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Research Article
Growth and Survival of Blue Swimming Crab, *Portunus pelagicus* Larvae at Different Photo Period and Light Intensity

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Abstract

Background and Objective: Blue swimming crabs, *Portunus pelagicus* is a commercially important species of the southeast Asian region especially Malaysia. However, an establish methods for extensive larval rearing is in developmental stage. Thus, optimization of hatchery culture for this species including photo period and light intensity is therefore vital. This study presented the effect of different photo period and light intensity levels on survival and growth rates of blue swimming crab, *Portunus pelagicus* larvae. **Materials and Methods:** Three different photo period regime (24 h light: 0 h dark, 12 h light: 12h dark and 0 h light: 24 h dark) and three different light intensity (1302, 326 and 1.2 lux) were adopted during this experiment. **Results:** Light intensity of 1302 lux and full lightness 24 h lights achieved the highest specific growth rate. For the early larval stage of Zoea 1 and Zoea 2, high intensity of 1302 lux and 24 h light resulted high survival rate and for the late larval stage of Zoea 3 and Zoea 4. **Conclusion:** It was concluded that higher light intensity and longer photo period conditions are required during early larval stages meanwhile medium light intensity and ambient photo period of 12 h: 12 d are required during the later stage of culture.

Key words: Larviculture, *Portunus pelagicus*, light intensity, photo period, specific growth rate, blue swimming crabs

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The blue swimming crab, *Portunus pelagicus* have been considered as model crabs in previous studies cause of the fact that they are easy availability, convenient size and the fact that they are commercially important[1-4]. With reference to the blue swimming crab, *Portunus pelagicus*, there are only a few studies showing that photo period and light intensity can influence larval survival, growth and development.

Light and photo period generally used for maximize growth, survival and development of early life stages especially in crustacean culture[5-9]. With low larval survival[10-13], it is important to optimize their rearing conditions through variations in photo period regimes and light intensity. In addition, difficulty in obtaining juveniles from wild will trigger their larviculture activity in hatchery seed production[14-16]. For economic value, these crabs are always in greater demand and forms the important sources of commercially fisheries both national and international market[17]. As authors knowledge, there is no study were done on the effects of both photo period and light intensity on *P. pelagicus* larvae in the control conditions. Thus the present study investigated the effects of various photo period regimes and light intensity on survival and growth rates of commercially important blue swimming crab, *P. pelagicus*.

MATERIALS AND METHODS

Larval culture and laboratory design: Ovigerous berried crabs were caught by local fisherman from the Setiu Wetlands, Terengganu, Malaysia (5°38'19'' N, 102°46'20'' E) and brought back to the hatchery of Institute of Tropical Aquaculture, Universiti Malaysia Terengganu, Terengganu, Malaysia. Animals were maintained in 8 t circular fibreglass tanks, with aeration, at density of one crab per ton of water and at a water salinity of 30-32 ppt as described by Azra and Ikhwanuddin[2] until hatch. Newly hatched, vigorously swimming larvae were collected from the hatching tank and transferred into the experimental tanks (150 L fibreglass tank filled with 100 L treated and filtered seawater, 29-30°C temperature) at 50 larvae per litre.

Photo period and light intensity trials: For photo period experiment, newly one day hatched larvae of *P. pelagicus* were used in this experiment. Three treatments (24 h Light -L, 24 h Dark-D, 12 h L: 12 h D) were conducted throughout the study period with 6 replicates for each treatment of photo period. Dead larvae and uneaten food were siphon out from the tank daily or every 2 days. Live *Artemia* was given at around 1000 and 1800 h after the 10% daily water exchange. The experiment was terminated after 12 days of culture[4].

For light intensity experiment, newly one day hatched larvae were used in this experiment. Three treatments (low light intensity, medium light intensity and high light intensity) had conducted through the study period with six replicates for light intensity experiment. Dead larvae and uneaten food were siphon out from the tank daily or every 2 days[2]. Live *Artemia* was given at around 1000 and 1800 h after the water exchange. The light meter (Model YF-170, Tenmars Electronics Co., Ltd., Taiwan) was used to measure the light intensity for each treatment. The value of the high light intensity is 1302, 326 lux for medium light intensity and 1.2 lux for the low light intensity. The experiment was to terminate after 12 days of culture.

Larval survival and growth rate measurement: The survival rate (%) at a particular larval stage was calculated as the number of larvae moulted successfully to the next stage divide by the initial number of larvae in each replicate[7-9]. The larval stage was identified using dissecting microscope:

$$\text{Survival rate} = \frac{\text{Total number of survived larvae}}{\text{Initial number of stocked larvae}} \times 100$$

Sampled crab larvae were put into disposal vials (Bjorn bottle) preserved in 10% of formalin and the weight has measure with a microbalance. The mean wet body weight (BW) for each treatment for different larval stage had used to calculate the specific growth rate (SGR), according to the following formula:

$$\text{SGR}(\%) = \frac{\text{In}(\text{final body weight}) - \text{In}(\text{initial body weight})}{\text{Culture period}(\text{day})} \times 100\%$$

Statistical analysis: In the experiment, data were collected and analyzed using SPSS for Windows version 18.0 software. One-way analysis of variance (ANOVA) were used to determine whether the significant variation between treatments existed. All results are presented as Means±SE. The difference is displayed as statistically significant when $p<0.05$.

