OPPORTUNITIES REGARDING THE REARING OF STERLET *(Acipenser ruthenus)* IN FLOATABLE CAGES, LOCATED ON IRRIGATION CANALS

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Abstract

Sturgeon rearing technologies have been developed especially for the sterlet species (Acipenser ruthenus), as this is a species that reaches sexual maturity faster than other sturgeons and is also smaller in size and therefore easier to handle. With a prospect of major development, sturgeon farming is currently practiced in rearing systems with different types of fresh water, such as surface water, depth water (including geothermal water) and industrial water. At the beginning of the last century sturioniculture was successfully applied in ponds, but nowadays, with the need for quantitative and qualitative productions imposed by the principles of economic viability, and in the current context of the need to adapt to the effects of climate change, intensively controlled rearing systems have been developed.

The aim of this paper is the analysis of the opportunity to develop technologies for sterlet rearing in floating cages located on irrigation canals. The experiments took place in the Lunca Magistral Canal (CML) which is part of the irrigation network in Covurlui Plain. The Lunca Magistral Canal has a length of 19240 m and stretches from km 78.4 of the Danube from where it makes its way, passes behind Lake Brateș and reaches close to the commune of Vânători in Galați County. From C.M.L. 6 pressurization stations are supplied to irrigate 5,566 ha by sprinkling.

Preliminary results obtained 30 days after the population of a cage (located on the CM Lunca irrigation canal) with a size of 6x6m, with 500 sterlet specimens (Acipenser ruthenus) with an average weight of 11 g/specimen, reveals that sterlet immediately adapted to the specific conditions of the irrigation canal, with a daily growth rate of 0.167 g/day.

Key words: sturgeon, irrigation canal, sterlet, growth performance

INTRODUCTION

Fishery products play an important role in food security and nutrition strategies at all levels. It is estimated that global fish production in 2018 was about 179 million tons, of which 82 million tons came from aquaculture. From 1961 to 2017, the average annual growth rate of global fish consumption was 3.1%. [1]

Given the new strategies for sustainable development of aquaculture, the system of floating cage rearing of some economically valuable species (sturgeon, catfish, carp, etc.) benefits from increased attention from both researchers and farmers.

The analysis of the opportunity to develop technologies for rearing sturgeons in floating ponds / cages located on irrigation canals was the idea of this experiment. Of these, the sterlet species (*Acipenser ruthenus* Linnaeus, 1758) is a particularly valuable sturgeon for aquaculture considered to have the tastiest meat, compared to other fish in the Danube, being also a fresh water only species.

Currently, the amount of sturgeon in aquaculture exceeds that obtained by commercial fishing, China being the world leader (79,638 tons (t) of sturgeon biomass production in 2017), followed by Russia (6800 t), Armenia (6000 t) and Iran (2514 t). Italy is the European leader in sturgeon farming, with a biomass production of 850 tons in 2017. In Europe, sturgeon farming started as a meat-oriented production, but now it is mainly oriented towards caviar

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production, representing a source of higher profit. In contrast, in other countries, such as China, sturgeon farming is still mainly focused on meat production. World aquaculture caviar production was estimated at around 364 tonnes in 2017. In this context, Italy is the leading European producer, achieving a production of 43 tonnes of caviar in 2017 [4].

Rearing fish in floating cages or ponds began in the 1950s, with the advent of synthetic materials for building cages. Placement of fishponds / cages in irrigation canals, is a relatively new technological concept, used to maximize water use efficiency, by designing and placing removable facilities and establishing technologies for rearing fish in small bodies of water (irrigation canals).

The whole range of aquatic habitats created by irrigation systems can be integrated with fish farming. [2]

There are many irrigation systems in China that produce between 300-350 kg of fish / ha / year, but fish are not reared in the main supply channels, due to irregular flows and regular maintenance work. However, even internationally, these growth systems have not been sufficiently researched. Egypt has about 50,000 km of irrigation and drainage canals, of which about 3,532 km are of adequate size and are used for aquaculture.

Rice along with fish farming is widely practiced in the PRC, Egypt and Indonesia. [3]

MATERIAL AND METHOD

A period of 30 days was considered for the present experiment.

The floating pond used (photo no. 2), has a capacity of 26 m^3. The frame is double HDPE Φ = 200mm. Two growth enclosures were used, inserted into each other, made of polyamide (PA) mesh woven with knots.

