AACL BIOFLUX

Aquaculture, Aquarium, Conservation & Legislation
International Journal of the Bioflux Society

Preliminary results on growth of the *Polyodon spathula* juveniles in recirculating system conditions

[1]Marian T. Coadă, [2]Neculai Patriche, [1]Victor Cristea,
[3]Mioara Costache, [1]Elena Bocioc, and [1]Săndiţa Ion

[1]University „Dunărea de Jos" Galaţi, Department of Aquaculture, Environmental Science and Cadastre, Galaţi, Romania; [2]Institute for Research and Development in Aquatic Ecology, Fishing and Aquaculture, Galaţi, Romania; [3]Research Development Centre for Pisciculture Nucet, Dâmboviţa, Romania. Corresponding author: Marian T. Coadă, marian_tiberiu@yahoo.com

Abstract. The main purpose of the present experiment consists in evaluating the growth performances of North-American sturgeon larvae (*Polyodon spathula* (Walbaum, 1792)), raised in the recirculating system. Growth performance is influenced by many factors including food quality, quantity of food, culture species, fish size and water quality. The research was conducted between May 12th to June 8th, 2010, in the pilot laboratory of Department of Aquaculture, Environmental Science and Cadastre of the Faculty of Food Science and Engineering, Galaţi. Ewos type growing unit (1.40 x 1.40 x 0.40 m) was populated with 1500 larvae with an age of 72-120 hours and with an average weight of 8±0.2 mg/larva. During the experiment the physico-chemical water parameters were within the admissible limit of sturgeons growth (temperature 4-26°C, dissolved oxygen 5-14 mg L^{-1}, pH 6.5-8.5, N-$N0_3^-$ 1-20 mg L^{-1}, N-NO_2^- 0-0.01 mg L^{-1}, N-NH_4^+ 0.05-2 mg L^{-1}). The experiment results indicated a 78% survival and an individual body biomass of 1.15 ± 0.21 g. The research goal is to achieve the following objectives: a.optimization of feeding parameters (ratio, fodders type and frequency) and the efficiency of different fodders types usage (conversion signs of fodders); b. providing the conditions for the biological material adaptation to the growth condition of the recirculating system.
Key Words: *Polyodon spathula*, recirculating sistem, *Tubifex sp.*, stocking density.

Rezumat. Principalul scop al experimentului de faţă, constă în evaluarea performanţelor de creştere a larvelor de sturion nord-american (*Polyodon spathula* (Walbaum, 1792)) crescut în sistem recirculant. Performanţa de creştere este influenţată de mai mulţi factori, inclusiv calitatea hranei, cantitatea de hrană, specia de cultură, mărimea peştilor şi calitatea apei. Cercetările au fost efectuate în perioada 12 mai - 8 iunie 2010, în laboratorul pilot al Departamentului de Acvacultură, Ştiinţa Mediului şi Cadastru din cadrul Facultăţii de Ştiinţa şi Ingineria Alimentelor, Galaţi. Unitatea de creştere de tip Ewos (1.40 x 1.40 x 0.40 m) a fost populată cu 1500 de larve în vârstă de 72-120 de ore având greutatea medie de 8±0.2 mg. În timpul experimentului parametrii fizico-chimici ai apei s-au situat în limitele admsibile creşterii sturionilor (temperatura 4-26°C, dissolved oxygen 5-14 mg L^{-1}, pH 6.5-8.5 upH, N-$N0_3^-$ 1-20 mg L^{-1}, N-NO_2^- 0-0.01 mg L^{-1}, N-NH_4^+ 0.05-2 mg L^{-1}). Rezultatele experimentului indică o supravieţuire de 78% şi o biomasă corporală individuală de 1.15±0.21 g/exemplar. Activitatea de cercetare are drept deziderat atingerea următoarelor obiective: a. optimizarea parametrilor hrănirii (raţie, tip de furaj şi frecvenţă) şi eficientizarea utilizării diferitelor tipuri de furaje (indicii de conversie ai furajelor); b.asigurarea condiţiilor pentru adaptarea materialului biologic la condiţiile de creştere din sistemul recirculant.
Cuvinte cheie: *Polyodon spathula*, sistem recirculant, *Tubifex sp.*, densitate de populare.

