Survival and Growth of *Clarias gariepinus* and *Heterobranchus longifilis* Larvae Fed with Freshwater Zooplankton

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**Abstract:** The suitability of the freshwater zooplankton was investigated in two African catfish larvae, *Clarias gariepinus* and *Heterobranchus longifilis*, at the end of yolk sac resorption. This live food was compared to *Artemia* nauplii, another live food. With those two regimens, four lots of larvae were constituted with two replicates: Cg zoo, larvae of *C. gariepinus* fed with freshwater zooplankton; Cg art, larvae of *C. gariepinus* fed with *Artemia*; Hl zoo: larvae of *H. longifilis* fed with freshwater zooplankton and Hl art: larvae of *H. longifilis* fed with *Artemia*. After a 10 day-experiment, survival rates ranged from 97% to 98% and 78.5% to 81.5% were obtained in Cg zoo, Cg art, Hl zoo and Hl art, respectively. Final mean weight were 11 ± 0.003, 13 ± 0.003, 67 ± 0.001 and 89 ± 0.005 mg for Cg zoo, cg art, HI zoo and HI art, respectively with specific growth rate which respectively were 11.28 ± 0.3%, 14.3 ± 0.2% 14.29 ± 0.22% and 17.2 ± 0.5% per day. Those results show that freshwater zooplankton proved suitable for first feeding of *C. gariepinus* and *H. longifilis* larvae and could constitute a valuable alternative for larval rearing.

**Key words:** *Clarias gariepinus*, *Heterobranchus longifilis*, *Artemia*, freshwater zooplankton, feeding, survival and growth.

1. **Introduction**

Actually, the availability of juveniles constitutes a major obstacle in the development of the commercial fish farming of African Clariid catfish such as *Clarias gariepinus* [1-3] and *Heterobranchus longifilis* [4, 5]. After mastery of reproduction of these species which constituted at long time main limiting factor, embryonic breeding of them remains not mastered [6]. Now, the mastery of larviculture of a fish species is the second indispensable link allowing to obtain its juveniles in continuous. Indeed, the larval period is extremely important in ontogenesis because it corresponds to the passage from endogenous to exogenous feeding, with organ formation and working bound to this function [7]. It is considered a critical stage in many fish species in their life history [8]. The major difficulty in larvae rearing encountered lies principally in the choice of good-quality that was acceptable to the species concerned. According to the literature, *Artemia* constitutes an excellent starting food in larviculture of freshwater fish [9-12]. But due to escalation in the coast and not availability of *Artemia* in our developing countries especially in the rural fish farming, research of substitutes which will be easily accessible to lesser cost is necessary.

This work compares the suitability of the freshwater zooplankton and the *Artemia* for feeding *C. gariepinus* and *H. longifilis* larvae.

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2. Materials and Methods

2.1 Source of Fish Larvae

Larvae of the African catfish *C. gariepinus* and *H. longifilis* were obtained by artificial reproduction of captive broodstock at the Training and Research in Fish Farming, Unit of Hydrobiology and Aquaculture Laboratory, University of Abomey-Calavi, Benin. Two females per species (around 300 g body weight per female) were hormonally induced to spawn using Ovaprim (0.5 mL kg⁻¹ body weight). The eggs harvested 10 h after, were fertilized with laitance of males (around 500 g body weights per male). Those fertile eggs were incubated in hatcheries with flowing water using the procedure of Viveen et al. [13]. Hatching occurred 27 h after incubation. After hatching, the larvae were separated into the different feeding trials with two replicates.

2.2 Mass Production of Freshwater Zooplankton

Freshwater zooplankton (rotifers, cladocerans and copepods) were mass-produced in rectangular concrete tanks (2 × 2 × 1 m) with manure fertilization method. Each tank was half-filled using 2000 liters of water (clean water (3/5) + fishponds water (2/5) filtrates under plankton net of 50 µm for inoculating phytoplankton) and adding chicken droppings (doses = 0.6 g L⁻¹ attached in sack) [14]. Then the zooplankton was inoculated. After 5-7 days of culture the freshwater zooplankton were harvested with the plankton net (55 µm) and thoroughly washed with tap water prior to feeding. The zooplankton used was constituted of rotifers (78%), cladocerans (9%) and copepods (13%).

2.3 Production of Artemia Salina

*Artemia salina* is crustacean species which leaves in seawater. *Artemia* cysts (INVE Aquaculture Nutrition, High HUFA 430 µm, Hoogveld 91, B-9200 Dendermonde, Belgium) were incubated and hatched under optimal conditions according to the manufacturer’s protocol. 24 h after incubation in artificial seawater, newly hatched *Artemia* nauplii were separated from the hatching debris by interrupting the air supply in the hatching vessel. Then, nauplii were siphoned out to a fine-mesh (100 µm) harvesting box. The *Artemia* nauplii were washed and fed to the larvae.

