Sea urchins of Peninsular Malaysia: Spatial distribution and species-habitat association

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A R T I C L E   I N F O

A B S T R A C T

Sea urchins are keystone herbivores in coral reefs that can prevent coral-algae phase shifts and promote coral resilience in the Caribbean. However, knowledge of sea urchin populations in the Indo-Pacific region is less extensive and their role in marine ecosystems remains uncertain. To fill this knowledge gap, this study examined the spatial distribution and species-habitat association of sea urchins in Peninsular Malaysia as a first step in exploring their potential for promoting reef resilience. Firstly, geographical information on the population characteristics of sea urchins in Peninsular Malaysia (Sunda Shelf and Malacca Strait Marine Ecoregions) was gathered. Using literature, questionnaire, and field surveys, ten species of sea urchins from six families were identified in the species record for Peninsular Malaysia. *Prionocidaris bispinosa* represents the first record for Malaysia, documented in the intertidal seagrass meadow at Tanjung Kupang, Johor. Combining density data from literature and field surveys, sea urchin density for Peninsular Malaysia was estimated to be 46.94 ± 66 individuals/100 m^2. Secondly, the species-habitat association of *Diadema setosum* and *Echinothrix calamaris* were determined in belt-transect surveys (n=57), with transects laid parallel to shore at Pulau Rawa, Johor. Multivariate regression analysis identified *D. setosum* to be more associated with live coral cover and coral growth form, while *E. calamaris* distribution was driven by habitat rugosity, water depth and live coral cover. These findings suggest contrasting species-habitat associations for the two co-existing species. Given the limited information about sea urchins in Malaysia, this study appears to be the first in-depth study of its kind in the country, deepening our knowledge of sea urchin distribution and the importance of habitat in shaping that distribution. This baseline data serves as valuable information in the planning and management of natural habitats for biodiversity and conservation in Malaysia's marine ecosystem.

1. Introduction

1.1. Sea urchins in Malaysia

Coral reefs worldwide are degrading and shifting to macroalgae-dominated reefs (Bruno and Selig, 2007; Done, 1992; Hughes, 1994; Pandolfi and Jackson, 2006) due to the combined effects of climate change, ocean acidification, and local impacts such as coastal development and overfishing (De'ath et al., 2012; Souter et al., 2021). Consequently, coral settlement and post-settlement survival has been reduced (Leong et al., 2018). The herbivory of sea urchins, however, has been shown to facilitate reef recovery and enhance reef resilience by preventing the proliferation of algae that negatively impact coral settlement, growth, and survivorship in the Caribbean, West Pacific, Kenya and Red Sea (Dang et al., 2020; Korzen et al., 2011; Kuempel and Altieri, 2017; Lessios, 2016; O'Leary et al., 2013; Sangil and Guzman, 2016). Given their critical role in coral reef recovery, it is essential to understand sea urchin population distributions on local coral reefs, but such data is scarce in Malaysia. In Caribbean reefs, the scarcity of baseline information on urchin communities before the 1983 *Diadema antillarum* mortality event left several fundamental questions concerning the extent and causes of recent reef ecosystem change unresolved (Lessios, 1988). This situation subsequently led to disagreements over the sea urchins' "natural" role in reef ecosystems because the baseline density of *D. antillarum* was never quantified (Cramer et al., 2016). This very same information gap applies to Malaysia, where sea urchins are ubiquitous but distribution and abundance data, limited.

1.2. Distribution patterns in Peninsular Malaysia

The seas of Malaysia span across five marine ecoregions — the Sunda Shelf, Malacca Strait, North Borneo and a small part of the

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