Introduction. The paddlefish *Polyodon spathula* (Walbaum 1792) has the propensity to consume planktonic organisms. In the wild, the main food consists of zooplankton, fish always swimming with his mouth wide open, filtering water (Patriche 2001).

In the USA, *P. spathula* is grown until the age of one summer for restocking the natural habitat where natural reproduction has become impossible due to the hydrotehnical works (Saprrowe 1986). The paddlefish feeding habits have been studied and it was found that they can change their diet depending on the habitat. In lakes, sturgeon feed on is based aquatic insects, such as Diptera, Ephemeroptera and Trichoptera, with molluscs, crustaceans, fish and fish eggs, sometimes, to be swallowed depending on the availability of food in a particular area (Harkness & Dymond 1961; Chiasson et al 1997; Beamish et al 1998). This species was observed feeding on the clams (Jackson et al 2002).

Production of stocking material is generally achieved in two ways:

- the basin is populated with 5000-15000 larvae/ha and they are fished in autumn;
- 50.000 larvae/ha are grown for 30 day, after that the spawns with an average weight of approx. 3g/ex are caught and stocked in other basins, in density of 5000 spawns/ha. In this case the spawns reach in fall weights of 50–150g/ex (Stoicescu et al 1998).

In the USA it was obtained an average individual growth increment of 50 mg/day and a survival of 65% after 15 days of growth in pools in which were given artificial feed. Once the fish are about 7.5 cm in length, they can be trained to accept extruded pellets (1.5 mm, 45% protein). If fish are trained on a prepared diet, larger fish will accept larger-size extruded pellets. Feed conversion ranges from 1.5 to 2 kg feed/kg fish (Mims 2001).

Introduction of *P. spathula* in fish farms in Romania was made by larvae of USA imports in the period 1992-1999. The objectives of the National Strategic Plan for Fisheries and Aquaculture 2007-2013, Priority 2 - Aquaculture, Processing and Marketing, includes a set of measures to diversify and increase the quantity, quality and organic aquaculture production (Costache 2001).

Material and Methods. The experiment took place between 12.05.2010 and 08.06.2010 in the Research Pilot Station of the Aquaculture, Environmental Science and Cadastre Department (Food Science and Engineering Faculty), Galaţi. The growing system was populated with *P. spatula* of 3-5 days old (Figure 1); biological material derived from the Research and Development Centre for Fisheries, Nucet, Dâmboviţa, Romania.

Figure 1. Larvae aged 15-17 days.

The growing basin and the water conditioning unit represent the main components of the recirculating system. The feeding intensity and frequency was established according to the metabolic requirements of the biological material.

In the first part of paddlefish larvae post-embryonic growth experiment was given alive shredded food, at every 2 hours. The adaptation to the Classic Extra 1P (41% crude protein) pellet feed type was achieved gradually in the second half of the research by mixture of pellet feed with *Tubifex sp.* (49% crude protein).

Tanks and water conditioning unit are the main components of a recirculating system. A flow-through tank system has been successful for the production of juveniles < 25 cm in total length. Source of water can be ground water or surface water. Ground water should be aerated and heated to 22°C (Mims 2001).

The intensity and frequency of feedings were established according to the metabolic demands of the biological material. The feeding frequency for paddlefish varied according to stage of life cycle from up to 12 times/day for newly hatched to 8 times/day for juveniles. Adapting to the pelleted feed Classic Extra 1P (41% crude protein) was achieved gradually in the second half of the research by pelleted feed mixture with tubifex (49% crude protein).

Recirculating system used in this rearing period is composed by:

- Ewos type fiberglass tank with constructive dimensions of 1.40x1.40x0.40m;
- unit for water conditioning/filtering, represented by a professional Eheim 3 2080 external filter type, with a maximum flow of 1700 L/h;
- aeration/oxygenation unit consisted of RESUN AIR–PUMP: Model LP-100 type

compressor, which provides the necessary dissolved oxygen (DO);

- WTW multiparameter for measuring the temperature, pH and DO;
- Spectroquant Nova 400 type spectophotometer, using the compatible kits from the Merk company, for the concentrations of NH_4^+, NO_2^-, NO_3^-;
- Kern abt 320 analytical balance.