2.4 Experiment Plan

Two days after post-hatching, larvae were transferred in small circular baskets (Φ = 18 cm) directly placed in aquaria (60 × 30 × 30 cm) and rearing during 10 days [15]. The initial density is 100 larvae (Initial mean weight = 3 ± 0.05 mg per larvae for *C. gariepinus*; and 2 ± 0.01 mg per larvae for *H. longifilis*) per baskets, then 200 larvae per aquarium. According to species and feed, four lots were constituted with two replicates:

- Cg zoo: larvae of *C. gariepinus* feeding with freshwater zooplankton;
- Cg art: larvae of *C. gariepinus* feeding with *artemia*;
- Hl zoo: larvae of *H. longifilis* feeding with freshwater zooplankton;
- Hl art: larvae of *H. longifilis* feeding with *artemia*.

Larvae were fed in excess four times a day at 08.00, 12.00, 16.00 and 20.00. 11th day after feeding with live food, larvae were weaned with artificial dry diet.

2.5 Water Quality and Mortality Management

To maintain good water quality conditions, excess feed and faeces were collected (siphoning) each morning before feeding; dead larvae were removed twice daily and counted. Temperature, dissolved oxygen and pH were monitored once per day at 07.00 am using an Oxythermometer (DO-100 Oxygen Gauge, Voltcraft, Hirschau, Germany; precision: 0.01 mg/L et 0.1 °C) and pH meter (pH Scan 10, Oakton, Eutech Instruments, Vernon Hills, USA), respectively. Water temperature, dissolved oxygen and pH were similar in all feeding lots. Mean (± SE) rearing conditions (pooled samples) were as follows: water temperature = 27.5 ±
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0.2 (26.1-28.8 °C); dissolved oxygen = 6.2 ± 0.1 (6.0-6.5 mg L⁻¹); pH = 6.7 ± 0.04 (6.2-6.7). The photoperiod for this indoor experiment was set at 12 L: 12 D cycle (light period from 08.00 to 20.00 hours).

### 2.6 Larvae Growth and Survival Rates

Larvae were periodically sampled to assess growth rates. Individual body weight was measured using an electronic balance (Sartorius, 0.001 mg and 0.01 mg sensitivity). Each 2 day, random and representative samples of twenty larvae were taken from each replicate for this measure.

At the beginning and the end of the experiment, larvae total length was measured using a millimeter paper covered by transparent paper.

The specific growth rate (SGR), survival rate (S) and variation coefficient (CV) was calculated using the following formula:

\[
SGR = 100 \left[ \frac{\ln \text{final weight} - \ln \text{initial weight}}{\text{Number of experimental days}} \right] (1)
\]

\[
S = \left( \frac{100 \times \text{final number}}{\text{initial number}} \right) (2)
\]

\[
CV = \left( \frac{100 \times \text{Standard Error}}{\text{Mean}} \right) (3)
\]

### 2.7 Data Analysis

Growth and survival data are presented as mean values (± SE). Results were examined by Chi care test and analysis of variance (ANOVA 1) [16], respectively. When ANOVA indicated significant treatment differences, a fisher Post Least Standard Deviation test [17] was applied to compare means at the P < 0.05 level of significance. All statistical analysis was performed using Statview software (Version 1992-1998, SAS Institute Inc).

### 3. Results

Survival and growth of *C. gariepinus* and *H. longifilis* are presented in Table 1 and Fig. 1. High survival rates are found with Cg art (98 %) and Cg zoo (97 %) with no significant difference (P > 0.05). HI zoo has the lowest survival. Final body weight is important HI art (89 ± 0.005 mg) and HI zoo (67 ± 0.001 mg) with statistical differences between HI art and the other groups. The weak final body weights are obtained in Cg zoo (11 ± 0.003 mg) and Cg art (13 ± 0.003 mg). For this parameter, no significant difference is found between Cg zoo and Cg art. Between Cg zoo and Cg art, the SGR was statically different. It is the same between HI zoo and HI art. The highest SGR are obtained in HI art (17.2 ± 0.5 % day⁻¹) and the lowest is in Cg zoo (11.28 ± 0.3 % day⁻¹). According to the mean weight gain, significant differences are found between Cg zoo and Cg art and between HI zoo and HI art.

At the beginning to 8th day of larvae rearing, the body weight curve of Cg zoo and Cg art are similar (Fig. 2). It was the same of HI zoo and HI art body weight curve at the first four days of rearing (Fig. 3). After the 8th day at *C. gariepinus* and 4th day at *H. longifilis*, the curves of Cg art and HI art are respectively below of Cg zoo and HI zoo curves.