The first, used inside, was made of mesh with the fineness of 240 tex thread (density length 4100 m / kg) and the side of the eye a=7mm. The hanging ratio used was 0.5 in length and 0.7 in height, resulting in a parallelepiped-shaped enclosure with a side of 4.2 m and a height of 2.1 m, of which 1.5 m below the water level and 0.6 m above it, resulting in a useful growth volume of 26 m^3. The side of the 7 mm eye was chosen both to prevent confusion or escape of sterlet specimens, as well as specimens of other species, which could have competed for the food. To maintain the shape, a polypropylene (PP) wire was used as a contouring and strength element with a diameter of 4 mm, which at the top was inserted through each mesh. In height, the PP wire was fixed to the corners on the outside of the enclosure with PA thread with a fineness of 240 tex.

The second net, used on the outside, was made of mesh with the fineness of 666 tex thread (density length 1500 m / kg) and the side of the eye a=18mm. The hanging ratio used was 0.5 in length and 0.7 in height, resulting in a parallelepiped-shaped enclosure with a side of 4.4 m and a height of 2.2 m, of which 1.6 m below the water level and 0.6 m above the water, resulting in a useful growth volume of 29 m^3. To maintain the shape, a 4 mm diameter polypropylene (PP) wire was used as a contour and resistance element, which was inserted through each mesh, both at the top and on the height. In height, the PP thread was fixed at the corners from place to place with PA thread with a fineness of 240 tex. The outer net also had the role of retaining any bodies that could have strained the main net, that would have led to its rupture.

In order to increase the breaking strength due to the sun's rays, both nets were impregnated with a solution resulting from a mixture of petrol and tar, an operation that led to a black coloration.

A third category of net used has the role of preventing the entry of ichthyophagous birds in rearing enclosures and has been fixed to the outer net. For this, a fine mesh of 420 tex (density of length 2450 m / kg) was used. Due to the need to increase the resistance of this net to the action of the sun's rays and, at the same time, to be as visible as possible by maintaining a white-yellow tint, the impregnation was performed with a solution composed of PU ANTIFOULING composite.

The floating cage was located in the CM Lunca irrigation canal. The CM Lunca irrigation canal on which the experiment took place was artificially built in 1969 and serves a large agricultural area. The canal has a width of 75 m and a length of 19,240 m and stretches from km 78.4 of the Danube from where it takes in, passes behind Lake Brateș and reaches close to the commune of Vânători. CM Lunca is part of the irrigation network in the Covurlui Plain and is managed by A.N.I.F., South Moldova branch. The irrigation system of which CM Lunca is part consists of the main pumping station SPA Dunărea, 6 SPR pumping stations, 21 SPP pressure pumping stations, 37 canal motor pumps, 126 km of irrigation canals. CM Lunca is periodically supplied with water depending on the weather and the agricultural needs it serves.

The pontoon for serving the ponds is made of extruded polyethylene PE HDPE, the resistance temperature of the floats -50 / + 80ºC and the diameter 200 mm.

The length of the pontoon is 5m, draft 0.3 (m) and the podium of the pontoon is made of fir wood.

The biological material that was the subject of the experiments was represented by the sterlet species (*Acipenser ruthenus* Linnaeus, 1758), with an average mass of 11g / ex (photo 1). The number of specimens at the beginning of the experiment was 500.

Photo 1. Population of the cage with the sterlet species

Photo 2. Population of the cage with the sterlet species

Technological indicators are absolutely necessary in order to obtain information on the performance of the applied technology and the rearing system. The determination of body indices in fish provides information to the farmer on the fish body development, the growth rate, the state of maintenance (welfare) and the adaptability to environmental conditions.

The real growth increase - (Sr) - was determined gravimetrically, and consisted in weighing two samples at the time of population, determining the initial mass, and two samples, at the end of the analysed growth period, determining the final mass. It was calculated with the formula: $S_r = B_f - B_i$ [kg] where, B_f ,B_i - final and initial biomass of the batch [kg].

The individual growth increase was determined with the formula: (Wf - Wi) / N [g / ex.] Where Wf, Wi - final and initial average mass of the lot [g], N - number of specimens [ex].

