



Early Weaning of Asian Stinging Catfish, *Heteropneustes fossilis* (Bloch) Larvae

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ABSTRACT

Background: *Heteropneustes fossilis* commonly known as stinging catfish is a popular indigenous fish of the Indian sub-continent. The species has a high consumer demand because of its tender flesh, low fat and high iron content, and is recommended for anaemic patients. Although the species has high consumer preference and potential for commercial aquaculture but, high mortality of larvae and difficulties in accepting compound diet during larviculture are some of the major bottlenecks. Keeping this in mind, the present study was designed to determine the earliest age at which stinging catfish can be weaned to an artificial diet. The information generated from the present study would be very helpful in improving survival during larval rearing.

Methods: The larvae were randomly distributed @ 60 larvae/ tank in 21 circular FRP tanks containing 30 L water each and the feeding experiment started at 2 dph. Seven different feeding strategies depending on the type of food (zooplankton, *Artemia nauplii*, or microdiet) and the age at which those food items were provided to larvae, were evaluated.

Result: The results indicated that larvae survival in the groups weaned after 5 days post hatch (dph) was similar to that of those fed solely with *Artemia nauplii* and zooplankton, although growth of larvae in the weaned groups was less. As larval growth can be compensated at later stages of the rearing process, therefore, larval survival is considered as one of the most important parameters for evaluating the weaning success. Based on the present findings, it is suggested to rear stinging catfish larvae with zooplankton without dependence upon costly *Artemia nauplii*, and larvae may be weaned to artificial diet after 5 dph. The findings would be very helpful for improving larval rearing of this indigenous catfish species in Indian rural areas.

Key words: Feeding strategies, Growth, *Heteropneustes fossilis*, Survival.

INTRODUCTION

Heteropneustes fossilis belongs to the family Heteropneustidae and is a native species of several Asian countries like India, Bangladesh, Myanmar, Nepal, Sri Lanka, Pakistan, Indonesia, Cambodia and Thailand (Burgess, 1989). The species commonly known as stinging catfish, has a very high consumer preference due to its tender flesh, delicious taste and low fat content. In addition, its flesh is recommended to people with anaemia because of its higher iron content (Chakraborty and Nur, 2012). Moreover, stinging catfish is considered as a highly promising candidate species for diversification of freshwater aquaculture because of its tolerance to crowding stress, air-breathing capacity and acceptance of pelleted feeds (Tharakan and Joy, 1996). However, the major constraints in the farming of this species are the high mortality rates and limited knowledge about feeding strategies during larval rearing. Therefore, it is of utmost importance to develop effective, reliable and efficient larval rearing techniques to ensure consistent production of quality seeds to meet the demand.

Live feed is considered as the most suitable feed for successful larval rearing of most fish larvae. But, large scale production and supply of live food organisms particularly zooplankton on continuous basis is a serious constraint (Mitra *et al.*, 2007). Although, *Artemia* can be used to overcome the continuous production and supply of live feed and its nutritional value can be enhanced through enrichment with required nutrients (Øie *et al.*, 2011) but it may not be

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affordable to the small-scale farmers of the Indian sub-continent because of high cost. The use of artificial feeds could partially alleviate above problems; but their use at very early larval stages usually leads to low survival and poor growth of the larvae due to improper development of digestive system, and unacceptability of the artificial feed (Watanabe and Kiron, 1994). Co-feeding of fish larvae with live and artificial feeds for few days has been reported to overcome the problems associated in acceptance and digestibility of artificial feeds and help in early weaning of the larvae (Hamre *et al.*, 2019). However, it is difficult to follow a universal weaning strategy for the fish larvae because of difference in timing of differentiation, development and functionality of their digestive systems

(Cahu and Zambonino Infante, 2001). Keeping this in mind, the present study was designed to determine the earliest age at which stinging catfish can be weaned to an artificial feed and develop a suitable feeding strategy. The information generated from the present study would be very helpful in improving survival during actual larval rearing of this important indigenous and promising catfish species.

