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Species of Sea Urchins (Echinoidea) in the Intertidal Zone of Pahawang Island, Pesawaran, Lampung

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Abstract

Background: *Sea urchins are susceptible to environmental changes, including ones caused by anthropogenic activities in coastal area. They are commonly found in coral reef areas, seagrass beds, and mixed sand and coral rubble substrates. These marine ecosystems face critical problem as a result of water pollution, thus affecting their ecological roles as habitats for sea urchins. Pahawang Island is located in the Lampung Bay area and has substrate characteristics that are suitable for the habitat preferences of sea urchins. On the contrary, Pahawang Island becomes famous tourist destination and this can potentially cause damage to habitats of sea urchin. The purpose of this research is to identify sea urchin species (Echinoidea) in the intertidal zone of Pahawang Island, Lampung.* **Methodology:** *Samples were collected using surveying method by walking along the intertidal zone during low tide. Sampling locations include Jelarangan Hamlet, Suwak Buah Hamlet, Andreas Resort around Kalangan Hamlet, and Pahawang Hamlet. Sea urchins were identified based on morphological characteristics.* **Findings:** *Sea urchins found in the intertidal zone of Pahawang Island consist of four species: Echinothrix calamaris, Diadema setosum, and Diadema antillarum, and Mespilia globulus. E. calamaris and D. setosum were found on substrates such as seagrass beds, coral, and sand, while Diadema antillarum and Mespilia globulus were only found in waters with coral substrates. These four species of sea urchins inhabit diverse habitats and play important ecological roles in the ecosystem, even influencing the conditions of other benthic organism communities in intertidal zone of Pahawang Island.* **Contribution:** *This study provides baseline data on sea urchin species within specific area to later plan conservation strategies related to human-induced environmental changes.*

Keywords: *Echinoidea; Intertidal; Lampung; Pahawang Island; Sea urchin*

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INTRODUCTION

Sea urchins are benthic animal classified under the class Echinoidea. The body of a sea urchin is typically round with five identical segments and spines located on its hard, calcareous shell (Parvez et al., 2016). The spines on the sea urchin's shell play functional roles. They are used to protect the body from predators and waterborne particles, as well as for locomotion and digging, particularly in irregular sea urchins (Moureaux et al., 2010). Sea urchins are commonly found in coral reef areas, seagrass beds, and mixed coral rubble substrates (Alwi et al., 2020). Being able to survive on different kinds of substrate, sea urchins play a very significant role in the marine food chain. The majority of sea urchins are herbivores and they help control algal populations. Some algae species consumed by sea urchins include *Undaria pinnatifida*, *Grateloupia elliptica*, *Sargassum confusum*, and *Ulva australis* (Yang et al., 2021). The abundance of sea urchins has a positive impact on coral reefs because their dominance helps maintain coral cover. This is because sea urchins feed on algae, which compete with corals for resources such as space and light (Ditzel et al., 2022). Additionally, sea urchins serve as a food source for other organisms in the marine environment (Sonico, 2018).

Marine ecosystem is now facing a severe pollution problems caused mainly by anthropogenic activities, including fishing, industry, and tourism. Coastal populations also have roles in this problem by directly disposing waste into the water. Pollutants entering marine environment will accumulate and lead to disruption of marine ecosystems (Parra-Luna et al., 2020). Echinoderm, such as sea urchins and sea cucumbers, has been studied for their responsiveness towards contaminants. Embryo development of several sea urchin species showed sensitivity to different types of heavy metal exposure (Morroni et al., 2023). Adult sea urchin also accumulates selected metals and organic contaminants in gonad and visceral mass (Parra-Luna et al., 2020; Rocha et al., 2018; Søndergaard et al., 2019). Sea urchins are particularly vulnerable to pollutant bioaccumulation due to their feeding habits. Habitats of sea urchin, including sea grass and coral reef ecosystems, are also facing severe degredation and loss caused by human activities (Ballesteros et al., 2018; El Zrelli et al., 2017; Zhang et al., 2023; Zhao et al., 2021). It could reduce the ability of these ecosystems to provide habitats for other marine organisms.

