Habitat Characteristics and Morphometrics of Starfish (*Archaster typicus*) in the Seagrass Ecosystem of the Waters of Malahing Hamlet, Bontang City

Muhammad Hardiansyah | Aditya Irawan* | Lily Inderia Sari

Department of Aquatic Resources Management, Faculty of Fisheries and Marine Science, Mulawarman University
Jl. Gunung Tabur No. 1. Kampus Gn. Kelua Samarinda 76123
**E-mail: aditarm83@fpik.unmul.ac.id*

ARTICLE INFO

Research Article

Article history:
Received January 9, 2025
Received in revised form May 25, 2025
Accepted January 25, 2026

DOI: https://doi.org/10.30872/nsr77q68

Keywords: *marine, tropical, biota, aquatic monitoring*

ABSTRACT

The purpose of this study was to determine the habitat and morphometric characteristics of Archaster typicus in seagrass beds and to determine the density and composition of seagrass in the Malahing Hamlet Waters, Bontang City. The study was conducted from June - September 2024. The research locations were grouped into 3 research stations (North, East, South) with quadrant transects. Starfish identification data were analyzed using seagrass density and Regression correlation. Archaster typicus is relatively common in shallow waters, and the habitat found is on sand flats. The highest and lowest average morphometric character results in arm length were at the eastern station 4.5 ± 0.7 cm and the lowest at the southern station 4.2 ± 0.6 cm, the highest body height at the eastern station 0.7 ± 0.2 mm and the lowest at the southern station 0.4 ± 0.2 mm, the highest arm base width at the eastern station 1 ± 0.1 mm and the lowest at the northern station 0.9 ± 0.1 mm, the highest overall diameter at the southern station 8.2 ± 1.5 cm and the lowest at the northern station 8.4 ± 0.7 cm, the highest bodyweight at the eastern station 7.6 ± 2.4 grams and the lowest at the northern station 7.3 ± 1.4 grams, the highest distance between arms at the southern station 5.6 ± 1.1 cm and the lowest at the northern station 5.1 ± 0.6 cm.

INTRODUCTION

The seagrass ecosystem is one of the coastal ecosystems that plays an important role in maintaining the balance of the marine environment. Seagrass beds distributed between mangrove and coral reef ecosystems function as feeding grounds, spawning areas, and habitats for various marine organisms. Seagrass meadows may consist of a single seagrass species (monospecific) or a mixture of several species (mixed vegetation), with varying levels of density (Azkab, 2006). In addition, seagrass ecosystems contribute to sediment stabilization, carbon sequestration, and shoreline protection against coastal erosion.

One of the faunal groups commonly found in coastal and seagrass ecosystems is sea stars (Asteroidea). *Archaster typicus* is one of the sea star species frequently encountered in sandy substrates and seagrass habitats. This species exhibits a distinctive behavior of burying its body within sandy substrates as an adaptive response to environmental conditions such as desiccation, exposure to solar radiation, and predator avoidance (Aziz, 1996). This adaptation demonstrates a close relationship between the morphology and behavior of the species and the characteristics of its habitat.

Studies on the habitat characteristics and morphometrics of *A. typicus* within seagrass ecosystems are important for understanding the relationship between environmental conditions and the morphological aspects of this species. Such information may provide insights into the adaptive strategies of *A. typicus* in response to variations in substrate type and seagrass density, as well as its contribution to the dynamics of coastal ecosystems.

This study was conducted in the waters of Malahing Hamlet, Bontang City, an area recognized for its extensive and productive seagrass ecosystem. The site represents an important location for examining the interaction between benthic organisms and coastal environmental conditions. The findings of this study are expected to provide baseline information useful for coastal resource management, particularly in supporting the conservation of seagrass ecosystems and their associated biodiversity.

METHODOLOGY

Study Location

The study was conducted in the waters of Malahing Hamlet, Bontang City, East Kalimantan, from June to December 2024. The research activities included the identification of seagrass and sea star species, preparation of research equipment, data collection, and data processing. The study area was established in the waters of Malahing Hamlet, Bontang City, comprising three observation stations. Analyses of the research objects and water quality parameters were carried out at the Water Quality Laboratory, Faculty of Fisheries and Marine Science, Mulawarman University, while sediment substrate analyses were conducted at the Soil Science Laboratory, Center for Environmental Research and Development (PPLH), Faculty of Agriculture, Mulawarman University.

