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# High Survival Rates of Sutchi Catfish, *Pangasianodon hypophthalmus*, Larvae Reared under Dark Conditions

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## ABSTRACT

The sutchi catfish, *Pangasianodon hypophthalmus* is an important species for aquaculture in Southeast Asia. However, the larvae demonstrate a low survival rate due to their strong cannibalism during rearing. The aim of the present study was to reduce their cannibalism and improve larval rearing methods. Larval rearing experiments were conducted under normal light conditions (following a diel rhythm) and continuous dark conditions with larval densities of 10, 20 and 40 individuals $L^{-1}$ from hatching day to 20 days old. The trial with 10 individuals $L^{-1}$ under dark conditions had the highest survival rate. The dark conditions with lower individual densities tended to produce higher survival rates than the light conditions with higher individual densities. Fish body weight on the final day of larval rearing showed that rearing larvae under dark conditions resulted in steady growth similar to growth under light conditions. It seemed that the feeding behavior of sutchi catfish depended on chemo-sense rather than visual sense. This study showed that the cannibalism of sutchi catfish larvae can be reduced by rearing under dark conditions at low densities with adequate access to food. Therefore, it was concluded that rearing under dark conditions is a method for reducing cannibalism and increasing survival rates.

**Key words:** Cannibalism, catfish larvae, chemo-sense, rearing experiments, taste buds

## INTRODUCTION

The sutchi catfish, *Pangasianodon hypophthalmus* (synonym, *Pangasius hypophthalmus*), is indigenous to originates from an area extending from the Mekong River basin in Vietnam to the Chao Phraya River in Thailand (Roberts and Vidthayanon, 1991; Rohul Amin *et al*., 2005). The sutchi catfish is widely cultured in Asian countries including Vietnam, Malaysia, Indonesia, Laos, Cambodia and China (Roberts and Vidthayanon, 1991; Rohul Amin *et al*., 2005; Subagja *et al.,* 1999; Chheng *et al*., 2004; Ali *et al*., 2005). Commercial production of sutchi catfish has increased recently because of its popularity in the market, rapid growth and omnivorous feeding habits (Chheng *et al*., 2004; Ali *et al*., 2005; Rohul Amin *et al*., 2005). Cultured sutchi catfish production in the region is considerable and Vietnam is the largest sutchi catfish producing country in the region (Phan *et al*., 2009). In 2007, Vietnam's total production of catfish was 1,200,000 tons, of which 95-97% was sutchi catfish (Phuong and Oanh, 2009). However, the larvae still show a low survival rate due to their strong cannibalism in the hatcheries (Ali *et al*., 2005; Baras *et al*., 2010; Slembrouck *et al*., 2009; Subagja *et al*., 1999).

In the case of African catfish, *Clarias gariepinus* and channel catfish, *Ictalurus punctatus*, there are extensive studies a bout feeding behavior (Hossain *et al*., 1998; Valentincic *et al*., 1994). The larvae and juveniles of African catfish show nocturnal feeding behavior. They have the ability to feed under dark conditions and they can be reared under dim light or dark conditions (Hossain *et al.*, 1998; Appelbaum and Kamler, 2000). This means that feeding under dark conditions must be dependent on chemo-sensory organs other than the eyes. Hecht and Appelbaum (1988) conducted behavioral experiments with African catfish larvae that showed the ingestion rate of the larvae with barbels removed was lower than in the control group and the eye-cauterized group. Mukai *et al.* (2008) demonstrated that African catfish have numerous taste buds and assumed that the taste buds play an important role in their feeding behavior. Channel catfish larvae also can detect food using taste buds and olfactory organs (Valentincic *et al.*, 1994). Sutchi catfish larval rearing has been studied (Subagja *et al.*, 1999; Rohul Amin *et al.*, 2005); however, larval survival rate under dark conditions has not been investigated.

African catfish larvae exhibit high levels of cannibalism; however, it has been demonstrated that cannibalism can be reduced if sufficient food is provided or if the larvae are reared under dark or dim light conditions (Hossain *et al.*, 1998; Appelbaum and Kamler, 2000). In a earlier study (Mukai *et al.*, 2010), sutchi catfish were also found to have numerous taste buds on the surface of their skin. According to Mukai *et al.* (2010), sutchi catfish larvae can ingest *Artemia* under dark conditions, but it is not known if sutchi catfish can be reared successfully under dark conditions and if their cannibalism can be reduced. Therefore, this study sought to elucidate the effects of dark conditions on reducing cannibalism and improving survival rates.

