Contribution and researches concerning intensive growing of catfish (*Silurus glanis*) in open growth units under the influence of environmental factors

Cecilia Bucur†, Mioara Costache, M. Costache, Corina Gheorghe, Nicoleta Dobrota

*Research-Development Center for Pisciculture Nucet, nr. 549, jud. Dambovita – Romania tel./fax. 0245267003*

**SUMMARY**

In 2007, at the Research-Development Center for Pisciculture from Nucet, Dambovita, has been experimented the intensive growth of the Catfish (*Silurus glanis*) of 2 and 3 years of age, in open growth units, located in a water pond already extant, the growth units being exposed to the environmental factors.

The growth units with a capacity of up to 1500 m$^3$ are composed of modules, each with a capacity of 300 m$^3$ of water.

The experimentation of the intensive growth of the catfish has been performed in only two of the growth modules. The population density: 300 specimens per module (in the case of 2 years old catfish) and 200 specimens per module (for the 3 year old catfish).

The individual growth increase recorded was of 1.012 kg for the first variant, and 1.368 kg for the second variant, at a survival rate of 89%, and 94% respectively.

The catfish, an ichthyophagous fish in his natural habitat, in the first month of the experiment was fed with a mixed diet (low quality fish and forage, afterwards the catfish being exclusively fed with high quality forage).

The production increase per module was of 239 kg for the 3 year old catfish and of 241 kg for the 2 year old one.

The open growth system, exposed to the environmental factors may be an alternative to the fish farming technology as it offers the possibility of growing of catfish and other fish species for the market, the fish could be easily extracted anytime, for selling purposes, during the entire growth cycle.

Key words: *Silurus glanis*, intensive growth, open units/modules

**INTRODUCTION**

The catfish (*Silurus Glanis*) is considerate to be an ichthyophagous fish with a quite large spreading from Europe to the Central and South Asia. It’s a species

† e-mail address: bucurecilia@yahoo.com; scp_nucet@yahoo.com
with a huge potential economical importance for Romania, considering its meat with high nutritive values, rich in antioxidant fats, and from technological point of view it offers an alternative, being productive in super-intensive and intensive system, both in juvenile and young stadium, up to the commercial dimensions (1-3 kilos).

In traditional pisciculture, the catfish grows in multi-cultures with different species of *ciminidae*, but catfish production obtained this way is modest. The ponds for rearing of second summer old carps, can be inhabit with 100 – 200 exemplars/ha of one ear old catfishes, and the ponds for feeding up (third summer) with 40 – 45 exemplars/ha of two ears old catfishes. (1), (4).

There were made researches in this area in our country 15-20 years ago, concerning growing catfish in an intensive system, in floating cages (catfish 1year old) (2), being fed with granulate fodder of superior quality, but this technology hasn’t been extended to Romanian aquaculture.

The Research-Development Center for Pisciculture Nucet, Dambovița, Romania, fixed as main aim for 2007 to experience the intensive growing of catfish at older ages (for commercial purposes) in open units of growth having capacities up to 1500 m³, exposed to the influence of environmental factors. These may be growth locations for any fish species able to be grown in an intensive system.

Open growth system, consisting in units with the capacity of 1500 m³, has got the advantage that it can be placed in any fish basin (pond, pool, lake) and may be a competitive alternative to the classical biotechnologies of fish growing, offering in the same time the opportunity for high level fish productions (providing meat of catfish or of any other fish of culture) for market all year long, in controlled conditions, that are able to satisfy the requests imposed by the European standards concerning animal health condition and productions’ quality.

### MATERIAL AND METHODS

In order to realize the tests of catfish intensive growth and in the same time of other species of fish, it had been projected and realized here, at Nucet, the building of some open growth units, under the direct influence of the environmental factors, being placed inside of a pond. The growth unit having a capacity of 1500 m³ consists in 5 modules (cages/modules of 20 m x 10m x 1.5 m) with the capacity of 300 m³ each one, having the aspect of battery modules placed into the fish basin. (Photo 1). It is made by zincates wire netting having 10 mm links, which is put on pine pylons by different heights, depending on configuration of pond bottom.

The distribution of the experimental modules has been performed on the water providing side of the basin. Water providing of the basin has been done permanently and it had a constant flow during the whole period of growing.
To a better control over the catfish population from the growing area, the growth unit – with 1500 m³ capacity - built to have a battery shape with 5 modules of which one should be let free in the first step, because it might appear differences in growing at a certain time of the cycle, or injured specimens. It’s indicated to be done the fish selection after their size at the control fishing, in order to avoid losses due to an eventual aggressive behaviour in stress conditions.

