Jurnal Perikanan

Fisheries Journal, 16 (1), 258-264 (2026)
http://doi.org/10.29303/jp.v14i3.1882

ANALYSIS OF THE SPONTANEOUS RESPONSE OF SAND LOBSTER (*Panulirus homarus*) LARVAE TO DIFFERENT UNDERWATER LIGHT COLORS IN LABORATORY SCALE TESTS

Analisis Respon Spontan Benih Bening Lobster Jenis Pasir (*Panulirus Homarus*) Terhadap Warna Cahaya Bawah Air Yang Berbeda Pada Uji Skala Laboratorium

Savilla Okta Wahyudi*, Hari Subagio, Mochamad Arief Sofijanto, Ninis Trisyani

Fisheries Study Program, Faculty of Engineering and Marine Sciences, Hang Tuah University

Arief Rahman Hakim Street No. 150, Sukolilo, Surabaya 60111

*Corresponding Author: savillaokta02@gmail.com

(Received January 8th 2026; Accepted Januari 24th 2026)

ABSTRACT

Sand lobster (*Panulirus homarus*) are a high-value fishery commodity. *Peurulus* are usually using passive fishing gear such as "pocong". The use of underwater light has the potential to increase effectiveness by attracting *peurulus*. This study analyzed the spontaneous phototactic response of peurulus to variations in underwate light color. The phototactic response was measured from the position of the end zone after light exposure. The container was divided into 5 zones, with LED lights placed iin the 5 zone. The study was conducted at the Hang Tuah University Aquaculture Laboratory, using a completelyrandomized design (CRD). The treatments included three colors of 3-watt LED light: white, red, and purple, each repeated 20 times. The independent variabel was light color, and the dependent variable was the phototactic response based on the zoning of the peurulus position at the enf of light exposure. The Mann-Whitney test results showed a significant difference between white and purple light ($p<0.05$). However, there were no significant differences between white-red and red-purple. Peurulus showed the highest positive phototaxis response to white light (average zone 2.8), followed by red (average zone 2.7), and the lowest to purple (zone 2.1). These differences are thought to be due to variations in wavelength and light intensity for each color.

Key words : *Peurulus*, Underwater Light, Phototaxis, *Panulirus homarus*

ABSTRAK

Lobster pasir (*Panulirus homarus)* termasuk komoditas perikanan bernilai ekonomi tinggi. Penangkapan Benih Bening Lobster (BBL) biasanya menggunakan alat tangkap pasif seperti "pocong". Penggunaan cahaya bawah air berpotensi meningkatkan efektivitas dengan menarik perhatian BBL. Penelitian ini menganalisis respon spontan sifat fototaksis BBL pasir terhadap variasi warna cahaya bawah air yang berbeda. Respon fototaksis diukur dari posisi zona akhir setelah paparan cahaya. Wadah dibagi menjadi 5 zona, dengan lampu LED ditempatkan pada zona ke-5. Penelitian dilakukan di Laboratorium Budidaya Universitas Hang Tuah, menggunakan rancangan acak lengkap (RAL). Perlakuan mencakup tiga warna cahaya LED 3 watt : putih, merah dan ungu, masing-masing diulang sebanyak 20 kali. Variabel bebas adalah warna cahaya dan variabel terikat adalah respon fototaksis berdasarkan zonasi posisi benih saat akhir paparan cahaya. Hasil uji lanjut Man-Whitney menunjukkan perbedaan signifikan antara cahaya putih dan ungu (p<0,05). Namun, tidak ada perbedaan nyata antara putih-merah serta merah-ungu. BBL menunjukkan respon fototaksis positif tertinggi pada cahaya putih (rata-rata zona 2,8), diikuti oleh merah (rata-rata zona 2,7) dan terendah ungu (zona 2,1). Perbedaan ini diduga disebabkan variasi panjang gelombang dan intensitas cahaya tiap warna.

Kata Kunci: Benih Bening Lobster, Cahaya Bawah Air, Fototaksis, *Panulirus homarus*

INTRODUCTION

Lobster, also known as crayfish or barong, is a highly valuable fishery commodity in Indonesia, with increasing demand for both consumption and as seed for aquaculture (Witomo, 2015). Indonesia ranks 8th among the world's leading producers, with an annual production volume of 6,917 thousand tons. The southern coast of Java, within the Indonesian National Fisheries Management Area (WPP NRI) 573, is a potential lobster-producing region (PSDKP, 2023).

The sand lobster (*Panulirus homarus*) is one of the most common lobster species found in Indonesian waters, particularly in the Indian Ocean. It has a greenish or brownish base color with bright spots scattered across the surface of its abdominal segments (WWF, 2015). Lobsters are nocturnal and typically hide in crevices or under coral reefs, as well as in tropical and subtropical coral reefs (Pratiwi, 2018).

