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Resistance to fasting and effect of delaying first feeding on growth and survival in african catfish *Heterobranchus bidorsalis* larvae (Geoffroy Saint-Hilaire, 1804)

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Abstract

After the artificial reproduction of catfish *Heterobranchus bidorsalis*, larvae of two days old and 2.23 ± 0.27 mg of mean weight were used to perform two experiments in order to assess their resistance to fasting and the effect of delaying first feeding on their growth and survival. In the first experiment, it was noted that the first larvae died at D5 (3.33%), the largest daily mortality was recorded at D10 with 53.33% and all larvae died at D11 (6.67%). At the end of the second experiment, results showed that growth was better in larvae fed at D6 (594.25 ± 107.05 mg mean weight) than those fed at D4 (323.59 ± 110.78 mg) and D2 (275.32 ± 146.58 mg). In contrast, the survival rate was better for larvae fed at D2 and D4 than those fed at D6 with respectively 37.00 ± 16.46%, 18.66 ± 1.47 % and 5.67 ± 6.42%.

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Introduction

The Clariidae, commonly known as catfishes, have a significant economic interest (Teugels, 1994). Several species were introduced in fish culture and represent an important part of world trade. Among these species, *Clarias gariepinus*, *Heterobranchus longifilis* and *Heterobranchus bidorsalis* are widely cultured in many countries in the world particularly in African countries.

In Côte d'Ivoire, the two last species are being investigated since several years at Oceanologic Research Center (CRO) in order to optimize their breeding chain. However, in African catfish culture, the supply of fingerlings for commercial production appears to be a major constraint (Imorou Toko *et al*., 2008, Alla *et al*., 2011). During the early life stages, larvae are fed with Brine shrimp (*Artemia sp.)* nauplii or de-capsulated cysts which are, according to several authors, excellent starter feeds for freshwater or marine fish species Dhert and Sorgeloos, 1994; Lavens and Sorgeloos, 1996; Leger *et al*., 1986; Verreth *et al*., 1987). But this food is expensive and not always available (Olurin and Oluwo, 2010; Imorou Toko *et al*., 2008; Alla *et al*., 2011; Ossey *et al*., 2012). That increases the cost of production of these fish and then, constitutes a major obstacle to their intensive culture. To remove this obstacle, we must either find a substitute food for *Artemia salina* or reduce its use time and evaluate its impact during larval rearing.

In this last case, although some works have been done on weaning larvae of *Clarias gariepinus* (Verreth and Tongeren, 1989), *Sander lucioperca* (Kestemont *et al*., 2007), *Heterobranchus longifilis* (Imorou Toko *et al*. 2008) and on resistance to fasting of *H. longifilis* larvae (Alla *et al*., 2014), there is not enough information about delaying the first feeding in the larvae of these species. That would save *Artemia salina* and help to decrease their production cost. It is in this context that we undertake this study which aim is to determine the larval resistance to fasting and assess the effect of delaying fist feeding on their growth and survival in African catfish *Heterobranchus bidorsalis*.

Materials and methods

Two experiments were performed with *H. bidorsalis* larvae obtained after artificial fertilization at the hatchery of Oceanologic Research Center of Abidjan using methods developed by Legendre (1986), Slembrouck and Legendre (1988) or Gilles *et al*., (2001). Larvae were two days old and 2.23 ± 0.27 mg of mean weight.

Determination of resistance to fasting

The first experiment, including two (2) trials, was made with six (6) batches of thirty (30) larvae either a total of one hundred and eighty (180) larvae. The first trial was conducted with thirty (30) larvae distributed within bowls of one (1) larvae per bowl each containing 60 ml of water.

Larvae were maintained at fasting and every morning, they were checked up and water entirely renewed. When mortality was observed, larva was immediately removed and bowl emptied until the death of all lance to larvae.

For the second part of the first experiment, five (5) batches of thirty (30) larvae either one hundred and fifty (150) larvae were used. The second part of the experiment began when the first mortality was recorded in one batch of thirty (30) larvae. From that day, a first batch of thirty (30) larvae was fed, then another batch the next day and so on until the fifth batch.

Effect of delaying first feeding on growth and survival

For the second experiment, four (4) batches of one hundred (100) larvae were conducted with triplicate in 50 liter aquaria with 2 larvae per liter of density. The 1, 2, 3 and 4 groups were fed ad libitum with *Artemia salina*, beef brain and compound food CN + respectively from the 2nd, 4th, 6th and 8th day after hatching. Every morning, before feeding larvae, aquaria were cleaned to remove food scraps and assess mortalities.

Weekly, a random sample of ten (10) larvae in each aquarium was weighed (mg) and measured (mm) individually with a precision balance and an ichthyometer. At the end of the experiment, the remaining larvae of each aquarium were counted, measured and weighed individually to determine survival rate.