RESULTS

Growth increments: The data in Table 1 showed the mean specific growth rate (SGR) of body weight (BW) for light

Table 1: Mean specific growth rate of body weight for light intensity treatment on *Portunus pelagicus* larval stage from Zoea 1 to Megalopa stages

		Zoea 1		Zoea 2		Zoea 3		Zoea 4	Megalopa
Light intensity (lux)	Number of replicates	Mean value (%)	Standard errors	Mean value (%)	Standard errors	Mean value (%)	Standard errors	Mean value (%)	Standard errors
High (1302)	6	4.90[a]	0.94	5.93[a]	0.73	4.02[a]	0.80	2.42[a]	1.26
Medium (326)	6	2.62[b]	0.13	2.32[b]	0.44	1.12[b]	0.64	4.33[b]	0.86
Low (1.2)	6	1.72[b]	0.83	1.93[b]	0.62	1.02[b]	0.57	1.82[a]	0.78

Different superscript letters in each rows at different larval stages showed statistically significance between treatment at p<0.05

Table 2: Mean specific growth rate of body weight for different photoperiod treatment on *Portunus pelagicus* larval stage from Zoea 1 to Megalopa stages

		Zoea 1		Zoea 2		Zoea 3		Zoea 4	Megalopa
Light intensity (lux)	Number of replicates	Mean value (%)	Standard errors	Mean value (%)	Standard errors	Mean value (%)	Standard errors	Mean value (%)	Standard errors
24 h light: 0 h dark	6	4.72[a]	0.98	5.55[a]	0.54	4.05[a]	0.45	2.67[a]	0.82
12 h light: 12 h dark	6	3.42[a]	0.75	4.17[a]	0.64	4.03[a]	0.50	2.78[a]	1.11
0 h light: 24 h dark	6	1.72[b]	0.83	1.87[b]	0.68	1.42[b]	0.61	1.48[a]	0.66

Different superscript letters in each rows at different larval stages showed statistically significance between treatment at p<0.05

intensity treatment on *P. pelagicus* larval stage from Zoea 1 to Megalopa stages. The results exposed that larvae need medium of light intensity of 326 lux when larvae reached the Megalopa stages. The study showed that there were significant difference (p<0.05) of SGR in term of BW between high light intensity treatment and medium and low light intensity treatment at different larval stage. However, no significance different was found between medium and low light intensity Zoea 1 to Zoea 4 treatment. The Table 2 showed mean SGR of BW for different photo period treatment on *P. pelagicus* larval stage from Zoea 1 to Megalopa stages. The results showed that crabs prefer more photo period time at the late stage of culture (Z4 to megalopa stage). The study also shows that there is a significant different (p<0.05) between 0 L: 24 h D treatment compared to the other two photo period treatment. No significance different was found in Zoea 4-Megalopa stage between all treatment.

Survival rate: Figure 1 shows the effects of different types of treatment on light intensity of *P. pelagicus* to the survival rate from larval stage from Zoea 1 to Zoea 4 stages in the present study. The result showed that the crabs survived in low light intensity compared to high light intensity level Zoea 3 and Zoea 4.

There is significance different found at low light intensity compared to other two treatment of high and medium light intensity. On the other hand, Fig. 2 showed the effect of different types of photo period treatment of *P. pelagicus* survival rate from larval stage 1, Zoea 1 to Zoea 4 in the present study. The result showed that the survival was higher when crabs reared in ambient 12 h L: 12 h D in Zoea 4 compared to other treatments of photo period.

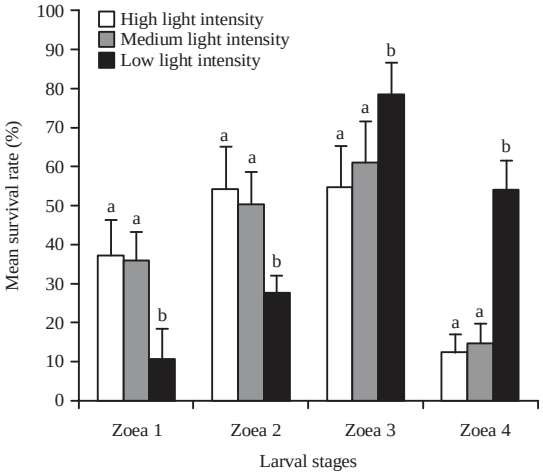

Fig. 1: Effect of different types of treatment on light intensity of Portunus pelagicus to the survival rate from larval stage Zoea 1 to Zoea 4 in the present study