MATERIALS AND METHODS

One day old larvae (1 dph, 0.2 mg) required for the present experiment were procured from the Catfish Hatchery of Live Germplasm Resource Centre of the ICAR-National Bureau of Fish Generic Resources, Lucknow. The study was carried out during the period of July 2017 to August 2017 at wet Laboratory of ICAR-NBFGR. The larvae were randomly distributed @ 60 larvae/ tank in 21 circular FRP tanks containing 30 L water each, and the feeding experiment started at 2 dph. Aeration was given in each tank to provide dissolved oxygen and help in a homogeneous distribution of feed throughout the water column. Water quality parameters such as water temperature, dissolved oxygen and pH values were maintained at 28.0-29.1°C, 6-8 mg/L and 6.8-7.6, respectively during the experiment period.

Seven different feeding strategies depending on different food types (zooplankton, *Artemia* nauplii or artificial diet) and duration at which those different food items were provided to larvae were evaluated (Fig 1). The age at which different food items were given to larvae, were intended to find out the most convenient weaning strategy for stinging catfish larvae. The larvae were reared under the following weaning strategies from the onset of the exogenous feeding at 2 dph until 22 dph: D-1, larvae fed with mixed zooplankton (Copepods, Cyclops and cladocerans) collected from a fish pond from 2 to 22 dph; D-2, larvae fed with *Artemia* nauplii (OSI PRO 80™, Ocean Star International, Inc., USA) from 2 to 22 dph; D-3, larvae fed with a artificial feed (Micro Elite 50, Lucky Star®, Taiwan) from 2 to 22 dph; D-4, larvae fed with *Artemia* nauplii from 2 to 8 dph, mixed zooplankton from 6 to 12 dph and artificial feed from 10 to 22 dph; D-5, larvae fed with mixed zooplankton from 2 to 7 dph and artificial feed from 5 to 22 dph; D-6, larvae fed with mixed zooplankton from 2 to 10 dph and artificial feed from 7 to 22 dph; D-7, larvae fed with mixed zooplankton from 2 to 12 dph and artificial feed between 9 and 22 dph. In all the treatments, larvae were fed with different feeds to satiation three times per day (08:00, 12:00 and 16:00 h) for 20 days. The feed waste and faecal residues were siphoned out daily before first feeding provided at 08:00 hr and 30% water exchange was done in all the experimental tanks.

The effect of different weaning strategies on stinging catfish larval growth performance was evaluated at 7, 12, 17 and 22 dph. At each sampling day, 5 larvae from each experimental tanks were randomly sampled, and individual total length (TL) and body weight (BW) were measured. Final survival was estimated by counting the animals surviving at the end of the experiment.

Data for survival and growth performance from each group were compared by one-way analysis of variance (ANOVA) followed by Tukey's b Honestly Significant Difference (HSD) method for *post hoc* multiple comparisons, as differences that are significant according to HSD are judged real significant. The accepted level for statistical significance was $P < 0.05$. The mean values of survival is expressed as mean $\pm$ standard deviation of the mean. Statistical analyses were conducted with SPSS (version 21.0, USA).

RESULTS AND DISCUSSION

Optimization of weaning strategies for fish larvae is the basic requirement for improvement of larval rearing practices. In this sense, the effect of the weaning strategy on larval survival is considered as one of the most critical factors for success of larval rearing (Valente *et al.*, 2013). However, weaning age of larvae depends on the development of the digestive system (Kestemont 1995). Co-feeding with live and artificial diet has been reported to improve the larval survival compared to feeding either type of feed alone (Holt, 1993) and helps in weaning of the larvae in a shorter time (Person Le Ruyet *et al.*, 1993). Importantly, in the present study, larval survival in groups weaned after 5 dph (D-5 to D-7) was similar to those groups fed solely on live prey *i.e.* zooplankton (D-1) and *Artemia* (D-2) (Fig 2) and the values ranged from 53.8 to 59.5%. This weaning experiment was carried out using commercial diet with gradual shift from live feed to artificial diet over a period of two days. As effective rearing protocol is required to facilitate the adaptation during weaning of larvae to artificial diet (Rao, 2003), from the findings of the present study, it is assumed that, the weaning process helped in that direction. Previously, in *O. bimaculatus*, (Pradhan *et al.*, 2014) and *Osteobrama belangeri* (Kumar *et al.*, 2018), it has been reported that the larvae weaned after 7 dph showed similar survival rates with those fed just live prey (*Artemia* nauplii or zooplankton). Interestingly, in butter catfish, early weaning before 7 dph resulted in poor survival, however, in the present study weaning before 7 dph did not show significant variation in survival rate.