The lobster life cycle consists of five stages, beginning with the production of sperm and eggs, which then hatch into larvae (phyllosoma) that last for 18 months (Setyanto *et al*., 2020). Lobsters move planktonically, unable to fight the current. This phase is called meroplankton, or temporary plankton. The phyllosoma phase lives in groups on the water's surface and moves with the current towards sunlight (Ajinugraha, 2021). Then, it moves to the *peurulus* phase, or clear seed, whose movement can already fight the current and live in shallow waters. Then, it undergoes a skin change or molting into small or juvenile lobsters that already have the same color as their parents. Lobster molting not only stimulates or accelerates their growth but also helps repair damaged body parts, such as legs or antennae, so they can grow back normally (Lesmana & Mumpuni, 2022). After that, they develop into adult lobsters that are ready to reproduce and start the life cycle again.

The capture of BBL generally uses passive fishing gear such as "pocong" made from used cement or rice sacks, which are shaped into a fan and then tied at the top in a pocong shape. The effectiveness of the capture still needs to be improved, one way is through the use of underwater lighting as an aid thought to be able to attract the attention of lobster seeds based on their phototactic properties. To determine which color of light is most effective in attracting the attention of clear lobster seeds and increasing their catch, it is necessary to analyze the phototactic properties of clear lobster seeds spontaneously to light.

RESEARCH METHODS

Research on the Analysis of Spontaneous Response of Sand Lobster Seeds (*Panulirus homarus*) to Different Colors of Underwater Light in Laboratory Scale Tests was conducted at the Cultivation Laboratory of the Fisheries Study Program, Faculty of Engineering and Marine Sciences, Hang Tuah University Surabaya, East Java, during March 2025.

For this study, the materials used were 2-2.5 cm sand lobster larvae caught by fishermen in Prigi Bay. The tools used in this study included containers and other supporting equipment. These included an observation tank measuring 100 x 20 x 18 cm, one plastic tub for rearing the BBL, three LED lights (white, red, and purple) for administering treatments during the study, four aeration stones to increase oxygen levels, one stopwatch to time the test, writing instruments for recording observations, one ruler to measure zones in the test tank, a luxmeter, a pH meter, a refractometer, a thermometer, and dissolved oxygen (D0) to measure water quality during the study.

The research method used was an experimental study, observing the phototactic response of the sand lobster larvae exposed to three different underwater LED light colors (white, red, and purple) for 10 seconds, each repeated 20 times. The 10-second observation duration was chosen based on initial tests of the sand lobster larvae with underwater light. At <10 seconds, the fry tend to remain still (adaptation); at exactly 10 seconds, almost all of them move spontaneously (initial phototactic response); and above 10 seconds, movement becomes a secondary adaptation. This selection ensures valid data reflecting spontaneous reactions in the laboratory.

The independent variable is light color, while the dependent variable is the phototactic response of lobster fry, measured based on the final positional zonation of the fry relative to the light. The hypothesis tested was a significant difference in the phototactic response of lobster fry to variations in underwater light color. Data collection was carried out by observing and recording the final position of the BBL in the zone. Phototactic response data were analyzed statistically using SPSS verdi 25.0 with the Mann-Whitney test to compare between treatment pairs.

RESULTS

Observations of the distribution of lobster seeds across five predetermined zones revealed differences in the average position of the seeds for each light color treatment. The average zone position of the lobster seeds can be seen in Figure 1.

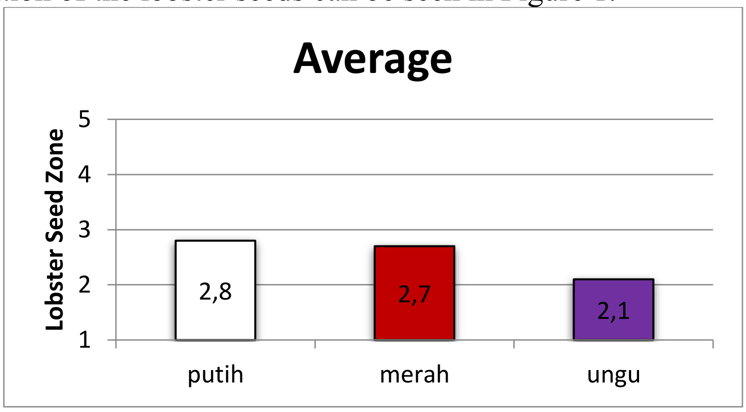

Figure 1. Average image of clear lobster seed zoning

Based on Figure 1, the position of the clear lobster seeds in relation to the color of white light has an average of Zone 2.8, red light in Zone 2.7, purple light in Zone 2.1. This means that the clear lobster seeds tend to be in zones farther from the light source, especially in purple light. Meanwhile, in white and red light, it shows that the clear lobster seeds choose areas that are not too close to the light source, but also not in dark areas. Thus, the light conditions in the average position can be categorized as moderate, namely areas that are not too bright and not too dark.

