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RESEARCH ARTICLE

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Relationship of observation depth and time against *Perna viridis* spawn in coastal waters of Waiheru Village, Inner Ambon Bay

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Abstract

The adhesion of green mussel spit is highly correlated with depth. This study aims to establish the correlation between the depth and duration of observation with the abundance of green mussel spat (*Perna viridis*) in the coastal waters of Waiheru Village, located in Inner Ambon Bay. This study was undertaken utilising three floating net cages (KJA) possessed by local fishermen. The KJA utilised in this investigation had dimensions of 2.0 × 2.5 metres. Each KJA is equipped with 4 threads of hanger rope, resulting in a total of 12 hangers. Each rope hanger is positioned at specific depths, specifically at depths of 3, 6, and 9 metres. The net is 40 cm by 40 cm. Observations were conducted on days 2, 4, 6, 8, 10, 12, and 14 after the nets were strung. The findings indicated that the depth and duration of observation significantly influenced the quantity of green mussel spat. Specifically, more spat was observed compared to other days, suggesting a stronger attachment at that depth and observation period. Nevertheless, on the 10th day of observation, there was a surge in the quantity of green mussel spit.

Keywords: Depth, green mussels (*Perna viridis*), spat number

Introduction

Green mussels, scientifically known as *Perna viridis*, are a species of marine organism[1,2]. These organisms are soft-bodied invertebrates with two symmetrical shells and short legs shaped like axes. Due to their significant economic worth, green mussels are a valuable biological resource in Indonesia[3]. Life typically adheres and congregates on intricate materials like wood, bamboo, coral, rope, etc. The aquaculture of green mussels has a substantial economic influence on coastal areas. Furthermore, mussel cultivation can be done with minimal production expenses while yielding substantial profits[4].

The depth at which green mussels are found plays a critical role in their growth and survival ability. Salinity, temperature, pH, and brightness are influenced by depth[5]. Clams affixed to the substrate will grow and mature in their natural environment. An appropriate substrate will facilitate the attachment and growth of green mussel seeds[6]. According to Jones et al. (2005), the attachment and growth of green mussels are significantly affected by factors such as water movement, organic matter content, water chemistry, and food distribution[7]. The green mussel spit attachment method varies considerably in different water bodies, such as the inner waters of Ambon Bay, particularly around Waiheru Village Beach. This study aims to establish the correlation between the water depth and the abundance of green mussel spat (*P. viridis*) in the coastal waters of Waiheru hamlet, located in Inner Ambon Bay

Materials and methods

Research site

This study was conducted in the coastal waters of Waiheru Village, Inner Ambon Bay, utilising the floating raft technique to examine the correlation between depth and the rate of attachment of green mussel (*P. viridis*) spit. This research fell under the category of quantitative descriptive research.

Data collection

The equipment utilised included a notebook, underwater camera, HB pencil and ballpoint pen, nylon rope (for hanging purposes), boat and paddle, Karoro (a type of protective gear), cutter knife, roller metre, gloves, medium plastic container or bucket, diving equipment (including fins, mask and snorkel), permanent marker, sample bottle, board, underwater paper, thermometer, pH metre, refractometer and buoy (to secure the sample in the sea). The components utilised include a solution consisting of 40% formalin, tissue rollers, and cotton. The floating net cages utilised in this investigation had dimensions of 2.0 × 2.5 metres. Each KJA is equipped with 4 threads of hanger rope, resulting in a total of 12 hangers. Each rope hanger is positioned at predefined depths of 3, 6, and 9 metres. The net is 40 cm by 40 cm. Observations were conducted on the second, fourth, sixth, eighth, tenth, twelfth, and fourteenth days after the nets were strung. The green mussel spat adhering to each net was extracted, gathered into a container, and tallied.

Table 1. Interpretation of correlation coefficient

Coefficient interval	Relationship Level
0,00 – 0,199	Very low
0,20 – 0,399	Low
0,40 – 0,599	Medium
0,60 – 0,799	Strong
0,80 – 1,00	Very strong

Data analysis

The link between depth and the number of green mussel species was examined using linear regression. The mathematical expression for a multiple linear regression equation is as follows:

$$Y = a + b_1x_1 + b_2x_2 + \dots + b_nx_n$$

Where:

Y = Predicted dependent variable

a = Constant

b = Regression coefficient

x_1 = Independent variable A
x_2 = Independent variable B

Results

Average number of green mussel (*P. viridis*) spawn attached

The average number of green mussel spat (*P. viridis*) attached at depths of 3, 6 and 9 metres for 14 days at 3 observation stations is presented in **Table 2**.