In 2007, having insufficient biological material there were populated only two modules.

The experiment of growing catfish in an intensive regime of open space had been developed for a period of 160 days (it debuted on the 15th of May 2007 and ended on the 22nd of October 2007).

It was populated with catfish of 2 years and respectively 3 years old, realizing the following densities of populating:

- Module nr.1 – 200 specimens - average weight being 1553g/specimen (catfish of 3 years old)
- Module nr.2 – 300 specimens - average weight: 885g/ specimen (catfish of 2 years old)

The catfish from the growth modules had been fed with mixed fodder during the first month since the populating, with less valuable fish – economically speaking – making a graduate shift to the feeding with rich protein level of granulate fodder. After this first month and then during the whole growing season, catfish was being fed exclusively with granulate fodder of ALLER 45-1 having the following contents: fish, fish oil and fish flour, cereals, produces and sub-produces made of oleaginous plants, meat powder.

The chemical content of the fodder was: 45% gross protein, 15% gross fat, 7% ash, cellulose 2.5%, vitamins: A – 2500 IE, D3 – 500 IE, E (α tocopherol acetate) 150mg/kg.

The fodder distribution had been realized manually in all the growth modules, during the entire period of the experiment. Initially the fodder
distribution was made once a day (with the daily control of the fodder use). After many experimental attempts, the daily portion was divided into 2 meals a day. Taking into consideration the night feeding behaviour of catfish, 25% of the daily fodder quantity was delivered in the morning (in order to maintain the fodder meals visiting reflex) and the rest of it (75%) was distributed after sunset. Although the growth cage surface isn’t too large (only 200 m$^2$) the density of populating and the huge quantity of fodder necessary for each module at the end of the growing cycle, impose fixation of four points for feeding/module.

Environmental conditions had been monitored following physical and chemical factors of the water, closely correlated with the growing rhythm and health condition of the piscicultural material. Water samples had been taken two times per month, except August, when this action was performed weekly, and that for the purpose of detecting the eventual modifications produced by the so called “water flourishing” phenomenon (what means that the algae had been excessively developed).

Water flourishing was favoured by the lack of rain water associated with the extending of the precipitations period, with very high temperatures in the precedent month.

Determination of the main hydro-chemical parameters had been performed by the already known classical methods.

*Temperature* was measured daily: morning, noon and evening with mercury thermometer and after that it was calculated the daily average temperature.

*Oxygen* dissolved into the water was measured during the first hours of the morning, before sunrise, using a portable device for oxygen measurements, Oxy-guard.

*Transparency* was determined by the help of Seccki disc.

The *pH* was measured calorimetrically by an etalon scale (STAS 6325-75).

*Calcium* is necessary at the highest degree to establish the damping power. It can be determined volumetrically (STAS 3662/62).

*Organic substance* was realized after volumetric methods with potassium permanganate (CCO-Mn) and consists in oxidizing the oxidable organic substances in the water.

The *nitrites* ($NO_2^-$) and *nitrates* ($NO_3^-$) were determined spectrophotometrically (STASS 8900/l -71).

*Ammonium ion* ($NH_4^+$) was measured from ammoniac nitrogen.

*Phosphorus* ($P_2O_5^{3+}$) was determined also spectrophotometrically and the carbonates and hydro-carbonates determination was volumetrically determined.

**RESULTS AND DISCUSSION**

For evaluating growing biotechnology and monitoring the health condition of the catfish, grown in open growth spaces there was made controlling fishing
once a month, in order to reduce the possible stress that could have been
provoked by the fish concentrating into the fishing operation, associated with
sunstroke and high temperatures of this summer.

Average weights that were detected resulted from weighing minimum 30
fish per module. In table nr.1 is given the level of average weights realized with
the occasion of control fishing, respectively of that of the crop, and in diagram
nr.1 is shown the evolution of these data.