Different letter at different larval stages showed significance difference at p<0.05

DISCUSSION

The results of the present study showed that photo period and light intensity affected the growth and survival of *P. pelagicus* larviculture. Previous study showed that both photo period and light intensity affected the portunid crabs culture[5-9]. The quantity and quality of food available and temperature of the surrounding water are the two most important environmental factors that affect the growth and moulting in crabs and other crustaceans[18]. Previous study stated that although crustacean larvae are considered non-obligated visual feeders, they may still utilize light for a more efficient feeding[19]. Indeed, evidence exists that newly

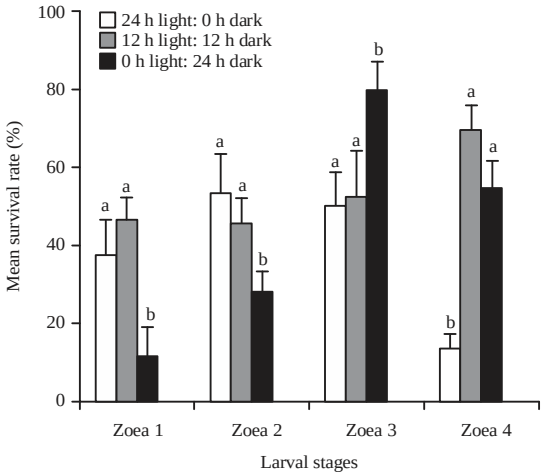

Fig. 2: Effect of different types of treatment on photoperiod of Portunus pelagicus to the survival rate from larval stage Zoea 1 to Zoea 4 in the present study
Different letter at different larval stages showed significance difference at $p<0.05$

hatched zoeal larvae of *P. pelagicus* fed three to 4 times more during daytime than at night time. Light is an important abiotic factor that can substantially affect larval performance of crabs, including feeding behaviour and growth[20-21]. In this study, there are significant different between the treatments for all the experiment. A 24 h light period caused a relatively rapid development of larvae in *P. gigas*[21]. In many decapod species, larvae are less severely affected by 0 h light and are able to capture prey at a reduced rate as in *R. ranina*[20] or they may actually feed at a rate equal to or greater than in light as in the American lobster, *Homarus americanus*[22]. Observations in *Jasus edwarsii* phyllosoma[5], where swimming speed increased logarithmically with increasing light intensity, clearly indicate that not only photo period can effect larval behaviour. Andres *et al.*[9] stated that the effect of photo period on *P. pelagicus* larval growth remains unclear and under constant darkness, developmental duration to this stage was one day longer than the fastest development recorded under constant light. Constant darkness in this study shows that the SGR in term of BW was the lowest mean in the both experiment. The study that had been by the Andrés[9] stated that constant darkness led to the lowest larval survival and developmental rate. In addition, larvae reared under constant darkness resulted in the smallest megalopa and the lowest dry weight.

In the present study, the *P. pelagicus* zoea were able to develop through the whole larval cycle in the absent of light[9]. In this study showed that the early stage of the *P. pelagicus* larvae needs light to growth. For example, from the study the survival rate for the early larvae stage for the photo period and light intensity was high than the treatment of constant darkness and low intensity. After reached Zoea 3 and Zoea 4, the survival rate of the larvae was higher that produce by the lower intensity and constant darkness than other treatments. Some studies found that the photo period did not affect larval survival of the crab, *Pseudocarcinus gigas*[21] and spiny lobster, *Jasus edwarsii*[5]. The factors that contribute to low survival of crabs' larvae were environment such as water quality[23,24], light intensity and photo period[21].

The different treatment of light intensity and photo period of *P. pelagicus* had a significant different on specific growth rate (SGR) in term of BW in larval for all larvae stages and the survival rate. The early larval stages of Zoea 1 and Zoea 2 need high light intensity and longer photo period. However the late larval stages of Zoea 3 and Zoea 4 required medium light intensity of almost ambient photo period condition (12 h light: 12 h dark). Future study on the effects of other environmental factors on *P. pelagicus* culture such as temperature, salinity and stocking density are recommended.

CONCLUSION

Photo period and light intensity significantly affect the survival, development and growth of *P. pelagicus* zoeal larval. However, the result of the survival rate on this experiment shows significant different between the treatment. The findings obtained at the present study are hopefully practically helpful to increase production of *P. pelagicus* larvae and avoid high mortality of the *P. pelagicus* larvae.

SIGNIFICANCE STATEMENT

This study discovers the suitable photo period and light intensity level that can be beneficial for used during the early culture techniques in *P. pelagicus* seed production. This study will help the researcher to uncover the critical areas of breeding technologies that many researchers were not able to explore. Thus a new theory on optimum light intensity and photo period level might be useful for most aquaculturist and portunid crab researchers.

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