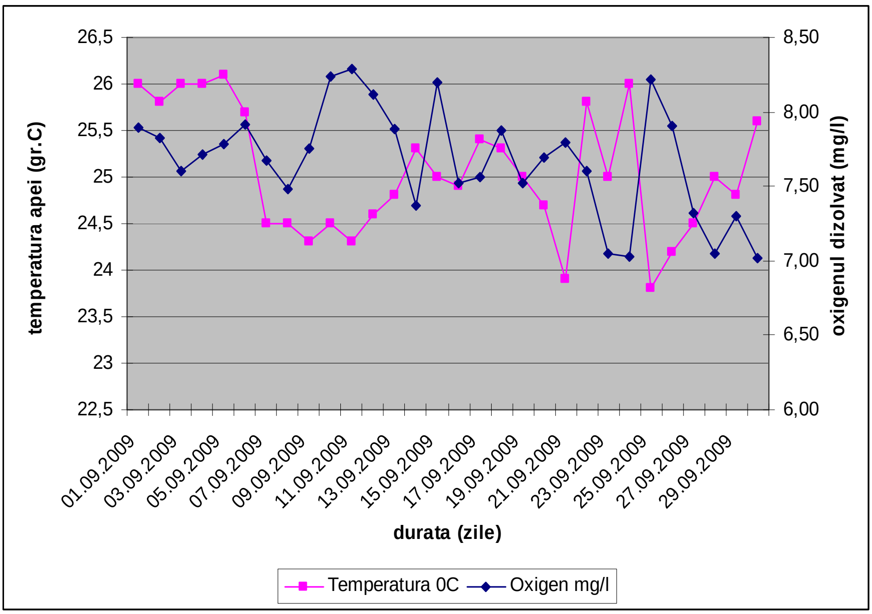

Fig. 4-Changes in physico-chemical parameters of water

In the two experimental variants, V1 (aquariums B1, B2) and V2 (aquariums B3, B4), significant growth increases were achieved in conditions of 100% survival rate in all tanks (table3). In variant V2, where the densities were twice as much as those in V1, the growth rate was almost double. Analyzing the average values for each variant, the result is an increase in fish biomass of 3,04 kg/m^3 in V1 and of 5,62 kg/m^3 in V2. Growth rate (GR), which is the technological indicator that shows the linear growth of fish, theoretically constant, varied between 27,73-33,03 g/day (V1) and 54,60-57,93 g/day (V2).

Figure 2 shows the evolution of the growth of fish in the four aquaria. We notice very close values of the repetitions of the two variants, confirming that the experiment went very well. Outcomes are repeatable.

Among the most significant technological indicators there are the specific growth rate (SGR) and feed conversion ratio (FCR). Both indicators were best in version V1. Thus, V1 has obtained an SGR value of 3,56%/day and a FCR of 0,91 g feed/g of biomass gained, while the V2 obtained an SGR value of 3,40%/day and an FCR of 0,97 g feed/g of biomass gained. From fig. 3 one can notice an inverse correlation that is logical, between SGR and FCR development. A low FCR is achieved when SGR grows.

With regard to water quality, the experiment monitored the daily water temperature, pH and the dissolved oxygen in water. The concentration of hydrogen ions (pH) varied between the limits of 7,0-7,4 units, except that higher values, close to 7.4 units occurred when purging the system with water from the city network. The evolution of temperature and dissolved oxygen is shown in fig. 4. It is noted that during the experiment, temperature ranged within 23,5-26,5 centigrades, which is optimal for the growth of the species. The oxygen varied between the limits of 7,0-8,5 mg/l, values also optimal for the species studied.

CONCLUSIONS

An effective way to reduce pressure on populations of sturgeon from the wild is their growth in different culture systems like traditional (ponds) or modern (RAS, cages etc).

Research has been aimed at increasing juvenile Siberian sturgeon *Acipenser baerii* in a pilot recyrculating aquaculture system represented by aquaria. The parameter that made the difference between the experimental variants was the stocking density. Technological indicators, calculated at the end of the experiment showed that doubling the density of population from 1,58 kg/m^3 to 3,17 kg/m^3 has not negatively influenced the caryng capacity of the system. This made it possible to easily obtain the biomass of fish increases of over 5,5 kg/m^3/month. The fish species has adapted very well in experimental conditions.

Acipenser baerii, sturgeon farming systems recently introduced in Romania, has a very fast growth rate, second only to beluga, representing a definite promise for the aquaculture sector in Romania.

AKNOWLEDGEMENTS

Research was conducted within the project POSDRU-6 /1.5/S/15-Management System of Scholarships for Doctoral Students-6583, funded by the EU and the Romanian Government. The authors thank the team of project management for financial support.

REFERENCES

[1] Birstein V.: Sturgeon Biodiversity and Conservation, Ed. Kluwer Academic, Olanda, 2002, p. 157-163;

[2] Bloesch J. : Action Plan for the conservation of sturgeons in the Danube River Basin, Council of Europe, 2006, p. 5-15;

[3] Cristea V.: Ingineria sistemelor recirculante din acvacultura, Ed. Didactica si Pedagogica, 2002, p. 14-60;

[4] Holcik J.: The Freshwater Fishes of Europe/General introduction to Fishes, Acipenseridae, 1997, vol 1/II;

[5] Oprea L., Georgescu R.: Nutriţia şi alimentaţia peştilor, Editura Tehnică, Bucureşti, 2000;

Oprea D., Oprea L.: Researches concerning feeding of Russian sturgeon fry (Acipenser gueldenstaedti- Brandt, 1833), reared in a superintensive system, 2008;

[6] Oprea D., Oprea L.: Comparative research considering rearing of beluga (Huso huso – Brandt, 1869) and bester (Huso huso × Acipenser ruthenus – Linne, 1758) larvae in a superintensive system, 2008, pp. 44 – 51,;

[7] Oprea D., Oprea L.: The effect of density on bester (H.huso × A. ruthenus) larvae reared in a superintensive system. U.S.A.M.V. Iaşi. Lucrări Ştiinţifice – vol. 52, Seria Zootehnie, 9 – 10 aprilie 2009, pag. 655 – 660.

[8] Oprea D., Oprea L.: Researches considering the effect of gradually insertion of fodder in alimentation for the growth rhythm of Siberian sturgeon larvae (Acipenser baerii -Brandt, 1869) reared in superintensive system., U.D.J. Galaţi, International Symposium Euro–Aliment, 2009;

[9] Oprea D., Oprea L.: Acquired results on rearing of sevruga larvae (Acipenser stellatus-Pallas, 1771) in superintensive system., Bulletin UASVM Cluj, nr. 66 (1-2)/2009;

[10] FAO-Fishery and Aquaculture Statistics, 2007 yearbook.