Table 1 Body weight evolution of 2-3 years old catfish

<table>
<thead>
<tr>
<th>Location</th>
<th>15.05.2007</th>
<th>14.06.2007</th>
<th>10.07.2007</th>
<th>16.08.2007</th>
<th>20.09.2007</th>
<th>22.10.2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>catfish 3 (g/ex)</td>
<td>1533</td>
<td>2070</td>
<td>2436</td>
<td>2543</td>
<td>2702</td>
<td>2901</td>
</tr>
<tr>
<td>Module 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>catfish 2 (g/ex)</td>
<td>885</td>
<td>1084</td>
<td>1392</td>
<td>1585</td>
<td>1740</td>
<td>1897</td>
</tr>
</tbody>
</table>

Diagram 1 Weight evolution at the 2-3 years old catfish, 2007

Taking account of the populated fish specimens number and being helped
by their monthly weight, it has been evaluated the whole fish quantity from each
module, for the purpose of establishing informatively the fodder rations.

The quantity of the fodder administrated during the experimental period of
the catfish intensive growing in open cages, under the environmental factors
influence resulted in the following representation (table nr.2):

The fodder was initially administrated at its normal standards, but after the
first control fishing it was noticed that the catfish this way fed were eating it
greedily getting over-swallowed their bellies, so an urgent measure to be taken
would impose: to wet the granules before distribution (photo 2).

**Temperature** is the physical factor with the most profound influence over
the biological activity. All the technological operations: feeding, control fishing,
crop fishing and so on, are being done taking account of the water temperature.
The image from the diagram nr.2 shows that the highest water temperature was
registered in July, when the average daily temperature during a whole week (19-24 of July) varied approximately around 30° C. During this period of time the fodder fish feeding was interrupted, and after that it began to be reinforced gradually, with a smaller quantity of fodder.

Table 2 Amount of feed administrated during the experimental period

<table>
<thead>
<tr>
<th>Feeding period</th>
<th>% feed /fish meal/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.05. – 16.06.2007</td>
<td>2%</td>
</tr>
<tr>
<td>17.06. – 30.06.2007</td>
<td>3%</td>
</tr>
<tr>
<td>02.07. – 19.07.2007</td>
<td>7%</td>
</tr>
<tr>
<td>20.07. – 26.07.2007</td>
<td>-</td>
</tr>
<tr>
<td>27.07. – 02.08.2007</td>
<td>3%</td>
</tr>
<tr>
<td>03.08. – 10.08.2007</td>
<td>5%</td>
</tr>
<tr>
<td>11.08. – 24.09.2007</td>
<td>8.7%</td>
</tr>
<tr>
<td>25.09. – 12.10.2007</td>
<td>3%</td>
</tr>
</tbody>
</table>

The oxygen that had been dissolved in the providing water source placed between 5.4 - 12.8 mg/l O₂ during the whole studied period. In the host basin the dissolved oxygen level didn’t get lower than 4.8mg/l O₂. In the growth modules there were only two critical periods of time (see the diagram nr.3): in the second part of June and respectively in the end of July, when the oxygen dissolved in the water got a very low level, but luckily without any consequences over experiment.

The rest of hydro-chemical parameters with some importance in fish growing took the following representation:

- **transparency** got in the growth modules values between 19 and 27 cm and 29-45cm in the host basin;
Diagram 2 Monthly variation of water temperature during the summer of 2007

Diagram 3 Variation of the oxygen dissolved in the growth modules summer of 2007

- **pH** was neuter all over the growing cycle – slightly alkaline in the providing water source (where it registered values between 7.0-7.4) and in growth modules: 7.0-7.8;
- **water hardness** got values between 3.92-5.82 (d GH);
- **carbonates** were absent all over the studied period and **bicarbonates** varied between 134.20-237.9 mg/l HCO_3^- for growth units, while in the host basin they were in the interval 122.0-237-90 mg/l HCO_3^-;
- **calcium** is indispensable for the evaluation of the damping power. It is determined volumetrically (STAS 3662/62); in the providing water source were found quantities between 24.0-32.80 mg/l; in the module 1 and the host basin: 23.20-40.0 mg/l;
- **the organic matter** from the host basin and modules took values of the area of piscicol optimum limit and there were only two moments of the growing
cycle when it placed in the area of the maximum optimum limit. But under the distribution of hydrating lime directly into the water populated with fish, the situation quickly balanced to normal, as it can be noticed from the diagram 4.

Diagram 4 Organic matter level in the providing water source, host basin and growth modules

- **Nitrites** (NO\(_2^−\)) and **nitrates** (NO\(_3^−\)) placed the area of piscicultural optimum all over the studied period;
- **Phosphorus** from P\(_2\)O\(_4^{3+}\) had been absent all over the determined period, both in the providing source and in growth units and host basin;
- **Ammonium ion** (NH\(_4^+\)) got values between 3.43-4.67 mg/l during a lower period (July 24\(^{th}\) – August 13\(^{th}\)) after what it registered gradually lower values till the end of growing cycle. (Diagram nr. 5)

Crop fishing was performed on the 22 October 2007, when the water temperature lowered to 12°C.

