THE PLASTICITY OF JUVENILES TO *Acipenser gueldenstaedtii* UNDER CONDITIONS OF REARING IN A FLOATING CAGE LOCATED ON A POND

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Abstract
The experiment aimed to evaluate the plasticity of juvenile Russian sturgeon (Acipenser gueldenstaedtii, J. F. Brandt & Ratzeburg, 1833) reared in a floating cage located on a pond. The biological material was 1400 juvenile Russian sturgeon with a mean weight of 9 g/fish and 40 days of age. The intensive rearing system was a 5x5x3 m floating cage in a pond. The fish were fed NUTRA MP-L extruded feed containing 52% crude protein and 20% fat three times a day. The experimental results showed a 64% survival of Russian sturgeon juveniles and the evaluation of productive bioindicators demonstrates high technological plasticity at 50% of the tested group. From the analysis of rearing conditions (environmental and technological), it was concluded that Russian sturgeon juveniles show a certain degree of plasticity depending on the adaptability of the Russian sturgeon to the different environmental conditions which depend principally on the anatomy and physiology of the species Acipenser gueldenstaedtii.

Key words: *Russian sturgeon, floating cage, pond*

INTRODUCTION

Sturgeons have a very high commercial value, which implies that it is the most sought-after product for aquaculture production. Sturgeon aquaculture can contribute to the conservation of declining native populations by regenerating as well as a constant supply for consumption, which reduces fishing pressure on the exploited wild population [1].

Seasonal factors, such as water temperature and photoperiod play an important role in the annual growth response and maturation cycle of *Acipenseriformes* [2].

Cages are often made of polyethylene or metal netting, assembled into rectangular or circular cages with support frames, fixed blocks, and floats [3]. As cages permit effective water exchange higher stocking densities can be maintained, with resulting high yields. Yields in sturgeon cage farming can range from 35–40 kg/m^3 [4, 5, 6, 7].

In Russia, for example, the dominant systems used in sturgeon aquaculture are cages (up to 65%), RASs (up to 25%), and flow-through water tanks and small ponds (less than 0.1 hectares) (the remaining 10%) [8]. The main advantages of cage farming include low capital costs and easy harvesting. However, the open farming environment leads to a relatively low feeding rate, and higher food coefficient (about 1.8–2.0).

The main reasons are that ponds cannot meet the sturgeon's needs for higher dissolved oxygen (DO) concentration, and water temperature often exceeds 30°C in sturgeon farming. These conditions make it hard for sturgeon to survive in ponds, and lead to low farming profit [9].

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In more intensive culture methods, there is a decreased dependency on the availability of natural food and greater or total dependence on the use of complete feeds formulated to meet the nutritional requirements of a particular fish species. There is a global trend in intensifying production methods in ponds [10].

To adapt rearing conditions to the specific requirements, the aim of this experiment was to determine the effect of physicochemical parameters and a system floating cage in a pond on the growth performance of a juvenile Russian sturgeon.

MATERIAL AND METHOD

The experiment aimed to evaluate the plasticity of juvenile Russian sturgeon (*Acipenser gueldenstaedtii*, J. F. Brandt & Ratzeburg, 1833) reared in floating cages located on a pond. The biological material that was the subject of the experiment was represented by the juvenile species (*Acipenser gueldenstaedtii*), descendants from wild parents (F1 Generation). This biological material was provided from Artificial breeding and grew in a recirculating system until the age of 40 days in the Institute for Research and Development in Aquatic Ecology, Fishing and Aquaculture, Galati - Pilot Station.

The biological material was represented 1400 juvenile Russian sturgeon with a mean weight of 9 g/fish and 40 days of age.

The fish were fed *NUTRA MP-L* extruded feed containing 52% crude protein and 20% fat three times a day (Table 1). The frequency of food administration was daily in three portions (06°°, 12°°, 18°°).

Table 1. The biochemical composition of *NUTRA MP-L*

Composition	Quantity
Crude protein %	52.0
Crude lipid %	20.0
Crude fibre %	0.7
Crude cellulose %	8.0
Phosphorus %	1.3
Digestible energy (MJ/kg)	19.6

The ration of administration feed was modified according to the growth rate, being determined by every ten days after weight control, seeing a different degree of adaptability between Russian sturgeon.