Water quality parameters

Water temperature, dissolved oxygen and pH in each bowl were measured every morning using an oxymeter Crison (Oxi 330) with a pHmeter (model WTW), by immersing the probe in the aquarium.

Statistical analysis

Statistical analyses were performed using STATISTICA 7.1 software. Results were expressed as mean ± standard deviation. An analysis of variance (ANOVA) was applied to test differences between mean weights and survival rates. The Kolmogorov-Smirnov test was used to check normality of the data distribution. If necessary, transformations were performed to obtain a normal distribution.

Results and discussion

Results

Physico-chimical parameters

Average temperature, dissolved oxygen and pH in bowls were respectively 27.5 ± 0.3 ° C, 6.3 ± 1.2 mg/l and 7.2 ± 0.1. In aquaria, they were 28.7 ± 0.5 °C, 5.8 ± 0.4 mg/l and 7.0 ± 0.4 respectively.

Table 1. Determination of larval threshold of resistance in *H. bidorsalis* larvae depending on time.

Age of larvae	1st Batch			2nd Batch			3rd Batch			4th Batch			5th Batch		
	NAL	DM	TM	NAL	DM	TM	NAL	DM	TM	NAL	DM	TM	NAL	DM	TM
D5	0	0	30*	1	1	29	8	8	22	1	1	29	1	1	29
D6	10	10	20	5	6	24*	1	9	21	6	7	23	9	10	20
D7	5	15	15	2	8	22	0	9	21*	5	12	18	4	14	16
D8	0	15	15	3	11	19	4	13	17	1	13	17*	2	16	14
D9	2	17	13	2	13	17	2	15	15	4	17	13	2	18	12*
D10	1	18	12	1	14	16	3	18	12	3	20	10	12	30	0n
D11	1	19	11	2	16	14	2	20	10	3	23	7			
D12	1	20	10	1	17	13	2	22	8	1	24	6			
D13	0	20	10n	1	18	12n	0	22	8n	1	25	5n			

DM: Daily Mortality

TM: Total Mortality

NAL: Number of Alive Larvae

*: Number of alive larvae at the fist feeding

n : Number of alive larvae at the end of experiment.

Larval threshold of resistance to fasting

During the first part of experiment 1, daily mortalities recorded in bowls are presented on figure 2. The first mortalities were observed at the third day of fasting (D5). They represent 3.33% of larvae. The highest daily mortality was obtained at D10 (53.33%) while the last larvae died at D11 (6.67%).

In the second part of this experiment, it was noted that despite the fasting, some larvae fed from D5 to D8 survived. In contrast, those fed at D9 died the day after the first feeding.

At the end of the experiment (D13), respectively, 10, 12, 8 and 5 larvae remained alive in the first, second, third and fourth batch fed. The greatest number of alive larvae was observed in the second batch (12), the first (10), the third (8) and the fourth with only 5 living individuals.

Number of alive larvae at the beginning of feeding (*) and the number of remaining larvae at the end of the experiment (n) for each batch are provided by Table 1.

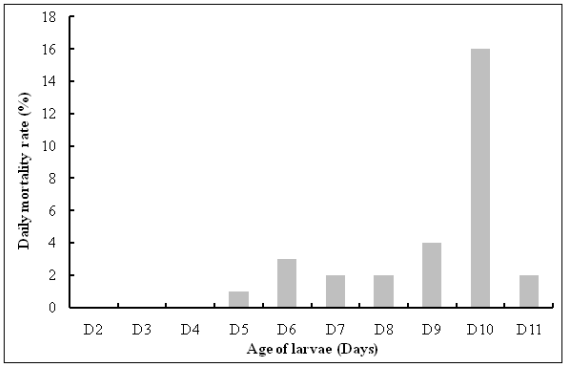

Fig. 1. Daily mortality rate of *Heterobranchus bidorsalis* larvae depending to their age.

Effect of delaying first feeding on larval growth and survival

The larvae of the fourth batch (fed eight days after hatching, at D8) all died before the first sampling. We have not therefore been able to follow their growth.

Figure 2 shows variations of the mean weight of *Heterobranchus bidorsalis* larvae depending on the rearing duration. There was no significant difference in weight ($p > 0.05$) between the batches during the first three weeks of experiment. The respective mean weights were 10.79 ± 2.45 mg; 8.45 ± 2.04 mg and 7.05 ± 2.59 mg for batches 1, 2 and 3.