Pahawang Island is part of a small island group located in the Lampung Bay area, Pesawaran Regency, Lampung, with significant biodiversity potential, such as coral fish, coral reefs, and marine invertebrates, including sea urchins (Prakoso et al., 2015). The substrate characteristics of the waters around Pahawang Island are suitable for sea urchins, creating an environment that supports their existence. On the contrary, Pahawang Island has emerged as one of tourist destinations in Lampung which encourages construction of accommodation facilities. These facilities posses a threat to structural changes of sea urchin habitat. In addition to that, research on sea urchin biodiversity in the waters of Pahawang Island has not been reported yet. This study collects initial information on the species of sea urchin in the area which will contribute in planning conservation efforts regarding anthropogenic activities. The available information on sea urchin biodiversity in Lampung is currently based on studies conducted at Sari Ringgung Beach. Identification results

indicate the presence of two sea urchin species: *Diadema* sp. and *Brissus* sp. (Mulyana et al., 2023). Therefore, the aim of this study is to identify the species of sea urchins (Echinoidea) in the intertidal zone of Pahawang Island, Lampung.

METHOD

The research was conducted from July to August 2024 in the intertidal zone of Pahawang Island, South Lampung Regency, Lampung Province. This study was limited to only identify sea urchin based on the substrate type. Sampling was carried out using a survey method by walking along the intertidal zone during low tide. The samples were collected in the areas of Jelarangan Hamlet (5°40'49"S, 105°13'48"E), Suak Buah Hamlet (5°40'43"S, 105°12'56"E), Andreas Resort near Kalangan Hamlet (5°39'54"S, 105°12'36"E), and Pahawang Hamlet (5°39'45"S, 105°12'55"E) (Figure 1). All four of these sampling sites were adjacent to either coastal residential area or tourist accommodation. Samples were collected directly with the help of tongs and gloves. The samples collected were then identified and preserved using 70 % alcohol. Sea urchin was identified based on morphological characteristics, including body color and shape, as well as the color and shape of the spines (Clark & Rowe, 1971).

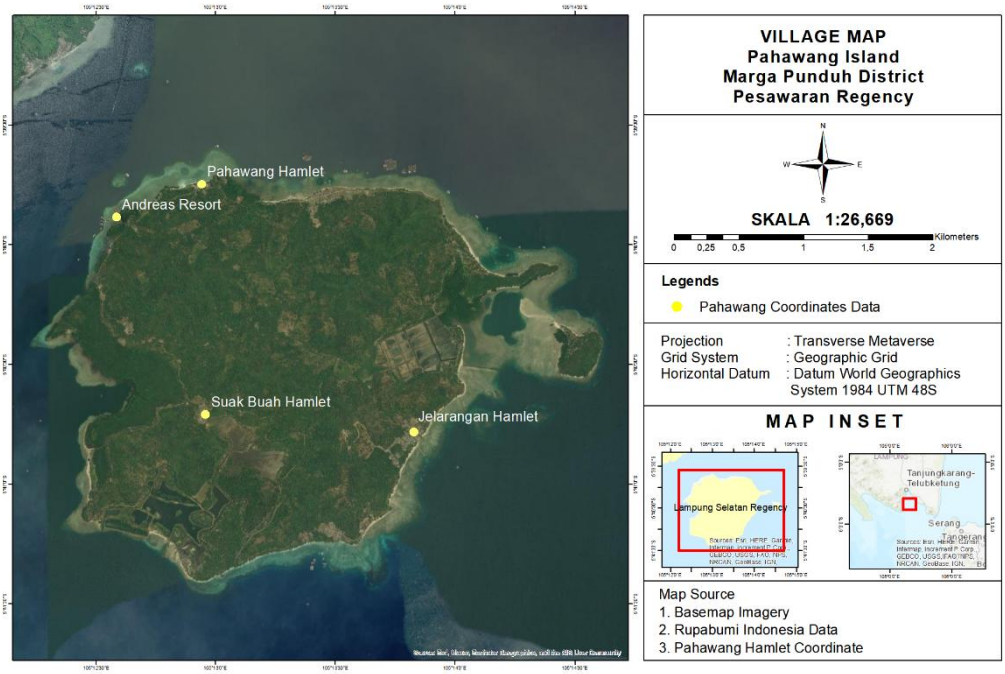

Figure 1. Research sites in the intertidal zone of Pahawang Island, Lampung

RESULT AND DISCUSSION

The sea urchins found in the intertidal zone of Pahawang Island consist of four species from two different families. Three of these species belong to the family Diadematidae: *Echinothrix calamaris*, *Diadema setosum*, and *Diadema antillarum*, while the other species, *Mespilia globulus*, belongs to the family Temnopleuridae. These four sea urchin species inhabit various types of substrates, including seagrass beds, coral,