Table 2. Average number of green mussel (*P. viridis*) spat that attached

Depth (m)	Observation time (day 1)						
	2	**4**	**6**	**8**	**10**	**12**	**14**
3	12.6	37.3	47.6	98.0	168.3	276.3	452.7
6	13.0	38.0	47.6	122.3	194.0	464.3	599.7
9	14.6	54.0	67.0	143.0	278.3	644.0	780.7

The linear regression calculations indicate that the constant (a) for the number of individual green mussels attached is 308.551. The regression coefficient (b) for depth is 63.479 (x_1), and the observation time is 99.608 (x_2). Therefore, based on the calculation, the regression equation can be expressed as $Y = 308.551 + 63.479 (x_1) + 99.608 (x_2)$. This equation can be described as a regression model using independent variables as predictors to forecast the dependent variable. The obtained coefficient of determination (R2) is 0.811, and the correlation coefficient is 0.901. The correlation coefficient 0.901 indicates a strong link between the depth and observation time on the number of green mussels (*P. viridis*) spat attached.

The investigation was extended using factorial analysis to examine the relationship between depth, observation time, and the number of green mussel spit (Perna viridis) adhered. The findings indicated a significant correlation at a depth of 9 metres on the 12th and 14th days of observation.

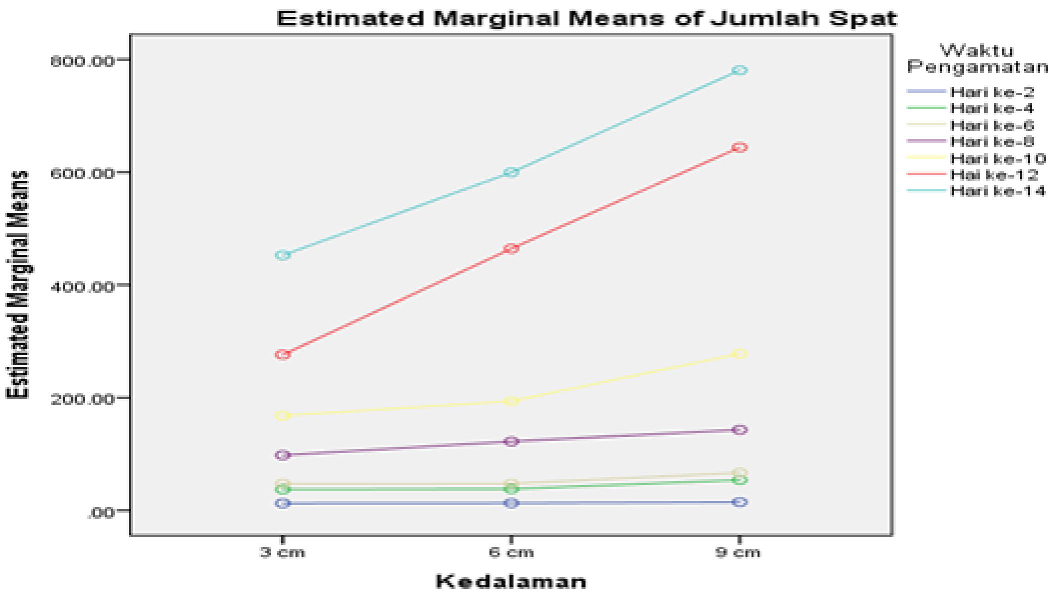

Figure 1. Graph of the average number of spat attached to the depth and time of observation

Measurement of physical and chemical factors of waters

In this study, water conditions including salinity, pH, dissolve oxygen (DO), and water temperature were still within the tolerance threshold range of mussel life. The average results of measurements of physical factors of water chemistry during the study are presented in Table 3.

The results in **Table 3** show that seawater salinity ranged from 30.37-30.61o/oo, seawater pH values ranged from 7.86-7.91, average DO levels ranged from 4.53-4.72 mg/l and average temperatures ranged from 30.29-30.33 °C.

Table 3. Average measurement results of physical and chemical factors during the study

Chemical physical factors	Depth (m)	Value
Salinity (o/oo)	3	30.37
	6	30.61
	9	30.61
pH	3	7.91
	6	7.91
	9	7.86
DO	3	4.53
	6	4.72
	9	4.57
Temperature	3	30.29
	6	30.33
	9	30.29

Discussion

The study's findings indicate that the duration and intensity of observation impact the quantity of green mussel spat. The abundance of green mussel spat (*P. viridis*) was lower at a depth of 3 metres compared to 9 metres. The growth of green mussels will be influenced by their capacity to connect. Wisnawa (2013) determined that the optimal depth for cultivating green mussels (*P. viridis*) is between 5 and 10 metres[8]. The optimal depth can impact the aperture and closure of clam shells due to the clam's requirement for water with low light intensity[9]. The purpose is to make the shells easier to open, allowing the feed filtration process to function optimally and naturally. According to Andriyani (2019)[10], a shallower depth can lead to rapid drying and cloudiness in mussels, while depths exceeding 10 metres expose them to wave impact. The study observed a notable rise in green mussel spat on day 12 due to elevated seawater temperature. On the tenth day, the temperature of the seawater was 28.67 °C and rose to 34 °C on the twelfth day. However, green mussels have a solid ability to adjust to these changes.

