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Note

Impact of increase in temperature and light intensity on development and metamorphosis of hatchery reared silver pompano *Trachinotus blochii* (Lacepede, 1801) larvae

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ABSTRACT

The impact of increase in temperature and light intensity on development and metamorphosis of hatchery produced larvae of silver pompano *Trachinotus blochii* (Lacepede, 1801) was studied. Two sets of larviculture tanks (Set 1 and Set 2) in triplicate were exposed to two different temperatures and varying light intensities. The growth of the larvae from day one to day 25 post-hatch (dph) and metamorphosis were studied. It was found that an increase of 2°C water temperature and increased light intensity significantly reduced the growth. The percentage of growth reduction gradually decreased and got stabilised towards the end of larviculture with a mean reduction of 15%. Further, a delay of three days in metamorphosis was also observed in Set 2. The reduced growth rate coupled with change in pigmentation of larvae can be considered as the resilience response of the larvae to combat temperature and light stress without compromising survival.

Keywords: Larval growth, Light intensity, Metamorphosis, Silver pompano, Temperature

Fishes, being poikilotherms, are directly influenced by changes in environmental parameters of the surrounding water. Among the ecological factors, water temperature is vital especially during embyrogenesis and larval development of marine fishes (Aldanondo *et al.*, 2008; Guan *et al.*, 2008; Villamizar *et al.*, 2009; Blanco-Vives *et al.*, 2010; Ostrowski *et al.*, 2011; Villamizar *et al.*, 2011). The anticipated seawater temperature rise due to climate change in future years can adversely affect the eggs and larvae of many species of fishes. Hence, it is probable that some of the existing commercial fisheries also may get affected due to climate change. In this context, selection of species having larvae with resilience for elevated temperature will be useful for development of farming practices which would be necessary for compensating the anticipated scarcity of fish due to climate change.

The silver pompano *Trachinotus blochii* (Lacepede, 1801) is one of the suitable candidate fish species for marine and brackishwater aquaculture due to its fast growth rate, good meat quality, high market demand and good adaptability to different farming environments (Jayakumar *et al.*, 2014). Realising the potential of the species for farming, the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), at its Mandapam Regional Centre, prioritised this species for captive breeding and seed production. The species was selected for investigating the effect of increased temperature and light intensity on development and metamorphosis of hatchery produced silver pompano.

Newly-hatched larvae obtained from the same brood of *T. blochii* were collected from the hatchery for the study. Rectangular fibre reinforced plastic (FRP) tanks (yellow colour) of 2 t capacity with 1 t filtered seawater were used. Approximately 5000 nos. of larvae were stocked in each tank at a stocking density of 5 larvae per litre. The larval rearing protocols were followed as per Nazar *et al.* (2012).

Set 1 tanks in triplicate was considered as control and were placed in the hatchery in such a way that they were not exposed to direct sunlight and the impact of sunlight was minimal. The second set of tanks (Set 2) in triplicate were placed in the hatchery exposed to direct sunlight for the entire day. The larvae were stocked in both the sets of tanks on first day post-hatch (dph). The study was carried out upto 25 dph which is the actual larviculture period.

A random sample of 10 larvae were collected from each tank (30 larvae per set) and placed in a beaker at 15:00 hrs every day. Larvae anesthetised with MS-222

(200-300 mg l^{-1}, Rombough, 2007) were observed under a stereozoom microscope equipped with an eyepiece micrometer. Colour of the larvae was observed from a clear contrasting background and total length (nearest to 0.01 mm) of the larvae were also measured. The larvae sampled were not returned to their original tanks after measurements to avoid handling related mortality.

Temperature (°C) and light intensity (LUX) were recorded at regular intervals twice daily during the entire study. Growth/development was recorded daily in terms of total length of the larvae. Data on larval length were analysed with univariate general linear model and the data on larval colour with multinomial logistic regression. The statistical analyses were carried out using the SPSS 20.0 statistical package (SPSS Inc., USA).