and sand. *Echinothrix calamaris* and *Diadema setosum* were found on substrates such as seagrass beds, coral, and sand, while *Diadema antillarum* and *Mespilia globulus* were only found in waters with coral substrates (Table 1).

Table 1. Sea urchin species found in the intertidal zone of Pahawang Island, Lampung, based on water substrates

No.	Families	Species	Substrates		
			Seagrass	Coral	Sand
1	Diadematidae	*Echinothrix calamaris*	+	+	+
2	Diadematidae	*Diadema setosum*	+	+	+
3	Diadematidae	*Diadema antillarum*	-	+	-
4	Temnopleuridae	*Mespilia globulus*	-	+	-

Annotation: + = found; - = not found

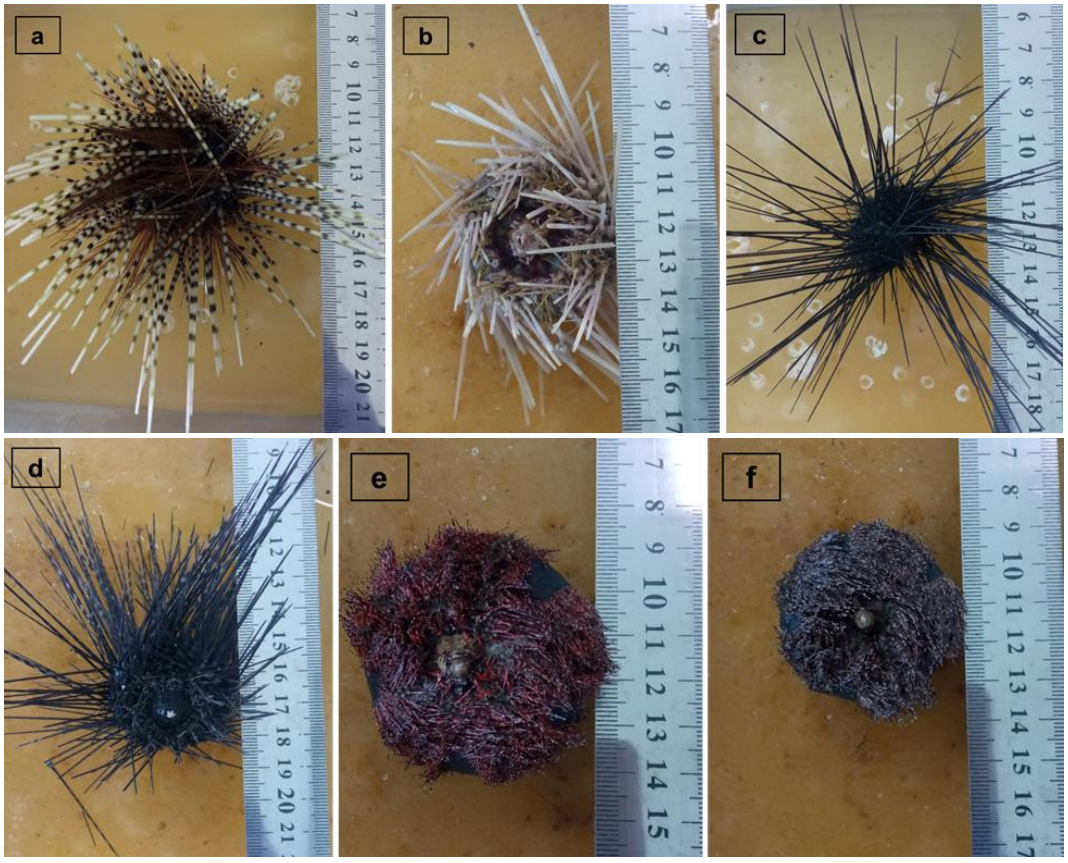

Figure 2. Sea urchin species in the intertidal zone of Pahawang Island, Lampung: (a) *Echinothrix calamaris*; (b) *Echinothrix calamaris*; (c) *Diadema setosum*; (d) *Diadema antillarum*; (e) *Mespilia globulus*; (f) *Mespilia globulus*