## MATERIALS AND METHODS

**Larval specimens:** Fertilized eggs of sutchi catfish, *P. hypophthalmus,* were obtained from the brood fish reared in a hatchery at the Borneo Marine Research Institute, Universiti Malaysia Sabah in 2008. The eggs hatched 24 h after artificial fertilization. The larvae were reared in a 10 ton fiber-reinforced plastic tank with sufficient aeration and a water temperature of 28-30°C. From the second day after hatching, the larvae were fed with rotifers (*Brachionus* sp.) and *Artemia nauplii.*

**Larval rearing experiments:** Groups of 50 (larval density, 10 individuals $L^{-1}$), 100 (20 individuals $L^{-1}$) or 200 (40 individuals $L^{-1}$) individuals of newly hatched larvae were introduced into 5-L plastic aquaria in triplicate. Each group was reared under conditions following a diel cycle (hereafter referred to as light conditions, n = 1.050) or under continuously dark conditions (hereafter referred to as dark conditions, n = 1.050). The larvae of the light condition groups were reared under 400-1300 Lux during the daytime under sunlight (about 12.5 h) with a roof and under no light at nighttime (about 11.5 h, less than 0.01 Lux). The larvae of the dark condition groups were reared continuously under 0.00 Lux (measured by Light Meter No. 40103, Extech Instruments Co.) in aquaria covered by black plastic sheets. The same amount of *Artemia* was fed to them twice per day and some of *Artemia* remained at the next feeding time. The water in the aquarium was changed once per day. Water temperature during experiments was 26.5-27.5°C. The aquaria were exposed to light for less than 10 min when the water was changed. The larvae remaining in each aquarium were counted and weighed at 20 days after the beginning of the rearing experiments. A two-way ANOVA was performed on lighting conditions (light or dark) and larval densities in the rearing experiments using a SPSS Ver17.

## RESULTS

**Survival rates:** Survival rates under light and dark conditions are shown in the Fig. 1. The survival rates in dark conditions tended to be higher than in light conditions and the survival rates of lower individual densities were higher than higher individual densities.

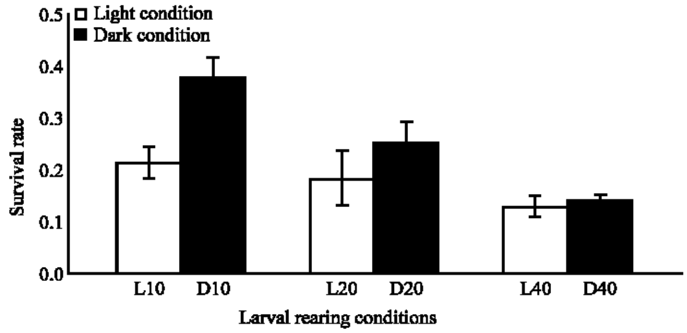


Fig. 1: Survival rates of larval rearing experiments. Larval density: 10, 20, 40 individuals $L^{-1}$. L: Light conditions (following diurnal cycle), D: Dark conditions (continuous dark conditions)

Table 1: Results of two-way ANOVA of survival rates under different lighting conditions and densities

| Source of variation | df | MS | F-value | p-value |
|---|---|---|---|---|
| Lighting conditions | 2 | 0.038 | 32.763 | <0.01 |
| Density | 1 | 0.031 | 26.659 | <0.01 |
| Light or dark×density | 2 | 0.009 | 7.692 | <0.01 |
| Error | 12 | 0.001 | | |

Table 2: Results of multiple comparison test.

| Individual | Light | Individual | Dark |
|---|---|---|---|
| 10 | 20 | 10 | 20** |
| | 40* | | 40** |
| 20 | 10 | 20 | 10** |
| | 40 | | 40** |
| 40 | 10* | 40 | 10** |
| | 20 | | 20** |

Bonferroni post hoc test in each lighting condition, respectively. **p<0.01, *p<0.05

Two-way ANOVA analysis (Table 1) also showed significant differences among different lighting conditions (light or dark conditions) as well as different individual densities. However, there was an interaction between the factor of individual densities and the different lighting conditions. Therefore, the lighting conditions and individual conditions with the significant difference could not be determined.

Post hoc analysis (Table 2) could not be applied to the lighting conditions because there were only two conditions: light and dark. Bonferroni post hoc analysis was performed to determine the differences in survival rate of individual densities under each lighting condition. Under the light conditions, there was a significant difference between the 10 individuals and 40 individuals (p<5%). Under the dark conditions, there were significant differences among 10, 20 and 40 individuals (p<1%).

