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Significance of light intensity to enhance the colour of marine ornamental fish *Amphiprion clarkii* (Bennett, 1830) in captivity

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ABSTRACT
In this present study imperative to develop a method for maintaining healthy and attractive colourful fishes within short duration by provide high light intensity to clown fish *Amphiprion clarkia.* the single batch of juveniles (n=100) were selected with an average length of 2.0 ±0.2 mm and average weight of 0.31± 0.02 g with sea anemone *Stichodactyla haddoni* (n=2). Optimum water quality parameters were maintained as Temperature-27±2 ^{0}C, Salinity-28±1 ppt, NH_4-0.001 ppm, Dissolved oxygen- >6.0±1 ppm, pH-7.7±0.2 photoperiod (12L: 12D) and water depth-1.5±0.2 m. 1000 L FRP tank and rectangular aquaria filled with 500 L water of estuarine water in a recirculating system treated with a biofilter and mechanical filter. A screen mesh was used on the outlet pipe in the aquarium to prevent fish escaping. Light intensity was maintained as 2700-3500 lux by Three white colour tube light was fixed on top of the tank with photoperiod of 13L:11D. Experimental fish of *A. clarkii* 50 numbers were placed in each tank. The result of these experiments shows Feeding motivation and it was based on the latency to begin feeding, which was defined as the time taken to start swimming towards food or to the first of food. From the current study, it was found that fast feeding (first snatch pellets occurring in 10 seconds or less) was more frequent in fish in colour lights. The experiment II demonstrated that after 10-15 days the lighting tank fishes colour was changed gradually from light brown with white bars to dark black with milky white bars and weight also, which indicates the light is responsible for growth and colour but in case of experiment I normal colour was occurred and the growth was slowly improved. Within 55-60 days after the juveniles got marketable size of 3.5±0.2 cm in experiment II but in experiment I it took around 90-95 days. Result of the experiment I showed variations in the growth and weight and morphologically miss bends was observed due to nutrients deficiency, but in the case of experiment II showed more colour, growth and no much variations in the growth patterns. The present study showed that ambient light intensity could change colour traits not only on the major body but also on fins. Growth functions obtained from light indicates (weight gain, specific growth rate and daily growth rate) of clown fish have better performances in white light compared to open water culture. In this context main theme of this paper was improving the colour patterns of *A. clarkii* to upsurge the marketable value by light intensity for crop a different colour verities as black, orange and brown.

Keywords: *Amphiprion clarkii*, Light intensity, Colouration, FRP (Fiberglass Reinforced Plastics).

1. Introduction
Most of the fish was small in size, having attractive colors and shape like clown fishes. Their movements were gentle and quiet without causing any sound into the water environment. They have adaptability to live within a confined space in captivity. The art of rearing and keeping fishes in an aquarium was an age-old practice. At the dawn of the 21st century fish keeping is reflected in ubiquitous aquaria that feature as an integral part of modern interior decoration [1]. Culturing of anemone fishes in hatchery contains minimum challenges as compared to other marine fishes. There were many breeding experiments conducted successfully on different species of clownfish [2-7]. But Colour is the one of the major factors, which determines the price of aquarium fish in the world market [8].
Fish are coloured in nature often show faded colouration under intensive culture conditions. Fish like other animals do not synthesize carotenoids and depend on dietary carotenoid content for the colouration. Hence, a direct relationship between dietary carotenoids and pigmentation exists in them [9]. The effect of fish colour due to environmental conditions such as light, feeding have been increasingly studied during this century, particularly after the first publications of endocrine modulation by light colour [10]. The previous studies shows the effect of light colour on fish mostly involve production variables, such as growth [11-14], feeding [15],

reproduction [10], stress [12], and survival [16]. Aquaria made of glass or Fiberglas is usually used in ornamental fish rearing or experimental studies in indoor systems.

