EFFECTS OF SHELTER AND PHOTOPERIOD ON GROWTH PERFORMANCE AND SURVIVAL OF *CLARIAS BATRACHUS* (LINNAEUS, 1758) LARVAE

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Received : 00.0.2015; Accepted : 00.00.2015

Keywords: Shelter, photoperiod, growth, survival, *Clarias batrachus* larvae.

Shelter is a physical structure that an animal uses for protection against physical environment and potential predators. The availability of shelter has been seen to be of extreme importance to the survival of animals. Cryptic or sheltering behaviour has been extensively documented in fishes such as European minnow (*Phoxinus phoxinus*), coho salmon (*Oncorhynchus kisutch*), steelhead trout (*Oncorhynchus mykiss*), Atlantic salmon (*Salmo salar*) and coelacanth (*Latimeria chalumn*). The occurrence of such behaviour has been linked to risk of predation, light intensity and developmental stages. Sheltering behaviour is of great importance at early life stages of fishes (Benhaim *et al*., 2009) because it is beneficial as it can lead to higher survival even when predators were excluded (Smith and Griffith, 1994). A number of other advantages of sheltering behaviour have been reported in the literature including thermal regulation and avoidance of high water flows (Valdimarsson and Metcalfe, 1998), avoidance of anchor ice (Heggenes *et al*., 1993; Whalen *et al*., 1999), protection from light at cold temperatures (Cunjak, 1988; Contor and Griffith, 1995) and reduction in maintenance metabolism (Millidine *et al*., 2006). Extensive studies have been carried out to evaluate beneficial effects of shelter on fish growth and survival (Hossain *et al*., 1998; Qin *et al*., 2004; Marshall *et al*., 2005; Johnston *et al*. 2006; Coulibaly *et al*., 2007; Barcellos *et al*., 2009; Murthy *et al*., 2012; Sahoo *et al*., 2002; Benhaim *et al*., 2009; and Rahmah *et al*., 2013).

C. batrachus (magur) is one of the promising cultivable air-breathing catfish in Asian countries with a production ranging from 20 to 100 t ha^{-1} (Thakur and Das, 1986; Areerat, 1987). Non-availability of quality seed is the major constraint to the wide spread aquaculture of this species. During larval rearing phase, larvae are very delicate showing cryptic behaviour and such behaviour might be advantageous if properly explored. No scientific literature on use of shelter in larval rearing of *C. batrachus* is available. Hence, the present study was attempted to evaluate the effects of shelter and photoperiod on growth and survival of *C. batrachus* larvae.

The study was carried out in the catfish hatchery unit of ICAR - Central Institute of Freshwater Aquaculture, Bhubaneswar, India. Nine uniform sized circular plastic tubs (20 L capacity) were used for the study. The tubs were maintained with filtered water up to 6 inch height making total volume to 15 L. Aeration was provided from air-blower through air tubes and stones at centre place of each tub. The 3 days old 195 larvae of *C. batrachus of* average length and weight of 9.44 ± 0.13 mm and 5.6± 0.27 mg respectively, were stocked randomly into triplicate tubs for each treatment group with equal biomass. Larvae were subjected to three shelter treatments as follows: T0 (control, no shelters); T1 (broken mud pots) and T2 (black polythene sheet made covering at 10 cm height above the tank). Having siphoned off in the morning at 8.00 A.M., the water exchange in the experimental units was done at 75 % of volume and subsequently larvae in all the experimental groups were fed *ad libitum* with live mixed zooplankton, predominantly consisting of copepods, rotifers, cladocerans and ostracods procured daily by netting from a pond over a period of 14 days. Sampling was carried out at the end of the experiment for assessment of growth performance (final length, final weight, length gain %, weight gain % and specific growth rate (SGR)) and survival. Twenty five fish from each tub were taken as the sample size for estimation of growth increment

$$\text{Length gain \%} = \frac{\text{(final length – initial length)}}{\text{(initial length)} \times 100},$$

$$\text{Weight gain \%} = \frac{\text{(final weight – initial weight)}}{\text{(initial weight)} \times 100},$$

Specific growth rate (SGR) =100 ($\log_e$ average final weight $-\log_e$ average initial weight) / number culture days.

while larvae were counted for estimation of survival using standard formulae as Survival (%) = (total number of animals harvested/total number of animals stocked) X 100. Water from each tub was sampled between 7.00 and 8.00A.M. at every alternate day and analysed for monitoring of important physico - chemical parameters such as pH, total alkalinity, free CO_2, ammonia nitrogen, nitrite-nitrogen and nitrate-nitrogen, following standard methods (APHA, 1998). While the water temperature and dissolved oxygen were recorded using dissolved oxygen meter (MERCK, Germany), for all the experimental units during the morning (6:00A.M.) and evening (6:00P.M.) The data on growth performance and survival were subjected to statistical analysis using SPSS v.16. Duncan's Multiple Range Test was performed at 95% significance level to compare the treatment means for different parameters.

Water quality parameters such as temperature, dissolved oxygen, pH, free CO_2, alkalinity, total ammonia nitrogen, nitrite and nitrate are depicted in Table 1. Water quality parameters were found in the optimum range required for the larval rearing of *C. batrachus* (Sahoo *et al*., 2008, 2010). The effect of shelter on growth performance and survival of *C. batrachus* larvae is presented in Table 2. The provision of shelter in larval indicated rearing significant ($P<0.05$) improvement in growth performance and survival of larvae. The significantly high growth parameters such as final length, final weight, length gain, weight gain, specific growth rate and survival were found to be in T2 (black polythene sheet covered at 10 cm above the tank surface) as compared to T1 (pieces of broken mud pots) and control (no shelter). Further, pieces of broken earthen pots (T1) as shelter showed significant ($P<0.05$) improvement in growth performance and survival compared to control (T0).