Statistical analysis was performed using the Microsoft Office Excel 2010.

Results and Discussion. The digestion speed is influenced by age, temperature, food quantity and quality and by the frequency of food ingestion. The determination of feed frequency was established depending on the digestion speed of larvae (Oprea & Georgescu 2000). The feed/weight ratio was determined daily depending on the daily growth gain, on the food intake capacity by weighing the given food and the uneaten food.

Food was distributed manually with a frequency of 12 meals per day in the first stage of the experiment and 8 meals per day in the next two weeks.

In the second experiment was performed the transition from natural feeds to granulate fodder Extra Classic 1P. Adapting to pelleted feed mixture was done gradually by natural feeding ground pelleted feed. Weight determination by analytical balance was achieved with daily weighing a total of 100 larvae (randomized selection; Figure 2).

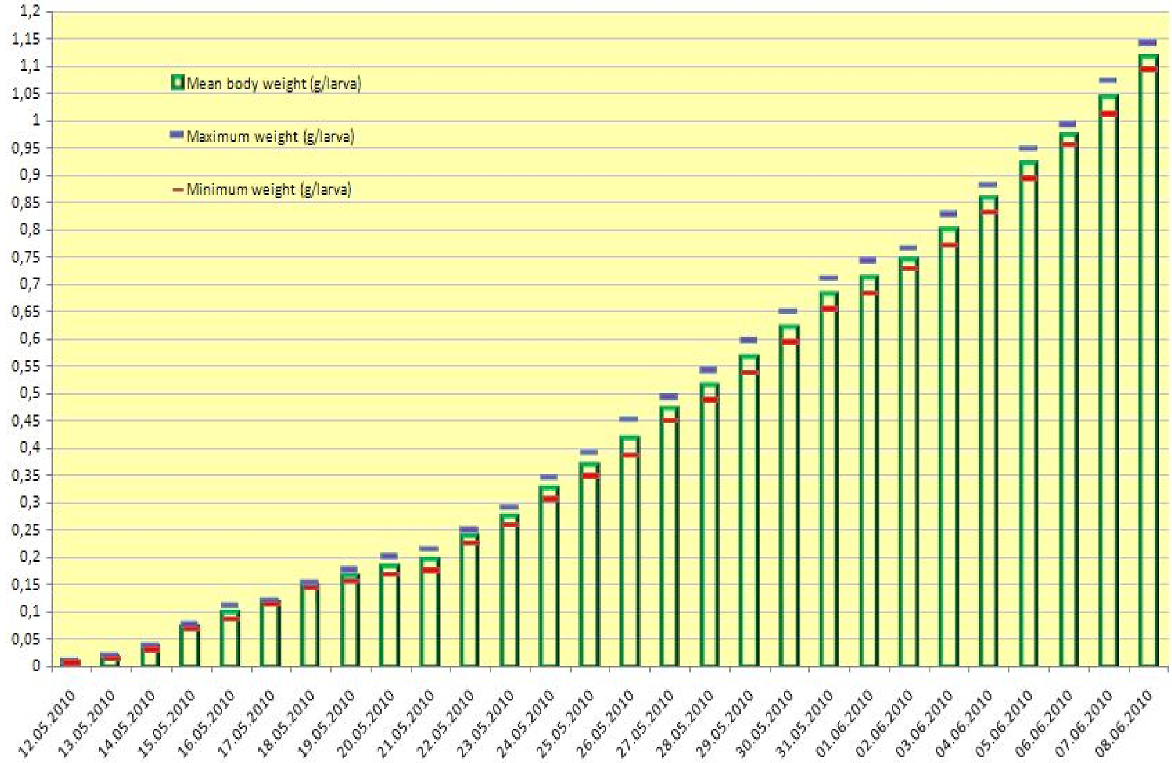

Figure 2. The evolution of growth rate in the period May 12th - June 8th, 2010.

The fodder conversion ratio was calculated using the following formula: FCR = F/(Bf-Bi) where: F - amount of fodder administered; Bf-Bi – growth gain; Bf, Bi - final and initial biomass. The specific growth rate was calculated using the following formula: SGR = [(Bf ln - ln Bi)/T]*100 where: Bf - final biomass; Bi - initial biomass; T - time interval (days).