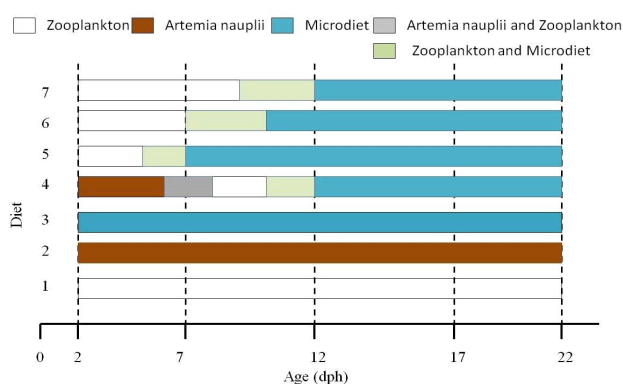


Fig 1: Graphical representation of different weaning strategies varying in food type (*Artemia* nauplii, zooplankton or artificial feed) and duration.

Therefore, it is inferred that the stinging catfish larvae can be weaned after 5 dph and importantly, feeding with only *Artemia* may not be necessary. As there is huge demand for *Artemia* for use as live feed and it is very costly which is beyond the capacity of small-scale hatchery owners, the present study findings are of significance. Although, most of the farmers use zooplankton as alternate source of live feed, but production is more complicated, laborious and expensive compared with the formulated diets, all these constraints limits their prospects of regular use (Hamre *et al.*, 2013; Pradhan *et al.*, 2014). Therefore, weaning of the larvae to artificial diet will reduce their dependence on the live feed. Additionally, in the present study, the larval group fed with diet D-4 (larvae fed with *Artemia* nauplii from 2 to 8 dph, mixed zooplankton from 6 to 12 dph and artificial feed from 10 to 22 dph) had highest survival (62.2%) and larval group fed only with *Artemia* nauplii (D-2) had lower survival rate (59.5%). This indicates that it is not required to feed the larvae continuously with *Artemia*. Higher survival in D-4 group might be due to gradual shift from live feed to artificial feed which might be enhancing the efficacy of artificial diets by promoting the assimilation and utilization of nutrients (Parma *et al.*, 2013, Pradhan *et al.*, 2014).

Although, there was no significant difference in larval survival between different groups, larvae fed solely with *Artemia* nauplii (D-2) showed highest growth performance (101.9 ± 1.2 mg; 38.1 ± 1.2 mm), followed by larvae fed with diet, D-4 (*Artemia* naupli, zooplankton and artificial diet) (67.2 ± 1.5 mg; 34.8 ± 0.7 mm) and larvae fed with solely with the mixed zooplankton (56.6 ± 1.2 mg; 14.5 ± 0.5 mm). On the other hand, larvae fed solely with artificial diet (D-3) showed lowest growth in terms of BW and TL (26.5 ± 0.4 mg; 19.0 ± 1.8 mm) and the growth performance in other weaned groups (D-5, 6, 7) was similar to D-3 group and their values ranged from 33.7 to 36.5 mg (Fig 2) and 20.2 ± 0.4 mm to 20.5 ± 0.6 mm in terms of BW and TL (Fig 3), respectively. The lower growth performance of stinging catfish larvae fed with zooplankton and zooplankton with artificial diet in comparison to those fed *Artemia* nauplii may be attributed to the fact that *Artemia* provides a highly digestible protein source for fish larvae, while zooplankton and other artificial protein sources have a low digestibility (Pradhan *et al.*, 2014, Stejskal *et al.*, 2017). Besides, the variations in nutritional value between both types of live feed might have resulted in differences in growth performance as observed between larvae fed with mixed zooplankton and *Artemia* nauplii (Manickam *et al.*, 2017). In addition, the larvae might have utilized digestive enzymes from *Artemia* nauplii to facilitate the digestion process (Dabrowski, 1984). Similar results have also been reported in *C. gariepinus* where *Artemia* fed group had higher growth rate compared to other diets (Onura *et al.*, 2018). Similarly, in other catfish species such as redbell catfish, *Mystus nemurus* (Kamarudin *et al.*, 2011), butter catfish, *O. bimaculatus* (Pradhan *et al.*, 2014) fed with *Artemia* nauplii showed significantly higher growth performance in comparison to microdiet (Holt *et al.*, 2011).