Observations showed that the phototactic response of the clear lobster (*Panulirus homarus*) fry to underwater light colors differed significantly depending on the light color used in laboratory-scale tests. Based on the Kolmogorov-Smirnov and Shapiro-Wilk normality tests, the data distribution across all light color treatments was not normally distributed, with a significance value (Sig.) <0.05 for all groups (white: 0.032/0.019; red: 0.022/0.046; purple: 0.015/0.006). Therefore, the analysis was continued with the non-parametric Mann-Whitney test.

The Mann-Whitney test revealed no significant difference in the phototactic response of the clear lobster fry between the white and red light treatments (p-values of 0.613 and 0.640) and the red and purple light treatments (p-values of 0.118 and 0.134). Conversely, there was a significant difference between the white and purple light treatments, with p-values of 0.031 and 0.038, respectively, indicating that white light elicited a different phototactic response than purple light.

Therefore, it can be concluded that the phototactic response of lobster larvae differed significantly only in the white light treatment compared to purple light, while the response was relatively similar in the white-red and red-purple light combinations.

This difference may be influenced by several factors, including light intensity and duration of exposure. Figure 2 shows the difference in light intensity (Lux) values in five different zones for the three light color treatments: red, purple, and white.

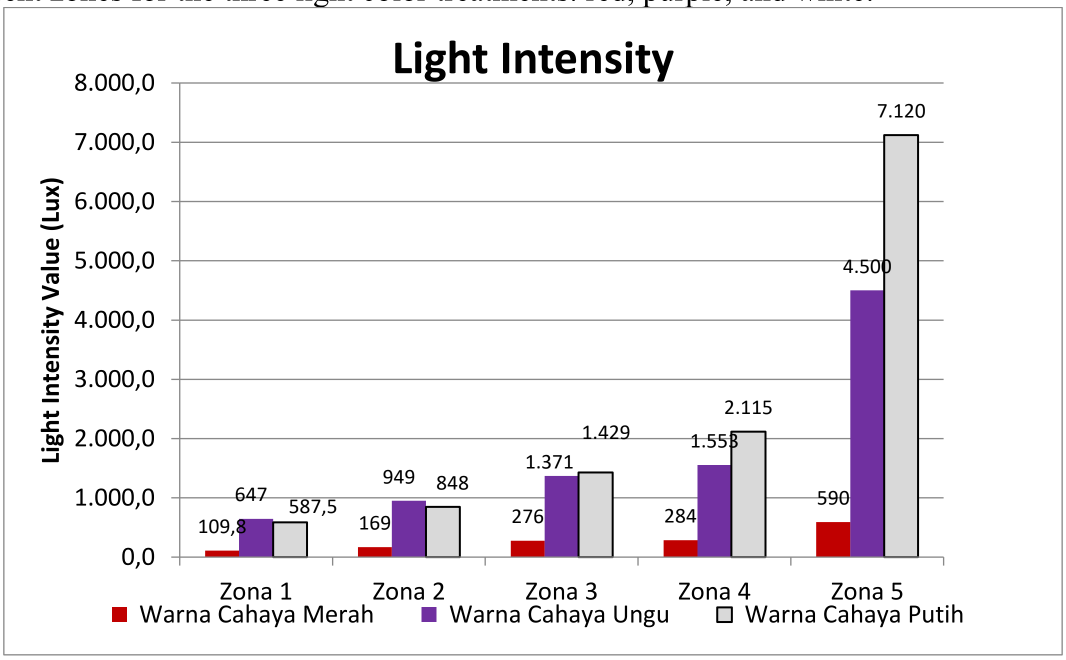

Figure 2 Light intensity

Figure 2 shows the light intensity values (in lux) in five different zones for three light colors: white, red, and purple. The graph shows that in each zone, white light has the highest light intensity compared to purple and red light. In zone 1, the zone furthest from the light source, the red light intensity is 109.8 lux, purple 647.0 lux, and white 578.5 lux. The values continue to increase in each subsequent zone, with the most significant spike occurring in zone 5, the zone closest to the light source, where the white light intensity is 7,120.0 lux, purple 4,500.0 lux, and red 590.0 lux. This pattern shows that white light provides a much higher light intensity across all zones, followed by purple, while red has the lowest value.