In the first experiment, specific growth rate (SGR) indicates the effectiveness of natural food. In the second, conversion factor slightly increased while SGR decreased significantly from 26.77 g%/day to 5.32 g%/day (Figure 3).

In the first 2 weeks, the survival rate was 92%, and the juveniles had reached an average weight of 369 and a biomass 509 g. After further 2 weeks, the survival rate was 84.8%, and the juveniles had reached an average weight of 1.115 g and a biomass 1304.55 g (Figure 4).

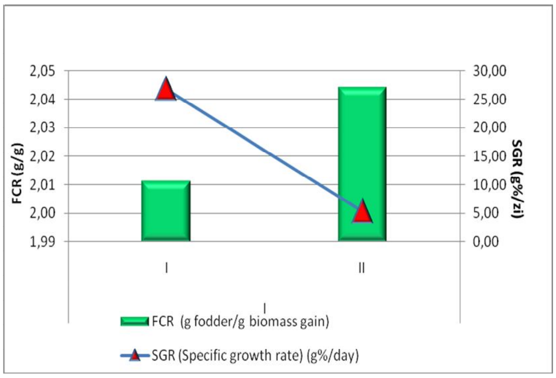

Figure 3. The variation of feed conversion ratio (FCR) and specific growth rate (SGR).

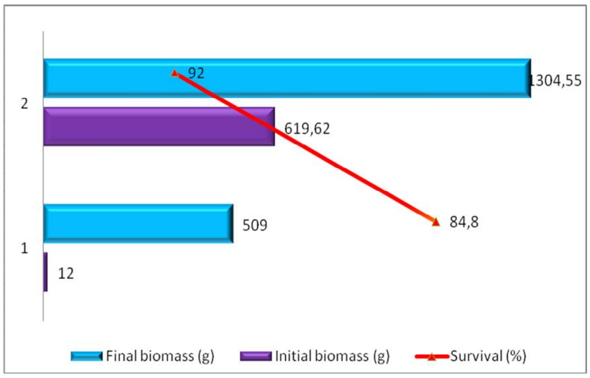

Figure 4. The percentage of survival and the initial and final densities.

Analyzing the average values recorded during the entire experimental period, the result is an increase in fish biomass of 1273.05 g/m^3 in the first stage and of 3261.38 g/m^3 at the end of the experiment (Table 1).

Table 1

Growth performance of the biological material

Indicator	*12-25 May*	*26 May - 8 June*
Initial biomass (g)	12	*619.62*
Initial biomass (g/m^3)	30.00	1550
Final biomass (g)	509	1304.55
Final biomass (g/m^3)	1273.05	3261.38
Biomass gain (g)	497	685
Biomass gain (kg/m^3)	1.66	2.28
Initial number fish	1500	1380
Final number fish	1380	1170
Survival (%)	92.0	84.8
Initial mean body weight (g)	0.0080	0.4490
Final mean body weight (g)	0.369	1.115
Number of days	14	14
GR (growth rate) (g/day)	13.44	18.51
SGR (specific growth rate) (g%/day)	26.77	5.32
Total feed distributed (g)	1000	1400
FCR (g fodder/g biomass gain)	2.01	2.04
Feeding level (g/kg net weight)	57	192
Feeding level (% biomass)	22.0	20.0
Density (number fish/m^3)	3750.0	3450.0

The standard deviation and standard error are measurements of the spread of the data. The variance is the average squared distance from the mean to any point. Through statistical analysis, the variation of the average square in first stage where the scores are more tightly clustered around the mean, while, after 2 weeks they are spread out further from the mean, the standard deviation is larger. Table 2 and Figure 5 try to graphically illustrate this difference.