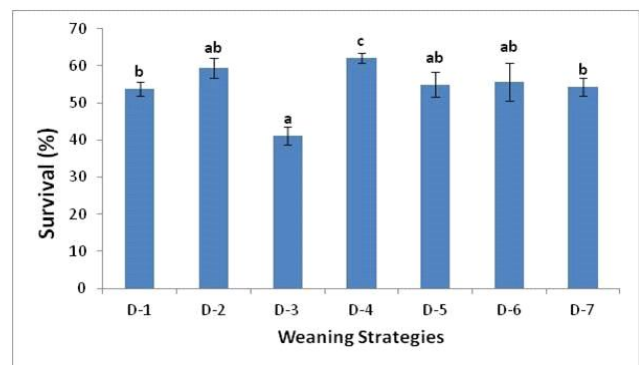


Fig 2: Survival of *H. fossilis* larvae reared under different weaning strategies. Different letters indicate the statistical differences among groups (ANOVA, $P < 0.05$).

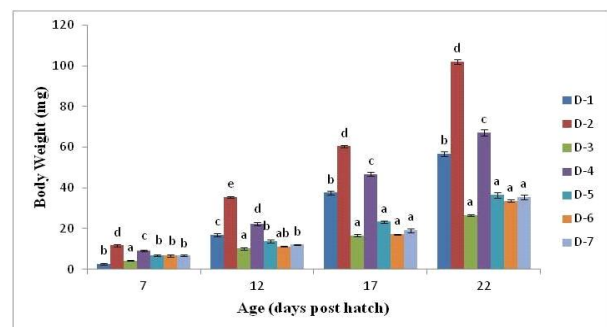


Fig 3: Body weight (mg) of *H. fossilis* larvae reared under different weaning strategies. Different letters indicate the statistical differences among groups (ANOVA, $P < 0.05$).

In addition, Senegalese sole larvae have been reported to grow at a lower rate when fed exclusively with inert diet than when fed on live feed (Yúfera *et al.*, 2003). Early weaning from live feed to artificial diet has been reported to result in reduced growth, mostly because of inability to digest the protein (Rønnestad *et al.*, 2013; Ljubobratovic *et al.*, 2020). It is to be noted that *H. fossilis* larvae are reported to have a morphologically complete digestive tract by 13 dph (Kumar *et al.*, 2019). Therefore, it can be inferred that weaning of larvae before the development of stomach resulted in poor growth. In accordance with our findings, it has been reported that growth of African catfish larvae fed with microdiets was similar to those fed with live food, only after the complete development of stomach (Verreth *et al.*, 1992). Similarly, Campoverde *et al.* (2017) reported that accomplishment of weaning of fish larvae from live feed to artificial diet is dependent on composition of diet and development of digestive system. Therefore, the developmental stages are considered as the most important independent variable affecting growth performance and nutritional conditions of larvae (Andrade *et al.*, 2012).

Although, the larval growth is an important parameter for evaluating the weaning success, survival of larvae is considered as very crucial parameter, since differences in larval size can be compensated at further stages of the rearing process (Valente *et al.*, 2013). Therefore, based on

the present study findings, it can be concluded that it is feasible to rear stinging catfish larvae with zooplankton without dependence upon *Artemia* nauplii and also that larvae may be weaned onto artificial feed after a short period of co-feeding when weaning takes place after 5 dph. As *Artemia* is beyond affordable capacity of most of the rural farmers, the results will be very helpful in larval rearing of one of the important indigenous catfish of the Indian sub-continent.

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