Results of the observation are presented in Table 1. The mean daily temperature recorded in Set 1 and Set 2 tanks were 29.0±0.2 and 31.0±0.2, respectively. The light intensity ranged from 1910 to 4450 lx and 2200 to 7160 lx in Set 1 and Set 2 tanks respectively. All the other parameters and feeding schedule were kept at optimum levels in both set of tanks. Statistical analysis revealed that temperature and light intensity together had high significant effect ($p<0.01$) on growth as well as change in pigmentation of the larvae. Average increase of 2°C in water temperature and increased light intensity in Set 2 resulted in reduced growth of about 10 to 33% from 7 dph to 12 dph. Subsequently, the reduction percentage gradually decreased and stabilised at around 15% from 21 dph onwards. The overall reduction of growth in terms of length at the end of the study was 15% in Set 2. It was observed that the maximum reduction of length due to stress induced by high temperature and light was in the mid phase of larviculture period *i.e.,* 10 to 15 dph. After 15 dph the percentage of reduction gradually decreased and got stabilised which indicates the resilience of the species (Fig. 1). Metamorphosis was observed on 18 and 21 dph in Set 1 and Set 2, respectively. A delay of three days was noted in metamorphosis of Set 2 fishes compared to Set 1. The pattern of larval pigmentation in Set 2 was observed to vary from translucent white (8 to 14 dph) to brown (15 to 20 dph) eventually to silver (21 dph onwards) compared to the pigmentations in Set 1 which remained black all through the larval phase till metamorphosis (Fig. 2a to f). The number of larvae that survived at the end of study was same in both the sets.

Table 1. Mean length (mm) and pigmentation of silver pompano larvae under different temperature (°C) and light intensities (lux)

Age (dph)	Light intensity		Mean length (mm)		Pigmentation	
	Set 1	Set 2	29.0 ± 0.2°C (Set 1)	31.0 ± 0.2°C (Set 2)	29.0 ± 0.2°C (Set 1)	31.0 ± 0.2°C (Set 2)
1	2720	2964	2.35 ± 0.02	2.35 ± 0.02	Black	Black
2	2681	3063	2.43 ± 0.03	2.44 ± 0.03	Black	Black
3	2695	3428	2.55 ± 0.02	2.60 ± 0.03	Black	Black
4	2713	3110	3.13 ± 0.07	3.05 ± 0.05	Black	Black
5	2639	3315	3.23 ± 0.13	3.35 ± 0.15	Black	Black
6	2698	3480	3.88 ± 0.06	3.71 ± 0.15	Black	Black
7	2629	3185	4.26 ± 0.09	3.85 ± 0.07	Black	Black
8	2672	3575	5.16 ± 0.03	4.04 ± 0.16	Black	White
9	2559	2385	5.67 ± 0.03	4.26 ± 0.15	Black	White
10	2525	2314	6.36 ± 0.12	4.39 ± 0.20	Black	White
11	2333	2290	7.07 ± 0.09	4.81 ± 0.19	Black	White
12	2479	2202	8.07 ± 0.09	5.38 ± 0.23	Black	White
13	3808	2309	8.33 ± 0.35	6.25 ± 0.27	Black	White
14	4450	5486	9.57 ± 0.33	6.79 ± 0.38	Black	White
15	2575	4993	10.70 ± 0.26	7.53 ± 0.45	Black	Brown
16	2099	5486	11.60 ± 0.51	8.40 ± 0.48	Black	Brown
17	2147	2566	12.50 ± 0.62	9.30 ± 0.55	Black	Brown
18	2126	2596	13.30 ± 0.67	10.39 ± 0.75	Silver	Brown
19	1912	2808	14.30 ± 0.49	11.30 ± 0.81	Silver	Brown
20	2100	2894	15.00 ± 0.60	12.50 ± 0.85	Silver	Brown
21	2059	7158	15.90 ± 0.65	13.30 ± 0.89	Silver	Silver
22	2024	2681	17.10 ± 0.69	14.50 ± 0.95	Silver	Silver
23	2912	4772	18.20 ± 0.78	15.40 ± 1.04	Silver	Silver
24	4250	2605	19.30 ± 0.71	16.50 ± 1.03	Silver	Silver
25	3522	4790	21.40 ± 0.53	18.10 ± 1.12	Silver	Silver