Furthermore, water quality monitoring during the study showed that parameters such as temperature, salinity, dissolved oxygen, and pH were within the optimal and stable range, thus confirming that differences in phototactic responses were more influenced by light color than environmental conditions. The average water temperature during the study was 25.3℃, consistent with Fadjar *et al*. (2022), who stated that the best temperature for keeping lobsters is 23-32℃. Salinity was recorded at an average of 33 ppt, consistent with Tong *et al*. (2000) who stated that saltwater lobsters are typically found in waters with a salinity of 25-40 ppt. Dissolved oxygen levels during the study averaged 5 mg/L, and the average pH was 8. This is in accordance with Lestari *et al*. (2018) who stated that the optimal dissolved oxygen content is 5-6 ppm with a pH needed for lobster survival ranging from 7.8-8.5.

DISCUSSION

Phototactic Response of Lobster Seeds

Clear lobster fry showed the highest tendency to approach white light, compared to purple and red light. Schmalenbach and Buchholz (2010) stated that during the *phyllosoma* stage, lobsters live in groups at the water's surface and utilize currents to move toward white light (the sun). However, with increasing age or the larval stage, the lobster's positive phototaxis response decreases. Larvae respond positively to light during the second and third larval stages before molting.

Jimbo *et al*. (2018) also investigated phototaxis in the early stages of caribou lobsters (*Panulirus argus*) and shimai lobsters (*Panulirus penicillus*). The results showed positive phototaxis in the early stages, but larvae in the middle and later stages showed no response to light. Juvenile lobsters tend to swim to deeper waters to seek shelter and forage.

Lobsters are more active when light intensity is low or dark. High light intensity in waters is feared to disrupt the lobster's foraging process. The difference in light intensity between these colors is thought to be one of the factors that influences the level of attraction and spontaneous response of sand lobster seeds to light sources during laboratory-scale tests.

The higher light intensity of white light likely provides a clearer and more attractive visual stimulus to lobster fry, thus encouraging more individuals to approach and respond positively. According to Schmalenbach *et al*. (2010), the *phyllosoma* stage of lobsters exhibits a positive phototactic response, being attracted to white light (sunlight). Lobsters' eyes are black, allowing them to capture even the smallest amount of light (Putra, 2021).

With red light, which has the lowest intensity, at 109.8-590.0 lux, the visual stimulus received by lobster fry is less optimal, resulting in a lower response. Red light has a longer wavelength and penetrates less well in water (Halsy *et al*., 2019). Light penetration in water is closely related to the wavelength emitted by the light (Jayanto, 2015). Wavelength is negatively correlated with the light's penetration power (Mulyawan *et al*., 2015). Only light with a wavelength of 400-750 nm is acceptable to marine life (Jayanto, 2015). Hungry lobsters are more easily attracted to light because it indicates the presence of food, a gathering place for positively phototactic organisms such as zooplankton (Jayanto, 2015).

The characteristic wavelength of violet light is in the range of 400-450 nm, and compared to other wavelengths, violet light has a shorter wavelength (Hasly *et al*., 2019). The limited visual ability of lobster larvae to detect violet wavelengths results in a less robust phototactic response than with white light. Research by Hasly *et al*. (2019) found that violet light causes swimming crabs (*Portunus pelagicus*) to remain in the light area longer, although their arrival time to the light source is slower than with blue, white, and green light.

The phototaxis response exhibited by lobster larvae is also influenced by their visual adaptation to aquatic environments. This is in line with the statement of Hasly *et al*. (2019), who stated that the ability of crustaceans to perceive light varies depending on the function of the receptors each individual possesses. According to Mamulaty *et al*. (2022), fish's ability to be attracted to light sources varies. Some fish are attracted to low-intensity light, others to high-intensity light, and still others to both high and low light intensities. Several factors, including light color, light intensity, exposure time, water conditions, and the condition of the fish, influence their attraction. According to Setyanto *et al*. (2020), underwater lights attract peurulus because they gather a lot of food around the light source, allowing them to take shelter between the attractors. Fish exhibit positive and negative phototaxis, meaning they react to light. Attracted by light, small fish and plankton congregate, while larger fish gather to search for food (Ta'alidin, 2004). Negative phototaxis can help larvae move to the bottom to forage, while positive phototaxis can help larvae remain in the water column for larval dispersal. Light brightness influences the life and abundance of lobster fry as an environmental indicator for shelter, foraging, and distribution within their habitat.

CONCLUSION

The results of the study showed that clear lobster seeds had the highest positive phototactic response to white light, while red and purple light showed a lower response, so both were less effective in attracting attention in laboratory tests.

ACKNOWLEDGEMENT

The author would like to thank all parties who have helped the author by providing encouragement and accompanying the author so that he could complete writing this research report.

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