Table 1. Water quality parameters observed during the experimental period

Sl. No.	Parameter	Range
1.	Temperature (ºC)	27.6 to 28.3
2.	pH	7.25 to 8.17
3.	Dissolved oxygen (mg L^{-1})	6.15 to 7.27
4.	Free CO_2 (mg L^{-1})	Nil
5.	Alkalinity (mg L^{-1})	111 to 130
6.	Total ammonia (mg L^{-1})	0.13 to 0.36
7.	Nitrite-N (mg L^{-1})	0.016 to 0.023
8.	Nitrate-N (mg L^{-1})	0.24 to 0.30

Table 2. Effects of shelters on growth parameters of *C. batrachus* larvae after 14 days (means± S.E, n=3)

	Growth parameter							
Treatment	Initial length (mm)	Initial weight (mg)	Final length (mm)	Final weight (mg)	Length gain (%)	Weight gain (%)	Specific growth rate (% d^{-1})	Survival (%)
Control (T0)	9.44±0.13^a	5.61±0.27^a	15.05±0.05^a	21.05±0.40^a	59.48±0.53^a	275.30±7.06^a	9.24±0.19^a	74.53±1.34^a
T1	9.44±0.13^a	5.61±0.27^a	16.67±0.14^b	31.27±0.85^b	76.55±1.44^b	457.67±15.21^b	12.03±0.23^b	83.59±0.78^b
T2	9.44±0.13^a	5.61±0.27^a	17.88±0.35^c	36.23±1.90^c	89.44±3.67^c	546.07±33.98^c	13.14±0.40^c	85.30±2.10^c
	One way ANOVA							
P value	0.000	0.000	0.00028	0.00034	0.00028	0.00034	0.000199	0.00482

The provision of shelter significantly improved growth performance and survival of *Mystus nemurus* larvae (Rahmah *et al*., 2013), *Macrobrachium rosenbergii* (Mamun *et al*., 2010), *Salvelinus alpinus* (Benhaim *et al*., 2009), *Paralichthys olivaceus* (Dou *et al*., 2003). It was generally believed that shelter was likely to improve growth by increasing their time of resting in shelter and promote survival by reducing aggressive interaction among individuals under laboratory conditions (Hecht and Appelbaum, 1987). In the present study, it was observed that *C. batrachus* larvae provided with shelter were at resting phase (comparatively immobile) whereas larvae in the control were moving and trying to hide below the air stone provided for aeration. Hiding behaviour in *C. batrachus* is probably due to stress caused by exposure to light (Srivastava and Choudhary, 2010). Similarly, Hossain *et al*. (1998) also reported the beneficial effect of shelter and low light during rearing of *Clarias gariepinus* fry and fingerling in hatcheries. Millidine *et al*. (2006) reported that the presence of appropriate shelter not only reduces the risk of predation but also provides a metabolic benefit to fish that is likely to have implications for growth performance and activity budgets. Benhaim *et al*. (2009) suggested improved performance in yolk-sac alevins of Arctic char related with reduced metabolic cost due to immobility provided with shelter. Several authors have demonstrated that individual survival probability is closely linked to the ability to retain latent stored energy above critical levels (Biro *et al*., 2004; Finstad *et al*., 2004). The growth and survival were significantly higher in T2 than T1 that might be due to difference in available sheltered area in both the treatments. Mercy and Shankaran (1992) also observed shelter with more area for hiding improved performance in *M. rosenbergii*.

The results of present study showed that black polythene sheet covered at 10 cm above the tank surface as shelter would be beneficial for improvement of growth performance and survival of *C. batrachus* larvae. The effect of shelter was evaluated in small plastic tubs (20 L), however, further studies can be undertaken to evaluate the effects of these shelters in larger tanks for mass production of fry.

CONCLUSION

A study was carried out to investigate the effects of addition of shelter and photoperiod on growth performance and survival of larvae of *C. batrachus* during larval rearing. The larvae of *C. batrachus* subjected to three shelter treatments are as follows: T0 (control, no shelter); T1 (pieces of broken mud pots) and T2 (black polythene sheet put at 10 cm height above the tank surface). Provision of shelter led to significant ($P<0.05$) improvement in growth performance and survival of larvae compared to control. The highest growth parameters such as final length, final weight, length gain, weight gain, specific growth rate and survival were found in T2 (black polythene sheet covered at 10 cm above the tank surface) as compared to T1 and control. Further, all the growth parameters were significantly ($P<0.05$) higher in T1 than control (T0). From this study, it was concluded that provision of black polythene sheet at 10 cm above tank surface as shelter would improve growth and survival of *C. batrachus* larvae.

ACKNOWLEDGEMENT

The authors are highly grateful to Director and Vice-chancellor, ICAR-Central Institute of Fisheries Education, Mumbai and Joint Director, Central Institute of Fisheries Education, Mumbai, India for their co-operation and encouragement during the study. Authors also express their sincere thanks to the Director, ICAR- Central Institute of Freshwater Aquaculture, Bhubaneswar, India for his kind help.

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