Each of these has certain advantages and disadvantages compared with each other. Glass aquarium is more luminous and costs less than fiberglass one while the latter has a certain background colour, lighter, stronger and better insulators than the glass one. Although, there are some documents dealing with the influences of light and background colour, some of which are related to transparent or opaque features of glass or fiberglass aquarium, nothing is known about the effects of these aquarium types on growth and pigmentation of fish [17]. However, the colour of farmed clown fishes is less attractive than their congener sourced from the wild [18]. Carotenoid composition in the integument has the potential to change the clownfish from yellow orange to orange pinkish when the fish were moved to wild to indoor tanks, but the lighting conditions were not examined [19].

It has been demonstrated that, under a given lighting condition, temporary colour changes can lead to a long term colour change [20, 21]. Barry and Hawryshyn suggested that light intensity could change pigmentation in coral reef fishes, but no study has been conducted on clown fishes to examine the relationship between colour performance and light intensity [22]. Light intensity has been reported to have profound influence of larvae and juvenile growth as well as survival in cod and haddock (*Melanogrammus aeglefinus*) [23]. Light intensity may affect swim bladder inflation in fishes [24], and optimal light intensity for feeding and growth varies among fish species [25].

Light intensity may modulate food searching activities [26], and thereby influence of larval foraging success. The present study investigated the effect of light on fish growth, survival and colouration because colour is an important criterion on ornamental fishes to increase the trade value. Overall among the commercially traded families of reef fishes, Pomacentridae dominate, accounting for nearly 43% [18]. The current study was conducted with clarkii clown *A. clarkii* is the one of the ornamental fish usually it has a black colour with variable amount of orange on head, ventral parts and fins and three milky white bars on head, body and base of caudal fins. These fishes have some remarkable behavioral characteristics such as symbiotic association with sea anemones [27].

2. Materials and methods

2.1. Experimental design and species selection

The experimental setup (I and II) was made at the marine ornamental fish hatchery, CAS in Marine Biology, Annamalai University. A single batch *Amphiprion clarkii* juveniles (n=200) were selected with an average length of 2.0 ±0.2 mm and average weight of 0.31± 0.02 g. Optimum water quality parameters were maintained as Temperature-27±2 ^{0}C, Salinity-28±1 ppt, NH_4-0.001 ppm, Dissolved oxygen- >6.0±1 ppm, pH-7.7±0.2 and photoperiod (12L:12D). They were fed with artificial pellets, boiled shrimp and clams meet at thrice a day with time 07:00, 11:00, 16:00 and a water exchange of 20-30% per day. Organic wastes were removed regularly. Depth of the tank was 1.5±0.2 meters with sea anemone *Stichodactyla haddoni* (n=2).

2.2. Experiment I (FRP tank) open system

1000 L FRP tank was selected and filtered estuarine water (500 L) was filled. Experimental fish of *A. clarkii* 100 numbers were accumulated in the tank with optimum physiochemical parameters and sun light was used as a light source while culture period.

2.3. Experiment II (lighting tank) closed system

The experiment was conducted in rectangular aquaria filled with 500 L water. An aquarium was supplied with estuarine water in a recirculating system treated with a biofilter and mechanical filter. A screen mesh was used on the outlet pipe in the aquarium to prevent fish escaping. Light intensity was maintained as 2700-3500 lux by three white colour tube light was fixed on top of the tank. Experimental fish of *A. clarkii* (*n*=100) were placed in the tank with optimum physiochemical parameters.

Fig 1: A. Fishes from FRP tanks showed uneven size. B. Identical size, Gorgeous colour was observed in lighting tank. C. Miss-bands and abnormal size fishes in FRP tanks. D. Normal growth and light colour from FRP tank.

3. Result

The results obtained of these study trials indicated that weight gain and colour was affected significantly by light. Light intensity motivates high feeding capacity compared to experiment I, experiment II was consumed high feed of all the three times. From the current study, we found that fast feeding (first snatch pellets occurring in 10 seconds or less) was more frequent in fish in colour lights. In experiment I the fishes not evenly taken feed the bigger one had high feed than the smaller and fitting was observed because of size variations (2.2 to 3.2 mm).