### Table 1  Survival and growth data for *C. gariepinus* and *H. longifilis* larvae feeding with freshwater zooplankton and *artemia* nauplii.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cg zoo</th>
<th>Cg art</th>
<th>HI zoo</th>
<th>HI art</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial larvae number</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Death number</td>
<td>4</td>
<td>6</td>
<td>43</td>
<td>37</td>
</tr>
<tr>
<td>Final larvae number</td>
<td>194</td>
<td>196</td>
<td>157</td>
<td>163</td>
</tr>
<tr>
<td>Deathly rate (%)</td>
<td>97a</td>
<td>98a</td>
<td>21.5b</td>
<td>18.5b</td>
</tr>
<tr>
<td>Survival (%)</td>
<td>3a</td>
<td>2a</td>
<td>2.15b</td>
<td>18.5b</td>
</tr>
<tr>
<td>Initial mean weight (mg)</td>
<td>3 ± 0.05</td>
<td>3 ± 0.05</td>
<td>2 ± 0.01</td>
<td>2 ± 0.01</td>
</tr>
<tr>
<td>Final mean weight (mg)</td>
<td>11 ± 0.003a</td>
<td>13 ± 0.003a</td>
<td>67 ±0.001b</td>
<td>89 ± 0.005c</td>
</tr>
<tr>
<td>Mean weight gain per day (mg/day)</td>
<td>9 ± 0.004ab</td>
<td>11 ± 0.007ab</td>
<td>6.5 ± 0.003bc</td>
<td>8 ± 0.005bc</td>
</tr>
<tr>
<td>Specific Growth Rate (SGR) (%)/day</td>
<td>11.28 ± 0.3a</td>
<td>14.3 ± 0.2b</td>
<td>14.29 ± 0.22b</td>
<td>17.2 ± 0.5c</td>
</tr>
</tbody>
</table>

Values followed by the same superscript are not significantly different (P > 0.05) from others in the same line.
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4. Discussion

Under the present experiment conditions, the survival and growth performances of the both species of African catfish feeding with zooplankton approach those obtained with *artemia* nauplii. The survivals are high and superior at 78.3%. It’s testified live food suitability on the larvae survival. This result is the same as in gudgeon (*Gobio gobio*) larvae [18], *C. gariepinus* larvae fed with zooplankton (*Brachionus calyciflorus*) and *H. longifilis* larvae fed with *artemia* nauplii [19]. Final body weights obtained in this experiment are more important than those reported by Awaïss et al. [3] on *C. gariepinus* larvae which are 8.7 ± 0.5. This difference could be due to live-food feeding period which is short (7 days). *H. longifilis* larvae feeding with zooplankton have reached more important body weight in short period comparing *C. gariepinus* larvae. Otémé and Gilles [16] reported more less body weight of same species. In 10 days *H. longifilis* larvae fed with freshwater zooplankton...
has $67 \pm 0.001$ mg (mean body weight). According to Otémé and Gilles [2], this body weight obtained in present experiment with freshwater zooplankton is sufficient for weaning *H. longifilis* larvae. In spite of initial body weight of *H. longifilis* larvae is $2 \pm 0.01$ mg versus $3 \pm 0.05$ mg for *C. gariepinus* larvae; final body weight of *H. longifilis* larvae is largely superior of the one of *C. gariepinus* larvae (Table 1). What shows that *H. longifilis* has more quickly growth than *C. gariepinus* [20, 21]. Another reason which contributed at this difference may be the mortality of larvae. Indeed, the mortality of *C. gariepinus* larvae was significantly lower than *H. longifilis* larvae. Thus, *C. gariepinus* larvae had a smaller space per individual than *H. longifilis* larvae. It is well known that fish density is related to fish growth.

The growth rate obtained here at both species is similar to those obtained in *C. gariepinus*, *Clarias macrocephalus* and *Labeo parvus* when comparing larvae fed a dry diets and live foods (*Artemia* nauplii and freshwater zooplankton).

The good survival and growth performances of those larvae fed with freshwater zooplankton and *artemia* nauplii obtained in the present experiment results in digestibility and of good nutrient quality of both prey. According to Lauff and Hofer [22], a principal interest of live-foods in larviculture encountered lies in its good digestibility. Live-foods can contribute to the own digestion until 80% due to the proteases which they contain. The digestibility of rotifers proteins by Cyprinidae larvae ranged from 89% to 94%, while for *artemia* it’s situated between 83% and 89%. Nevertheless, African catfish larvae such as *C. gariepinus* larvae use better the proteins of the *artemia* than those of the rotifers; what could justify the difference obtained at the level of the performances of survival and growth.

5. Conclusion

At the end of present experiment, it’s clear that *C. gariepinus* larvae and *H. longifilis* larvae fed with freshwater zooplankton approach the survival and growth performances of larvae of same species fed with *artemia* nauplii. Then, zooplankton could substitute *artemia* in larviculture of African catfish. But, the research on the species of zooplankton, the nutritional composition of zooplankton specie and the rationment are necessary in order to improve the efficiency of freshwater zooplankton.

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References