A period of 60 days was regarded for this experiment. The floating cage used in this experiment was dimension 5×5×3 m and had a capacity of 75 m^3 that was located in the pond.

The floating cage frame is double HDPE Φ 125, and the rearing enclosure was made of 240 tex fine mesh. To maintain the shape, a polypropylene (PP) wire was used as a contouring and strength element with a diameter of 6 mm, resulting in a parallelepiped-shaped enclosure with a side of 5m and a height of 3m, which 1.9 m is below the water level and the difference of 1.1m is above the water, resulting in a growth volume of 47.5 m^3.

In order to increase the breaking strength due to the sun's rays, nets were impregnated with a solution resulting from a mixture of petrol and tar, an operation that led to a black coloration. For safety, fine-meshed netting has also been used to prevent the entrance of the ihthiophagous birds into the rearing enclosures and has been fixed to the outside netting. For this purpose, a fine mesh net of 110 mm has been used, which does not allow access.

The floating cage was located in the Brateș Experimental Agro-Fisheries Research Laboratory in BP1 pond, with a 1Ha size and average depth of 1.9 m. The pond was supplied, with water using pumps, and an aerator was used to maintain the dissolved oxygen content during the hot season aerator Force 7/1, which injects a large volume of air in the form of bubbles, and a vacuum pump with a flow rate of 145 m^3/h.

After twenty experimental days, the floating cage was divided into two equal compartments by a fine net that allowed the same growth conditions for the sort of biological material because considerable differences were observed between the

Russian sturgeon, thus creating two experimental groups/variants.

Statistical analyses were performed in Microsoft Office Excel 2019.

RESULTS AND DISCUSSIONS

Promoting cage aquaculture requires the protection of the aquatic environment, which involves determining the carrying capacity of each ecosystem to be exploited to control pollution and maintain ecosystem integrity [11].

The physicochemical parameters of the water were determined throughout the experiment, especially in the morning before sunrise (6°°a.m.). Water temperatures were recorded throughout the experiment, and the highest value was recorded at the beginning of the experiment (27.5°C) and the lowest (22.6°C) at the final of the experiment period (figure 1).

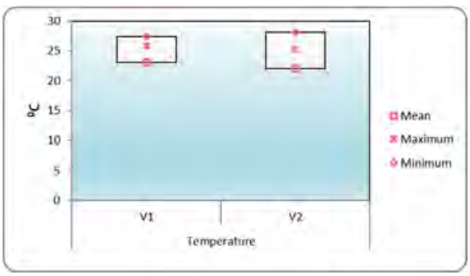

Figure 1 The temperature in the experimental period

Dissolved oxygen varied quite widely, with values below 5 mg/L recorded on a few days when the point aerator was turned on and the dissolved oxygen content was supplemented. The values recorded were a minimum of 3.13 mg/L and a maximum of 9.64 mg/L (Figure 2).

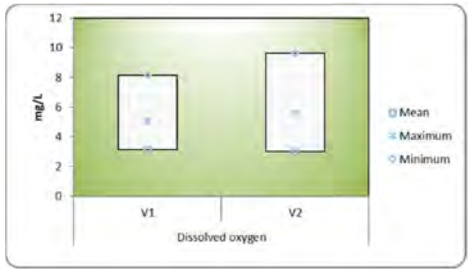

Figure 2 The dissolved oxygen in the experimental period

The water depth had values between 1.6 m and 2.1 m, and during the experiment, due to several external factors (irrigation, drought), the water level stagnated, the average depth being 1.7 m.