The daily growth rate - (GR) - was determined by applying the formula:

(Wf - Wi) / T [g / day] where Wf, Wi - average final and initial mass of the batch [g];

T - duration of the growth cycle [days].

Survival percentage - (%) - was determined by the formula: Nf / Ni x 100 [%] where, Nf, Ni - final and initial number of specimens.

The Fulton condition factor was thus calculated $K = Wx\ 100 / l^3$, where: W = fish weight, in g; l = standard length, in cm;

The food of the biological material consisted of special feed Sturgeon Aller bronze, 2 mm with 45% crude protein, 15% crude fat. The frequency of food administration was daily in three portions.

The methodology applied for the study of sterlet species rearing in floating ponds located in the CM Lunca irrigation canal focused on the following aspects:

- determination of the physico-chemical parameters of the water from the CM Lunca irrigation canal before and after the placement of the cages to verify their compatibility with the crop species;
- recording, studying and interpreting data of physico-chemical and hydrobiological parameters;
- performing and recording biometrics on batches of fish material collected by control fishing, once a week;
- statistical processing of technological indicators in order to determine the growth parameters.

RESULTS AND DISCUSSION

Following the analysis of biometric data, at the end of experimental stage 1 the average individual mass of the sterlet specimens was 21 g / ex. according to table no.1.

The physico-chemical parameters of the water, determined both before the beginning and during the analysed period, in the morning and in the evening, were included with a few exceptions, in the optimal interval for the growth of the sterlet species (fig. 1). Dissolved oxygen varied quite a bit, with values below 4 mg / l recorded in a few days, at which point the aerator was turned on.

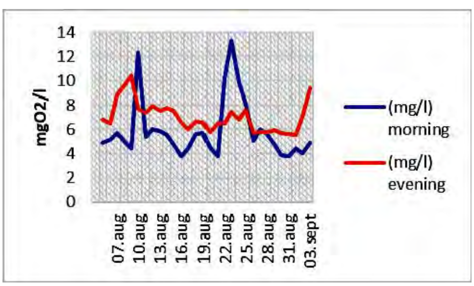

Fig. 1 Dissolved oxygen variation

Low levels of dissolved oxygen were recorded during the period when crop irrigation is stopped, the water being stationary.

The average temperatures of the water recorded during the experiment are presented in figure no. 2.

The highest value was recorded at the beginning of the experiment (28.3°C) and the lowest on September 3 (21.1°C).

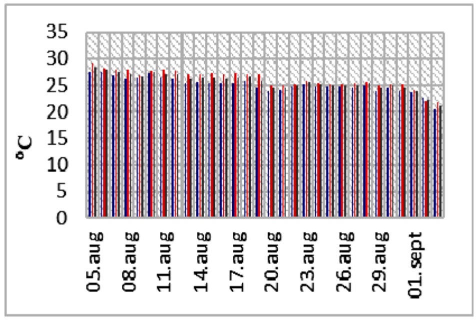

Fig. 2 Temperature variation in the floating cage

During the experiments, the growth performances of the biological material were monitored and recorded with the help of technological indicators presented in table no. 1. Also, during the experiment, the health of the biological material was checked. The adaptation of the sterlet species (*Acipenser ruthenus* Linnaeus, 1758) to the specific conditions offered by the CM Lunca irrigation canal (unpredictable and unstable environment) was achieved quite quickly. The feed was administered starting with the next day.