Table 2

Numerical measures of standard deviation and standard error

Days	*N*	*Mean*	*Std. Error*	*Std. Dev.*
0 to 5	4	0.033	0.014	0.028
5 to 10	5	0.143	0.016	0.035
10 to 15	5	0.280	0.031	0.069
15 to 20	5	0.518	0.035	0.079
20 to 25	5	0.758	0.031	0.069
25 to 30	4	1.012	0.042	0.085
Entire sample	28	0.453	0.065	0.342

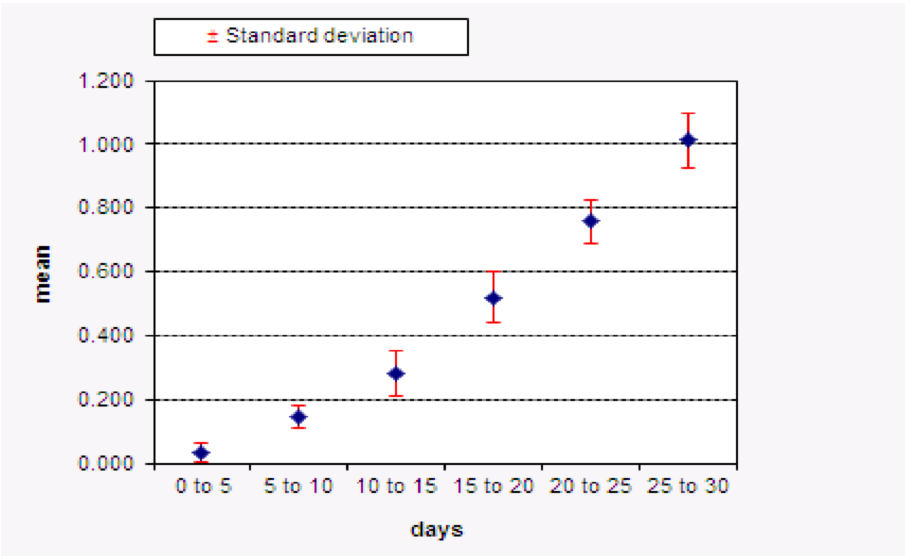

Figure 5. The standard deviations of the mean weight during experiment.

Decomposition of nitrogen compounds is of particular importance in aquaculture because a part of the degradation products, mainly ammonia (N-NH_3) and nitrite (N-NO_2) are toxic to a lesser extent, N-NO_3 and nitrates are toxic when the accumulation reaches high concentrations. In recirculating systems, residual organic matter (food consumed, sewage) is decomposed by heterotrophic bacteria in the simplest organic compounds, the final product of this process is NH_4, unstable compound that is converted into ammonia (NH_3). In a first step, ammonia is oxidized by autotrophic bacteria to nitrite (NO_2). In the second phase under the action of other autotrophic bacteria, nitrites are converted by oxidation into nitrates (NO_3) which become toxic when they accumulates too much (Cristea et al 2002).

Water quality parameters were maintained within acceptable limits for paddlefish larvae growth throughout the experimental period. To maintain water parameters within the allowable limits, we proceeded to remove organic waste and uneaten feeds. Due to high density of fish, we daily changed about 10-20% of the total water volume in the system.

Higher levels of nitrogen compounds were recorded at the end of the experiment due to increased amounts of biomass and feed into the tank.

The water physical-chemical parameters during the entire period of the experiment were measured daily (temperature, pH, DO) and periodically (NO_2^-, NO_3^-, NH_4^+):

- the temperature recorded values between 20.66-24.82°C;
- pH varied in the ecart 7.2-8.1 units;
- the dissolved oxygen concentration oscillated between 5.6-7.28 mg/L;
- nitrites recorded values between 0.68-1.14mg/L, over the admissible limit for the sturgeon rearing;
- nitrates varied in the limits of 4.6-5.9 mg/L;
- NH_4^+ had values between the interval 0.08-1.81 mg/L.

Conclusions. We proposed in this paper to evaluate the productive potential of recirculating aquaculture systems in the case of rearing the paddlefish larvae. Optimization of the frequency and daily feeding rate minimizes the amount of nitrogen and organic waste in the system.

Intensive rearing of larvae of paddlefish is a method that requires attention. After the experiment we can say that the species accept artificial feed easily.

Due to the vulnerability of larvae in natural environment, rearing postembryonal *P. spathula* species in recirculating system is an alternative to rearing in ponds.