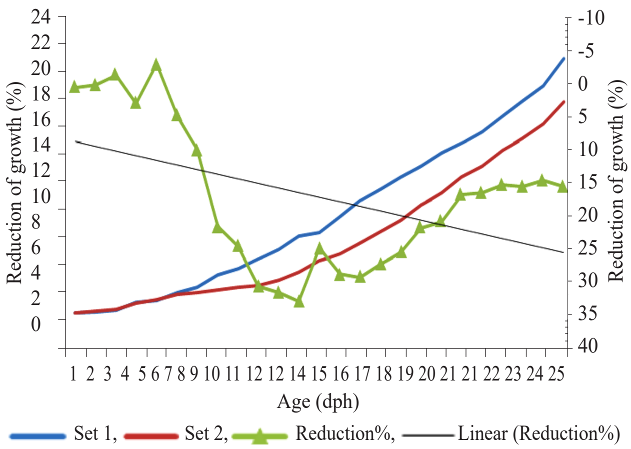

Fig. 1. Total length (mm) and % reduction of growth in silver pompano larvae (1 to 25 dph) at different temperature regimes (Set 1 and Set 2) Straight line indicate trend of reduction

Larval stages of marine finfishes are sensitive to environmental parameters (Berlinsky *et al.*, 2004; Yefera and Darias, 2007; Shi *et al.*, 2010). Among the most critical external factors in the early ontogeny of fish are photoperiod, temperature and salinity (Hart *et al.*, 1996; Boeuf and Bail, 1999; Kamler, 2002). Temperature affects virtually all the aspects of early larval development (Rombough, 1996; Fielder *et al.*, 2005; Wen *et al.*, 2013), such as the efficiency of yolk absorption and utilisation (Hart and Purser, 1995; Hardy and Litvak, 2004; Sakthivel *et al.*, 2016), time to first feeding rate and growth (Hart and Purser, 1995; Berlinsky *et al.*, 2004), survival (Gadomski and Cadell, 1991; Bidwell and Howell, 2001; Berlinsky *et al.*, 2004; Wexler *et al.*, 2011) and the behaviour as well as swimming speed (Johnston and Mathias, 1994).

Silver pompano is known for growing well in low salinities and having good adaptability to different farming environments (Gopakumar *et al.*, 2012; Kalidas *et al.*, 2012; Nazar *et al.*, 2012). In the present investigation it was found that the growth and metamorphosis of silver pompano larvae got significantly affected by the temperature and light in earlier stages. A significant reduction in growth of larvae was observed when the temperature was higher and the reduction was maximum during the larval stages between 10 and 15 dph and thereafter, the reduction in growth was less conspicuous. The reduction of growth can be attributed to the stress induced by higher temperature and light, which was more pronounced in the initial days of exposure. As the larvae exhibited resilience to the conditions, reduction in growth gradually declined and got stabilised towards the end of larviculture period. It is evident that the larvae had inherent capacity to combat stress caused by higher temperature and light intensity.