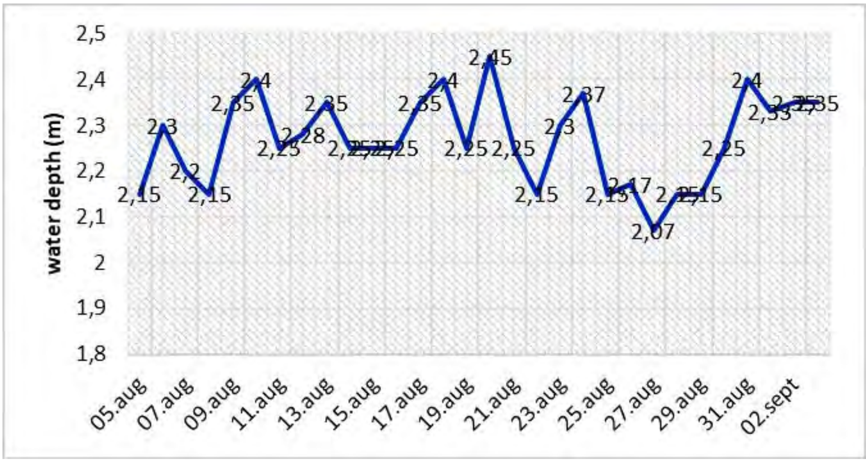

Fig. 2 Variation of water depth in the pond located in the irrigation canal

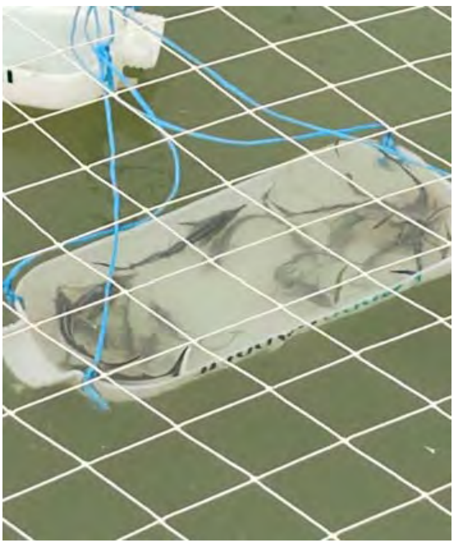

Photo 2. Sterlet species at the end of the experiment

The Fulton (K) condition factor ranged from 1 – 1.4; maintenance condition ranging from average to good.

The variation of the water depth in the irrigation canal during the vegetative period is one of the most important factors and very difficult to predict (fig. no. 2) in the irrigation canals. The water depth had values between 2.07m and 2.45m.

Irrigation water had variable flows during the experiment, becoming stagnant at certain time

Table 1 Obtained bioproductive indicators

Technological parameters	
Start of the experiment	
No. sterlets/floating cage	500
Floating cage volume [m^3]	26
Initial biomass [kg]	5,5
Individual weight [g]	11
Initial density [ex/m^3]	19
Fishing	
No. sterlets/floating cage	498
Final biomass [kg]	10,5
Final individual weight [g]	21
Survival [%]	99
Final density [kg/m^3]	0,40
No. rearing days	30
Individual growth increase [g]	0,01
Total growth increase [kg]	5
Total distributed food [kg]	12
Daily growth rate [g/zi]	0,167
Fulton condition factor [K]	1,0

CONCLUSIONS

-the results of the experiment performed on the growth of the sterlet species (*Acipenser ruthenus* Linnaeus, 1758), in floating cages located in the irrigation canals, showed that although the CM Lunca irrigation canals represent a strong unpredictable and unstable environment, still the rearing of the sterlet species is possible, the preliminary results being encouraging, the daily growth rate registering values of 0.167 g/day.

-survival of the biological material was 99%, which proves that the sterlet species (*Acipenser ruthenus* Linnaeus, 1758), easily adapts to the specific conditions of irrigation canals.

-the biggest technological problem encountered during the experiment was the large variations in water depth, being difficult to estimate the exact water needs of crops and, therefore, accurately estimate the possible consumption that can change the water supply of the irrigation canal. Thus, the irrigation water had variable flows during the experiment, becoming stagnant in certain periods.

- dissolved oxygen registered values below the limits recommended by the literature for the growth of the sterlet species (*Acipenser ruthenus* Linnaeus, 1758) during the periods when the irrigation of the neighbouring agricultural crops was interrupted.

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REFERENCES

[1] FAO (2020) Starea pescuitului și acvaculturii mondiale. FAO, Roma. https://doi. org/ 10.4060 / ca9229en

[2] Fernando C. H. & M. Halwart (2020) Possibilities for the integration of fish farming into irrigation systems

[3] Halwart M.,1998 Trends in rice-fish farming https://www.researchgate.net/publication/286389106_

[4] Nikolova L., Bonev s., 2020, Laughter and morphophysiological characteristics of male sterlet (Acipenser ruthenus Linnaeus, 1758) of different age, reared in a cage farm- Scientific Papers. Series D. Animal Science. Vol. LXIII, No. 1, 2020

Links:

[1] http://www.fao.org/3/a-i4508e.pdf

[2]https://www.researchgate.net/publication/334662123_Biofouling_in_marine_aquaculture_a_review_of_recent_research_and_developments