However, a significant difference ($p < 0.05$) was observed between the weight for the batch 1 and the other two batches from the second week of feeding (with mean weight of 35.86 ± 10.08 mg for the batch 1, 33.44 ± 10.31 mg for the batch 2 and 65.24 ± 12.84 mg for the batch 3) to the end of the experiment where the mean weights were respectively 275.32 ± 146.58 mg; 323.59 ± 110.78 mg and 594.25 ± 107.05 mg for batches 1, 2 and 3. We also noted that mean weights were not significantly different between batches 1 and 2 from the beginning to the end of the experiment even if the final mean weight of larvae was slightly higher for batch 2 than for batch 1.

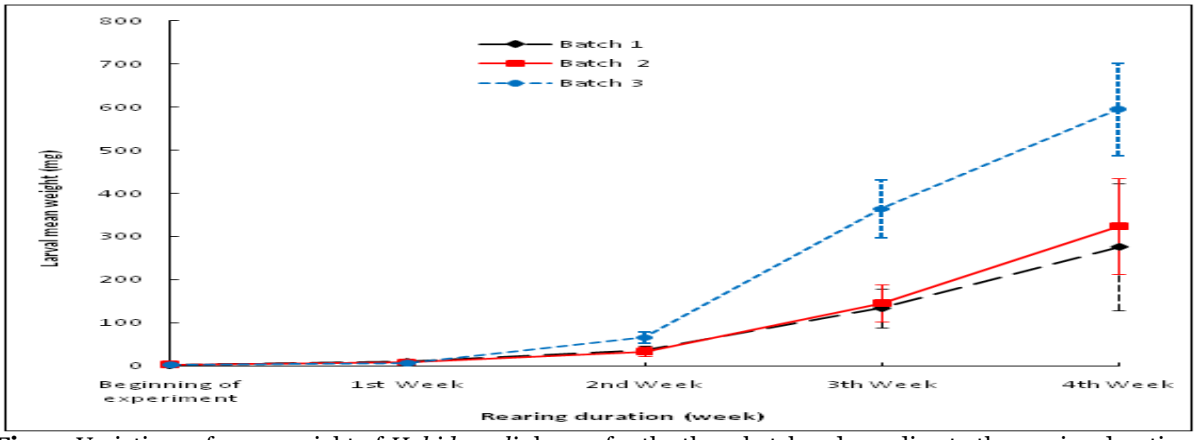

Fig. 2. Variations of mean weight of *H. bidorsalis* larvae for the three batches depending to the rearing duration.

At the end of the experiment, the survival rate of larvae was determined for each batch (Fig. 3). There was no significant difference in this parameter for the triplicates of the same batch. However, survival rates were significantly different ($p < 0.05$) between the three batches. Thus, the best survival rate was obtained with larvae of batch 1, fed two days after hatching (37.00 ± 16.46%). The lowest survival rate was recorded in larvae that received their first food ration six days after hatching, at D6 (Batch 3) with 5.67 ± 6.42%. Larvae of batch 2 (fed four days after hatching) gave an intermediate value of survival rate (18.66 ± 1.47%).

Discussion

Physico-chemical parameters (temperature, dissolved oxygen and pH) measured in bowls and aquariums varied very little during the experiment and did not really affect the larval growth and survival. Indeed, recorded values were in the range recommended by

several authors for rearing juvenile catfish (Boyd, 1990; Lawson, 1995; Tarazona and Munoz, 1995). It is from 10 to 35 °C for the temperature, higher than 3 mg/l for dissolved oxygen and 6.5 to 8.0 concerning pH (Boyd and Tucker, 1998; Viveen *et al*., 1985). The stability of these factors seems to be due, on the one hand to daily renewing water in bowls. On the other hand, the experiment was conducted in closed circuit with the same circulating water in aquariums.