Table 2 The Physico-chemical parameters during the experimental period

The Physico-chemical parameters	Units of measurement	Determined values			Maximum allowed values
		minimum	mean	maximum	
pH	units pH	7,44	8,50	9,43	6,5-8,5
Organic matter	mg $KMnO_4$/L	48,5	75,31	112,33	60
Chemical oxygen consumption CCO-Mn	mgO_2/L	12,27	19,05	28,42	15
Calcium Ca^{2+}	mg/L	24,04	44,09	56,11	160
Magnesium Mg^{2+}	mg/L	29,16	34,61	38,8	50
Ca^{2+}/Mg^{2+}	Report	0,706	1,29	1,92	5
Total hardness	^{0}D	11,22	13,18	14,58	20
Nitrites NO_2^-	mgN/L	0,001	0,06	0,19	0,2
Nitrates NO_3^-	mgN/L	0,35	1,36	4,1	5
Chlorides Cl^-	mg/L	9,57	31,09	82,9	40
Ammonium ion NH_4^+	mgN/L	0,1	0,18	0,23	2
Ammonia NH3	mgN/L	0,002	0,08	0,22	0,2

Table 3 The biotechnological indicators show the evolution of growth rate in both experimental variants

Indicators	Experimental Phase	Experimental variant		
		V1	V2	Mean
Total biomass [g]	Initial	6300	6300	6300
	Final	29700	9900	19800
Total biomass [kg/m^3]	Initial	6.30	6.30	6.30
	Final	29.70	9.90	19.80
Growth rate [g]		23400	3600	13500
Fish number	Initial	700	700	700
	Final	500	400	450
Survival [%]		71	57	64
Mean weight [g/fish]	Initial	9	9	9
	Final	59	25	42.08
Individual growth rate [g]		50	16	33.08
Experimental time [days]		60	60	60

For adequate fish growth, the optimum temperature for sturgeon rearing is 20 - 24°C, with the smaller fish preferring higher temperatures [12]. At high temperatures, the amount of oxygen is low, causing a decrease in the respiratory rate, which leads to a decline in growth. Oxygen requirements are between 7 and 9 mg/L for optimal sturgeon growth. In the present experiment, the dissolved oxygen recorded values below the optimal range with consequences on the growth rate, especially in the V2 variant, where the Russian sturgeon showed reduced plasticity under the given experimental conditions.

Sturgeons grow optimally in water with a neutral or slightly alkaline pH (7.8 - 8 upH). The indirect effect of pH is to influence toxic phenomena in the water (table 2). Also, the organic matter is in an optimal range between 35-50 mg KMnO4/L for sturgeon rearing [13]. In the experimental conditions of rearing in a floating fish cage located in the pond, it was higher for short periods of time (table 2).

The plasticity of the biological material (Russian sturgeon) is demonstrated by exposing it to different environmental conditions. Since Russian sturgeon originate from a RAS, where environmental conditions are controlled and maintained within optimal growth limits, in the pond, these conditions are dynamic with fluctuations recorded over periods of time intervals and influence the physiology of the organism. Due to weight differences, the floating cage was divided into two sections, and the biological material was sorted.

Russian sturgeon survival ranged from 57% in V2 to 71% in V1, with an average of 64%. At the end of the experiment, the individual mean mass of the Russian sturgeon indicated a weight of 59 g/fish at approximately 50% of the experimental group and the other group (V2) indicated an average weight of 25 g/fish. The results showed a positive individual growth rate in experimental variant V1 of 50 g compared to variant V2, where only 16 g was obtained.

The experimental results showed a 64% survival of Russian sturgeon juveniles and the evaluation of productive bioindicators demonstrates high technological plasticity at 50% of the tested group. The weight of fish produced in floating cages depends on many factors including the fish species, stocking density, fish size at stocking, culture period, cage size, water quality, and feeds used [14].

The recommandation is to use an intensive system (floating cage) located in the pond for fish culture, with the possibility of future studies to test the plasticity of the fish, especially for sturgeon.

CONCLUSIONS

The experiment showed that juvenile Russian sturgeon (*Acipenser gueldenstaedtii*, J. F. Brandt & Ratzeburg, 1833) show the required technological plasticity to be used for rearing not only in classical systems but also in intensive aquaculture systems (floating cage). From the analysis of rearing conditions (environmental and technological), it was concluded that Russian sturgeon juveniles show a certain degree of plasticity depending on the adaptability of the Russian sturgeon to the different environmental conditions which depend principally on the anatomy and physiology of the species *Acipenser gueldenstaedtii.*

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