Acknowledgements. Research was conducted in the project POSDRU no. 6/1.5/S/15 "Management System of Scholarships for PhD Students no. 6583 - SIMBAD" and "Efficiency of PhD Students Activity in Doctoral Schools no.61445 - EFFICIENT", funded by the European Union and Romanian Government. The authors thank to the management staff of the project for their financial support.

References

Beamish F. W. H., Noakes D. L. G., Rossiter A., 1998 Feeding ecology of juvenile lake sturgeon, *Acipenser fulvescens* in Northern Ontario. Can Field-Nat **112**:459-468.

Chiasson W. B., Noakes D. L. G., Beamish F. W. H., 1997 Habitat, benthic prey, and distribution of juvenile lake sturgeon (*Acipenser fulvescens*) in northern Ontario rivers. Can J Fish Aquat Sci **54**:2866-2871.

Costache M., 2001 [Studies on the introduction of *Polyodon spathula* species in Romanian pisciculture]. University Dunărea de Jos, Galaţi. PhD Thesis. [In Romanian]

Cristea V., Grecu I., Ceapă C., 2002 [Recirculating systems engineering from aquaculture]. Editura Didactică şi Pedagogică, Bucharest, ISBN 973-30-2785-5. [In Romanian]

Harkness W. J. K., Dymond J. R., 1961 The lake sturgeon: the history of its fishery and problems of conservation. Fish and Wildlife Branch, Ontario Dept. of Land and Forest, Toronto, 121 pp.

Jackson J. R., VanDeValk A. J., Brooking T. E., Vankeeken O. A., Rudstam L. G., 2002 Growth and feeding dynamics of lake sturgeon, *Acipenser fulvescens*, in Oneida Lake, New York: results from the first five years of a restoration program. J Applied Ichthyol **18**:439-443.

Mims S. D., 2001 Aquaculture of paddlefish in the United States. Aquat Living Resour **14**:391-398.

Oprea L., Georgescu R., 2000 [Nutrition and feeding of fish]. Editura Tehnică, Bucharest, ISBN 973-31-1483-9. [In Romanian]

Patriche N., 2001 [Sevruga, biology and artificial reproduction]. Ceres, Bucharest, ISBN 973-40-0521-9. [In Romanian]

Stoicescu C., Vizitiu D., Costache M., Dumitru C., Mircea V., 1998 Researches on the predevelopment and growth in summer I of the *Polyodon spathula* spawns, in clay basins. International Symposium "AQUAROM 98" Galaţi, May 18-22, Volume of Symposium Papers, pp. 235-237.

Sapprowe R. D., 1986 Threats to paddlefish habitat. In: The paddlefish: status, management and propagation. North Central Division, American Fisheries Society, Special Publication Number **7**:36-35.

Received: 26 December 2010. Accepted: 20 April 2011. Published online: 29 April 2011.
Authors:
Marian Tiberiu Coadă, University „Dunărea de Jos" Galaţi, Department of Aquaculture, Environment Science and Cadastre, 61-63, Gării St., 800003, Galaţi, Romania, e-mail: marian_tiberiu@yahoo.com
Neculai Patriche, Institute for Research and Development in Aquatic Ecology, Fishing and Aquaculture, 2-4 Portului St., 800032, Galaţi, Romania, European Union.
Victor Cristea, University „Dunărea de Jos" Galaţi, Department of Aquaculture, Environment Science and Cadastre, 61-63, Gării St., 800003, Galaţi, Romania, European Union.
Mioara Costache, Research Development Centre for Pisciculture Nucet, no. 549, 137335, Dâmboviţa, Romania
Elena Bocioc, University „Dunărea de Jos" Galaţi, Department of Aquaculture, Environment Science and Cadastre, 61-63, Gării St., 800003, Galaţi, Romania, European Union.
Săndiţa Ion (Plăcintă), University „Dunărea de Jos" Galaţi, Department of Aquaculture, Environment Science and Cadastre, 61-63, Gării St., 800003, Galaţi, Romania, European Union.
How to cite this article:
Coadă M. T., Patriche N., Cristea V., Costache M., Bocioc E., Ion S., 2011 Preliminary results on growth of the *Polyodon spathula* juveniles in recirculating system conditions. AACL Bioflux **4**(2):209-215.