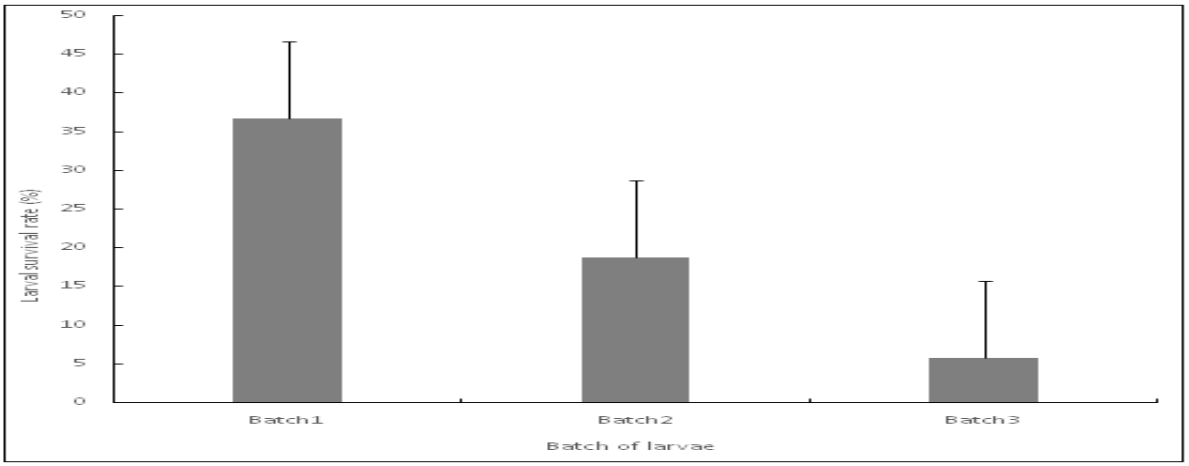

Fig. 3. Survival rate *H. bidorsalis* larvae depending on the batch.

The results of the first experiment showed that during the fasting, the first mortalities were recorded in the bowls the third day of fasting (D5). The greatest number of larvae died at D10 and the latest mortalities were observed at D11. These results are in agreement with those of Alla *et al.* (2014) with *H. longifilis*. They showed that in this species, in the same conditions, first mortalities also occurred at D5, the highest mortalities were obtained at D9 while the last were recorded at D12. They explained these results by the fact that, after vitellin resorption larvae used their body reserves to survive until D9 or D10. At that time, after exhausting, majority of larvae dead. These authors suggested that first mortalities observed in larvae occurred to the weakest populations, and the latest concerned the most resistant which after total depletion of their reserves were able to withstand until two to three days before dying. These results seem to show that in population with the same age and environmental conditions, the weakest died and the strongest resist.

As *H. longifilis* at D8 (Alla *et al*., 2014), our results also revealed that, after the fasting, *H. bidorsalis* larvae can survive if the fasting is broken at D9. That is shown by the relatively high number of alive larvae the next day after feeding of each batch and at the end of the experiment except of larvae fed at D9. Indeed, they all dead the day after their first feeding because they were very weak and exhausted. Larvae were therefore unable to survive to fasting. Moreover, these results confirmed the first experiment showing that the highest daily mortality was recorded at D10 which is actually the threshold of *H. bidorsalis* larvae resistance to the fasting. This is due to fact that, after a certain degree of fasting, the weakened animals are unable to eat and are doomed to perish even the presence of food (Guillaume *et al*., 1999).

Results also showed that larval growth is relatively low in the three batches during the first two weeks after feeding and is more important after this period. These results are in agreement with those of Legendre and Teugels (1991) during the larval rearing of *Heterobranchus longifilis* and *Clarias gariepinus*. They noticed that, the fish growth is slow during this period because larvae would mobilize most of their energy to develop various organs, so that at the 13th day, they get adult appearance. They observed that beyond the second week, the growth is fast because of the stored energy following the setting in place of the

digestive tract that values exogenous food. This stored energy will be used primarily for the growth of larvae. Our results also indicated that from the second week of feeding to the end of the experiment, larval growth was better in batch 3, those receiving the first food six days after hatching (D6). This may be related to compensatory growth. Indeed, many works on the rainbow trout *Salmo gairdneri* (Dobson and Holmes, 1984), juvenile Salmon (Miglavs and Jobling, 1989; Metcalfe and Thorpe, 1992) and African catfish *H. longifilis* (Luquet *et al.*, 1995) showed this compensatory growth. According to these authors, a temporary food restriction could, later, induce higher growth and a better index of consumption in animals fed continuously without restriction. This compensatory growth is due to both hyperphagia and improved metabolic transformation of nutrients.

Unlike growth, larval survival was lower in batch 3 compared to batches 1 and 2, evidenced by the high mortalities recorded in batch 3. This could be explained firstly by the inability of some larvae to resist to the fasting and secondly, by cannibalism which is considered as one of the leading causes of mortalities among Clariidae during larval rearing (Hecht and Appelbaum, 1988; Smith and Reay, 1991; Baras and D'Almeida, 2001; Coulibaly *et al.*, 2007). This phenomenon is related to the stocking density since according Kerdchuen (1992), it is caused by sporadic aggressiveness manifested by juveniles at low densities. That is the case, in our study, of larvae fed six days after hatching whose number was low, thus promoting cannibalism which reduced the survival rate.

Conclusion

At the end of this work, we can say that *Heterobranchus bidorsalis* larvae could resist to the fasting ten days (D10) after hatching before dying. Moreover, growth was better in larvae receiving their first food ration six days after hatching (D6). In contrast, the survival rate was higher in larvae fed at D2, two days after hatching at the end of the resorption of their yolk sac. Further studies may help to determine exactly when to start feeding larvae to reduce their cost of production.

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