The results of the statistical analysis were not entirely clear. However, there were tendencies for the dark conditions to have higher survival rates than the light conditions and for the lower individual densities to have higher survival rates in each lighting condition than higher individual densities.

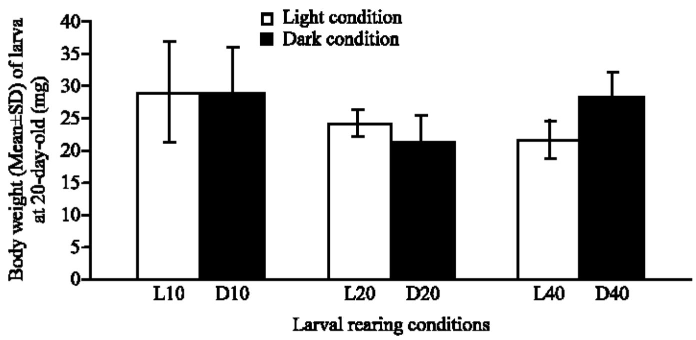


Fig. 2: Mean body weight of larvae under each condition (mg). Larval density: 10, 20, 40 individuals $L^{-1}$. L: Light conditions (following diurnal cycle), D: Dark conditions (continuous dark conditions)

Table 3: Results of two-way ANOVA of larval body weight under different lighting conditions and densities

| Source | df | MS | F-value | p-value |
|---|---|---|---|---|
| Lighting conditions | 1 | 13.892 | 0.601 | 0.453 |
| Density | 2 | 54.637 | 2.364 | 0.136 |
| Lighting conditions×density | 2 | 26.807 | 1.16 | 0.346 |
| Error | 12 | 23.111 | | |

**Larval body weight:** Body weights of 20-day-old larvae reared under light and dark conditions are shown in Fig. 2. Fish body weights were almost the same under light and dark conditions and the conditions of different individual densities. A two-way ANOVA (Table 3) showed no significant difference in the factors of lighting conditions and larval density and no interaction between the two factors.

## DISCUSSION

Statistical analysis of survival rates of the larval rearing experiments did not elicit clear results (Table 1). However, the survival rate of 10 individuals $L^{-1}$ density under dark conditions was obviously higher than the same density under light conditions. Moreover, there were tendencies for the dark conditions and lower individual densities to generate higher survival rates than the light conditions and higher individual densities (Fig. 1).

There was no significant difference between the body weight of larvae under light and dark conditions or individual densities (Table 3). Therefore, rearing larvae under dark conditions allowed steady growth similar to growth under light conditions.

Earlier studies demonstrate that larvae or juvenile African catfish can be reared under continuously dark conditions and survival rates under the dark conditions are higher than in other conditions such as continuous light and alternately light and dark conditions (Britz and Pienaar, 1992; Appelbaum and Mcgeer, 1998; Hossain *et al.* 1998; Appelbaum and Kamler, 2000; Almazan-Rueda *et al.* 2004; Adewolu *et al.*, 2008). The results of the present study of sutchi catfish coincide with these studies.

The African catfish larvae detect food using numerous taste buds located on the skin surface and in the buccal cavity (Mukai *et al.*, 2008). Mukai *et al.* (2010) also suggested that the sutchi catfish larvae had many taste buds on the barbels and body surface. The taste buds play an important role in the feeding behavior of sutchi catfish larvae. In the case of channel catfish, intact larvae can detect food with longer time than anosmic fish with taste alone (Valentincic *et al.*, 1994). Although, the feeding behavior of channel catfish larvae is complicated, snapping and biting behavior occur by taste stimuli. The present study could not identify which sense plays the most important role in feeding behavior; however, according to Kiyohara and Tsukahara (2005), taste buds play an essential role in feeding behaviors such as searching for food and placing food in the mouth.

The larval rearing of sutchi catfish still presents the problem that the larvae demonstrate a high level of cannibalism (Ali *et al.*, 2005; Baras *et al.*, 2010; Slembrouck *et al.*, 2009; Subagja *et al.*, 1999). Methods that can reduce cannibalism are required for sutchi catfish production. The present study suggests that sutchi catfish larvae can be reared under dark conditions with adequate feeding to increase larval survival rates. Therefore, larval rearing under dark conditions should be one of methods used to solve the problem of larval cannibalism.

## CONCLUSION

There is no previous study about sutchi catfish larval rearing under dark conditions. This study provided new finding that reared larvae under dark condition showed higher tendency of survival rate than under light conditions. This study recommends new larval rearing methods of sutchi catfish to increase survival rates.

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