The experimental juveniles were matured (length and weight) before placed into lighting tank and FRP tank. Continually the growth and weight was identified by weekly once with weighing gage (Eagle, china) and scale (Camel, India). The experiment II demonstrated that after 10-15 days the lighting tank fishes were changed the colour gradually from light brown with white bars to dark black with milky white bars, which indicates the light is responsible for growth and colour but in case of experiment I normal colour was occurred and the growth was slowly improved. Melanin is the one of the major pigments which responsible for black colour that pigments were more dominant in lighting tank and in FRP tank no black colour bands or body parts were observed.

Within the short duration of 55-60 days after the juveniles got marketable size of 3.5±0.2 cm in experiment II but in experiment I it took around 90-95 days. The result of the experiment I showed variations in the growth and weight and morphologically miss bends was observed due to nutrients deficiency, but in the case of experiment II showed more colour, growth and no much variations in the growth patterns as per formula.

4. Discussion

There were many breeding experiments conducted successfully on different species of clownfish [5-7]. However, there would be certain limitations in culture practices of anemone fish in private aquaria. The present study was analyzed about Significance of light intensity for colour of marine ornamental fish *Amphiprion clarkii* in captivity. Some the researches like Puvanendran and Brown; Vinoth *et al* demonstrated that photoperiod was influenced the growth of larvae and juveniles [23, 28], but current study proved that different photoperiod gives only growth not colour patterns and respectively light intensity influences the colour of ornamental fishes that was evidenced with this current investigation. Manipulation of light intensity has been shown to influence growth, survival, or feeding of many larval teleosts [29-31].

This present study examines the colour as well as growth rates of juveniles under light intensity regimes, because all anemone fishes are visual feeders [32, 33]. Colour and size of the fish was the important peculiarity for ornamental fish trade. According to Swagat gosh *et al* wild caught of *A. clarkii* clown contains black colour with variable amount of orange on head, ventral parts and fins and three milky white bars on head, body and base of caudal fins [34] but in case of experimental fishes in hatchery entails different colour than wild. The present study showed that ambient light intensity could change colour traits not only on the major body but also on fins.

Growth functions obtained from light indicates (weight gain, specific growth rate and daily growth rate) of gold fish have better performances in white light compared to red light and the effects of the light spectrum on several aspects of fish physiology have been investigated [35]. It has been generally accepted that light and background colour have a significant effect on pigmentation of fish [36-38] for example dark background increased significantly the degree of pigmentation in juveniles Atlantic cod compared to pale background [37, 39]. As for colour assessment, the result indicates that a higher black and orange colouration and a lower lightness were obtained on the skin of *A. clarkii* reared in lighting tanks compared to those in FRP tanks. The effect of light colour on growth performance has been proved which is different based on type of species and stage of life in fish. Fish are capable of colour vision [40].

The main role in this process is played by the eyes and pineal organ, because only they can detect colours [41] not light. For instance, the results of experiments by Rurchin demonstrated that species of fish can have different response to light quality [42]. In current study was performed in hatchery to identify the growth and colour differences between FRP tanks and lighting tanks, because the peoples were used to culture in FRP tanks and glass tanks but not in lighting tanks. Most species of anemone or clown fishes have well developed colour sight, and are therefore very sensitive to colour light, but the result indicates lighting tank that white light was responsible for growth and colour performance.

Briefly, with the increasing demand for the captive-produced marine ornamental fish, particularly clown fishes was successfully reared in captivity by using brackish water. In this context main theme of this paper was improving the colour patterns of *A. clarkii* to upsurge the marketable value by light intensity for crop a different colour verities as black, orange and brown. The effect of light intensity is species specific. Some species benefited from higher light intensities, e.g., sand whiting, *Sillago ciliata* [43], whereas some perform better under low light intensity, e.g., African catfish [32]. The conclusion of this study is *A. clarkii* juveniles colour enhancing and high growth was observed by light intensity.

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