Sea urchin *Echinothrix calamaris* has a flattened shell, with long and flat spines in white color (Figure 2B) or exhibit other variations, such as banded patterns

(Figure 2A). Both *E. calamaris* with white and banded pattern spines were identified in this study. *Diadema setosum* has long, sharp spines that are black in color. The body of *D. setosum* is black, with its mouth located underneath and facing downward, while the anus is located on the top and faces upward (Figure 2C). The sea urchin species *Diadema antillarum* has long black spines, sometimes with a grayish-white hue, and the spine length can reach up to 20 cm (Figure 2D). *D. antillarum* typically lives on coral reefs and coral rubble. The sea urchin *Mespilia globulus* has a round body with black plates and brown spines. Its primary spines are short, hard, and covered with thin skin (Figure 2E and 2F). *M. globulus* identified in this study varied in spine color, including light and darker brown.

The sea urchin species *Echinothrix calamaris* was found on substrates such as seagrass beds, coral, and sand. This indicates that *E. calamaris* can adapt well to different types of substrates. Previous studies have mentioned that *E. calamaris* feeds on or grazes on certain types of seagrass, such as *Syringodium isoetifolium* (Coppard & Campbell, 2007). Furthermore, the distribution of *E. calamaris* is influenced by several important factors in its habitat, including water depth and live coral cover (Mok et al., 2023). *Diadema setosum* is an important sea urchin species because it plays a role in maintaining balance within coral reef ecosystems. In this study, *D. setosum* was also found on substrates such as seagrass beds, coral, and sand, similar to *E. calamaris*. A low number of *D. setosum* may lead to a phase shift in the reef, from a coral-dominated reef to an algae-dominated reef. Conversely, an excessive number of *D. setosum* may cause bioerosion and threaten coral survival (Vimono et al., 2023). A previous study conducted in the waters of Sari Ringgung Beach, Lampung, reported that *D. setosum* was also found in coral and seagrass habitats, with no sea urchins found on muddy sand substrates (Mulyana et al., 2023).

Sea urchins of the species *Diadema antillarum* and *Mespilia globulus* were only found on coral substrates in this study. *D. antillarum* plays a very important role in coral reef ecosystems because an increase in its population can aid in the recovery of coral cover. *D. antillarum* feeds on algae, leading to a significant reduction in algae abundance. This decreases competition between adult coral colonies and algae, allowing coral recruitment (coral spat) to occur in the area (Lessios, 2016). *Mespilia globulus* is a species that prefers to consume macroalgae rather than seagrass (Nadiarti et al., 2021). When *M. globulus* is cultured ex-situ along with the coral species *Acropora millepora*, it significantly affects the survival rate and colony size of the coral. The survival rate of the coral was highest in treatments with the highest density of *M. globulus*, while the coral colony size reached its largest in treatments with moderate to high sea urchin densities (Craggs et al., 2019). The presence of macroalgae is often found in close proximity to coral colonies. However, *M. globulus* can also live in seagrass beds with moderate to high densities (Nadiarti et al., 2021). This suggests that the diversity and density of sea urchins can impact the condition of other benthic organism communities. The species of seagrasses and corals where sea urchins were found have not been identified in this study. Further research is needed to better understand the specific forms of interaction between sea urchins, seagrasses, and corals in the waters of Pahawang Island.

CONCLUSION

The sea urchins found in the intertidal zone of Pahawang Island consist of four species from two different families: *Echinothrix calamaris*, *Diadema setosum*, and *Diadema antillarum* from Diadematidae, and *Mespilia globulus* from Temnopleuridae. These four sea urchin species inhabit diverse habitats and play important ecological roles in the ecosystem. This study provides baseline data on sea urchin species within specific area to later plan conservation strategies related to human-induced environmental changes.

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