At the crop fishing were studied:
- survival;
- average weight g/ex.;
- the specific fodder use (FCR) – kg fodder/ kg growth weight;

The survival rate of the experiment biological material was 94% per 3 years old catfish and 89% for the 2 years old ones.

Average final weights and the specific use for consumption are presented in the following table. (Table nr. 3)

The necessary fodder use for 1 kg catfish meat in the shown experiment is of 6.9 kg of fodder and 170 g low quality fish /kg weight for 3 years old catfish and respectively 6.2 kg of fodder and 165 g low quality fish /kg weight for the 2 years old ones, results that are comparable with those obtained by the
Hungarian research explorers (3.3–6.5 kg of fodder/kg weight) in the intensive catfish growing in cages, over a period of one and two summers. (2)

Diagram 5 Level of ammonium ion in the providing source, host basin and growth units

Table 3

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish raising performance</td>
<td>Module 1</td>
</tr>
<tr>
<td>Total feed given per module (kg)</td>
<td>1670</td>
</tr>
<tr>
<td>Total initial biomass (kg)</td>
<td>307</td>
</tr>
<tr>
<td>Average initial fish weight (g/fish)</td>
<td>1533</td>
</tr>
<tr>
<td>Total final biomass (kg)</td>
<td>545</td>
</tr>
<tr>
<td>Average final fish weight (g/fish)</td>
<td>2901</td>
</tr>
<tr>
<td>Individual fish growth rate (g/fish)</td>
<td>1368</td>
</tr>
<tr>
<td>Total fish growth rate (kg)</td>
<td>239</td>
</tr>
<tr>
<td>Feed conversion ratio (FCR - (kg/kg)</td>
<td>6.9</td>
</tr>
</tbody>
</table>

The higher result of the specific fodder use of our case is the result of a technological error what was discovered later, and that error was that a part of the distributed granules were lifting to the water surface being quickly consumed by the carp fish grown in the host basin.

At the crop and control fishing was made the macroscopic examination of skin, searching both sides of the fish, the head and fin area. There were identified fish with superficial scares provoked by the aggressively of other fish of the unit, both at the 3 years old catfish and the 2 years old ones. (photo nr.3)

Although, from the ethological point of view, the catfish is characterized by the cannibalism phenomenon, when it lives in huge densities in narrow spaces – phenomenon favoured by the competition for food and agglomeration stress of the crop fishing and control fishing – there hadn’t found specimens with more profound skin lesions or scares; just a few specimens with superficial scares. (photo nr.4). So, that was the reason we didn’t have to proceed to separating catfish into another module.
Microscopic examination consisted in studying the native samples obtained by skin scraping of the following areas: head, fins, gill, where had been discovered the presence of parasites of protozoa type (*Tricodina sp.*, *Tricodinella sp.*, *Apiosoma sp.*) and of mono-genre *Dactilogyrus sp.*, but the intensity of the parasitic infection was week.

**CONCLUSIONS**

Growth modules with the capacity of 1500 m³, under the influence of the environmental factors, present the following advantages:

1. they are simple installations and there aren’t necessary high costs for their building;
2. they can be resized in different types of aquatic basins;
3. they permit the water free circulation on the whole surface, functioning as an open system;
4. they confer facility for distribution and monitoring of fodder use;
5. insure the security of fish material;
6. they offer the possibility of a rapid fishing whenever it might be requested, even beyond the fishing seasons.

The catfish growing in this system has got the following advantages:
1. it resolves the problem of restoring and preserving the catfish populations, considerably diminished after an uncontrolled fishing;
2. catfish can be intensively grown for commercial purposes, in open growth modules, under the environmental factors influence, beginning with the second summer of the growing cycle;
3. there can be obtained huge quantities of catfish meat on the unity of water volume by clear away the technological errors found.

The experiments performed so far demonstrate that there is a great potential both of catfish and other fish species to be grown intensively.

What remains is a better formula for a technological management in order to reduce the specific consumption per kg of growing.

REFERENCES
Ferenc, M., Laszlo, V., 1980 – Acvacultura Hungarica (Szarvas), vol. II.