The newly-hatched larvae of silver pompano are usually black in colour and become silvery as they grow and metamorphose (Nazar *et al.*, 2012). A conspicuous variation of pigmentation was observed in the second set

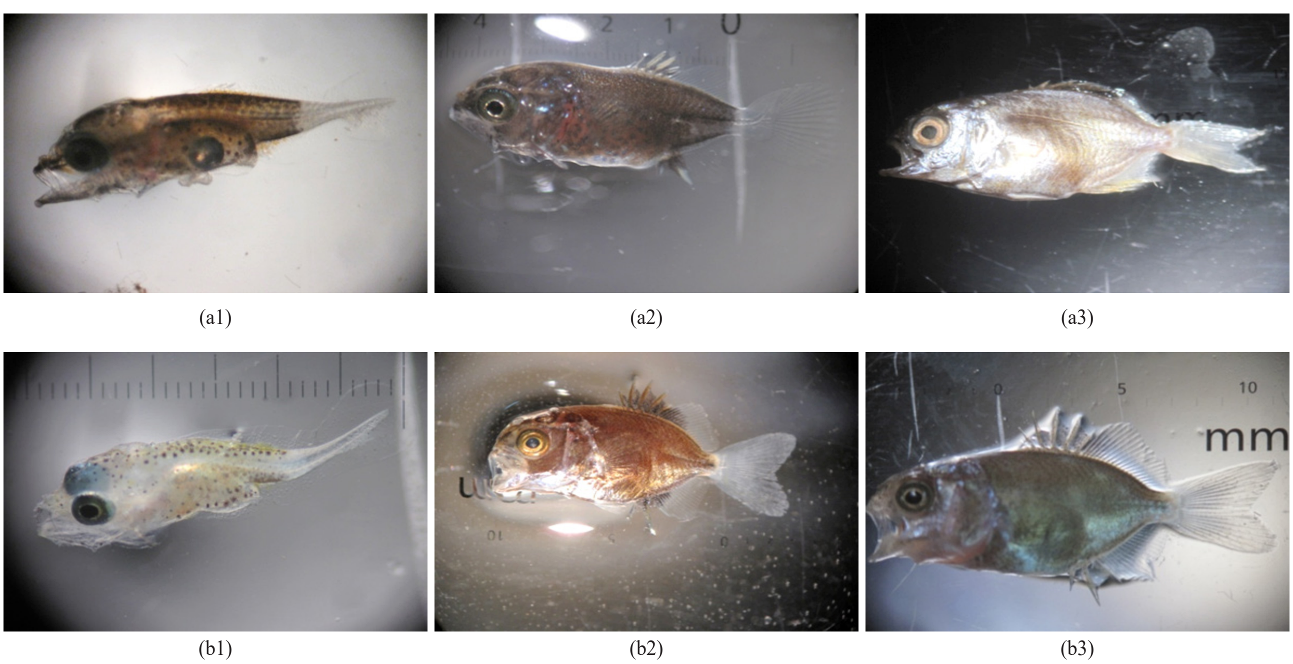

Fig. 2. Variation in pigmentation of silver pompano larvae observed at different temperatures
Larvae in Set 1 (29 ± 0.2°C): (a1) 8 dph (black); (a2) 15 dph (black); (a3) Metamorphosed larvae at 22 dph (silvery)
Larvae in Set 2 (31 ± 0.2°C): (b1) 8 dph (translucent white); (b2) 15 dph (brown); (b3) Metamorphosed larvae at 22 dph (silvery)

from 8 dph and all the larvae appeared translucent white whereas the larval pigmentation continued to be black in the control. However, the whitened larvae showed normal movement and feeding behaviour. It is evident that the change in pigmentation might be due to the temperature and light induced physiological changes. The appearance of original silvery colour at the end of larviculture period in Set 2 implies that the larvae had the resilience to combat stress. The reduced growth rate coupled with change of pigmentation of the larvae and delay in metamorphosis in response to high temperature and light intensity can be taken as an adaptive strategy of the larvae to combat stress. It is also evident that the larvae had resilience to overcome the adverse temperature conditions without affecting survival. It is felt that the resilience to adverse environmental parameters in the larval stage itself is very much advantageous for selecting the species for coastal aquaculture in the anticipated scenario of climate change. However, further detailed studies are needed to clarify the impact of various environmental parameters on the larval stages.

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