The findings demonstrated a strong correlation coefficient of 0.901 between the depth of salt water and the abundance of green mussel spit (*P. viridis*) attached. The strong correlation can be attributed to the presence of abundant natural nutrients in the coastal waters of Waiheru Village, located in Inner Ambon Bay. While mussels consume a range of suspended particles, including phytoplankton, microzooplankton, detritus, and dissolved organic matter, phytoplankton is their preferred and most consumed food source[11–13]. The presence of phytoplankton in the coastal waters of Waiheru Village, Inner Ambon Bay, is believed to be influenced by various factors, such as wind patterns, ocean currents, upwelling processes, water temperature, salinity, nutrient levels, water depth, and the interaction of different water masses that can facilitate phytoplankton photosynthesis. The presence of phytoplankton is strongly linked to food availability for species at higher trophic levels[14].

The diet of green mussels will impact the growth of their tissues. Food storage and utilisation can modify the body weight to shell length ratio[15]. Helm et al. (2004) found that mussel feeding patterns are influenced by the natural diet available in their habitat, which provides vital nutrients for their growth[16]. Riisgard (2001) states that mussel filtration rates are affected by particle/cell size, plankton density and quality, mussel size, and environmental conditions[17]. Environmental factors impacting filtration rates include dissolved oxygen, pH, temperature, salinity, suspended particles and chlorophyll[18,19]. The velocity of surface currents can impact food availability, whereas physiological and ecological aspects may be more conducive to spatial development and growth[20].

The mean value of saltwater salinity varied between 30.37 and 30.61 o/oo. Mussels (*P. viridis*) are organisms with a broad salt tolerance and may survive in waters with a salinity range of 27-34 ‰. Therefore, the current salinity levels in the waters are still within the acceptable range for the survival of individual mussels. Wang et al. (2011) stated that salinity plays a crucial role in the existence of organisms, such as in the dispersion of aquatic biota[21]. Salinity fluctuations in estuaries and coastal regions exhibit dynamic variations in space and time. Green mussels exhibit a notable capacity to withstand various water salinity levels. There is a positive relationship between salinity and osmotic pressure. Osmoregulation is linked to energy use; the more osmotic work is done, the more energy the organism needs. A high level of osmoregulation can hinder growth because more energy is used for osmoregulatory rather than for the growth process.

The pH of seawater is generally stable due to the presence of buffers, which are compounds such as carbon dioxide, carbonic acid, carbonate, and bicarbonate. Water pH is typically affected by the rate of photosynthesis, industrial emissions, and domestic waste. Different aquatic creatures possess varying capacities to withstand different pH levels in water. The pH of seawater at the research site varied between 7.86 and 7.91. Fauziah et al. (2012) determined that the ideal pH range for the survival of *P. viridis* clams is between pH 6 and 9. The pH level has a significant impact on the clam spawning process. Clam spawning will occur more rapidly in an alkaline environment and slower in an acidic environment[22].

The dissolved oxygen values in the coastal waters of Waiheru Village, Inner Ambon Bay, varied between 4.53 and 4.72 mg/l. Nurjanah (2005) stated that clams (*P. viridis*) require a minimum oxygen content of 3.76-6.24 mg/l under ideal water circumstances[23]. The DO levels in the coastal waters of Waiheru Village, Inner Ambon Bay, are currently within the acceptable range for the survival of *P. viridis*, a type of clam. Aquatic creatures rely on dissolved oxygen for respiration, while bacteria and other decomposers use it to break down organic debris. The presence of oxygen in the coastal waters of Waiheru Village, Inner Ambon Bay, is believed to be affected by multiple factors, such as the abundance of phytoplankton and organic waste content. The water's oxygen is derived from three primary sources: air diffusion, the photosynthesis of phytoplankton and aquatic plants, and the input of rainwater and surface flow.

Temperature plays a crucial role in controlling biological processes and the geographic range of organisms. The water temperature observed during the investigation varied between 30.29 and 30.33

degrees Celsius. Green mussels (*P. viridis*) exhibit a high tolerance to temperatures ranging from 10-35ºC. Therefore, it may be inferred that the temperature in the coastal waters of Waiheru Village, Inner Ambon Bay, falls within the optimal range for spat attachment, indicating favourable conditions. Wedemeyer (1996) stated that water temperature significantly impacts various physiological functions of organisms, including respiration, metabolism, and growth, reproduction, and ammonia excretion[24]. It is observed that high water temperatures are more favourable for the growth of green mussels compared to low temperatures. Ultimately, this study establishes a strong correlation between the element of depth and the duration of observation. Clam spats will reproduce successfully at a specific depth due to the ample availability of food or plankton.

Conclusions

The study's results indicate a significant link between depth and observation duration on the amount of green mussel spat (*P. viridis*) attached. The correlation value is 0.901, and the regression equation is $Y = 308.551 + 63.479 (x_1) + 99.608 (x_2)$. As observed on days 12 and 14, the number of spats connected at a depth of 9 metres is significantly more than at depths of 3 and 6 metres.

Acknowledgments

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Conflicts of Interest

The authors declare no conflict of interest

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