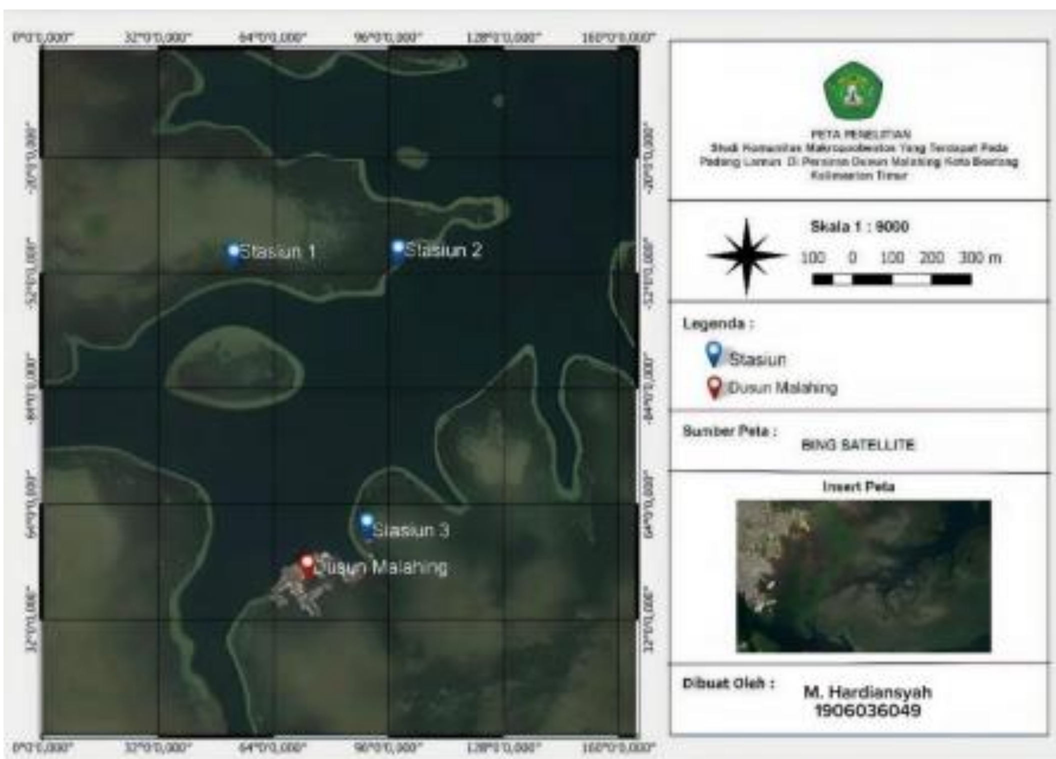

Figure 1. Study location map

Data Analysis

Seagrass density was determined using the quadrat transect method. Seagrass density data were calculated using the following formula (Tuwo, 2011):

$$Kji = Ni / A$$

Where:

Kji = seagrass species density
Ni = total number of shoots of a species
A = area of the sampling plot used

Relative density was defined as the ratio between the number of individuals of a species and the total number of individuals of all species, aimed at determining the percentage contribution of each species density to the total density of all species (Tuwo, 2011).

$$KR=(Ni/ \Sigma n) \times 100\%$$

Where:

- *KR* = relative density
- *Ni* = total number of shoots of a species
- $\sum n$ = total number of individuals of all species

Simple correlation analysis was performed using Microsoft Excel, where variable x represented seagrass density and variable y represented sea star density. This analysis was conducted to determine the relationship between sea star density and seagrass density. The correlation coefficient (r) ranges from -1 to 1; values approaching 1 or -1 indicate a stronger relationship between the two variables, whereas values approaching 0 indicate a weaker relationship. A positive value indicates a direct relationship (xxx increases as y increases), while a negative value indicates an inverse relationship (x increases as y decreases) (Sugiyono, 2007).

RESULT AND DISCUSSION

Based on morphological observations, *A. typicus* possesses five arms and a flattened body form. The arms are pointed in shape and characterized by brown bands extending along their length. White, blunt, and flattened spines are distributed along the arms. The aboral surface ranges in color from brownish to grayish white, while the oral surface is white and contains a centrally located mouth. The body changes to an orange coloration when preserved in alcohol. This species inhabits sandy substrates by burying itself within the sediment and is less frequently encountered in areas with dense seagrass cover.

Density of *Archaster typicus*

The total density of *Archaster typicus* recorded at each station varied considerably. The northern station exhibited a density of 24 individuals/m², the southern station 40 individuals/m², and the eastern station 32 individuals/m². Differences in the density of *A. typicus* among stations were presumably influenced by variations in habitat characteristics, particularly substrate composition and ecosystem conditions. The southern and eastern stations were predominantly characterized by sandy substrates, whereas the northern station was dominated by muddy and sandy-mud substrates. According to Supono and Arbi (2012), the distribution of sea stars is strongly influenced by substrate type or habitat, as well as by the abundance and availability of food resources and other environmental factors affecting the aquatic ecosystem.

Morphometrics of *Archaster typicus*

The range, mean, and standard deviation of morphometric measurements obtained from 24 individuals of *Archaster typicus* showed differences in both size and frequency distribution among the sampling stations. Morphometric measurements collected from the research stations demonstrated considerable variation.

The highest and lowest morphometric values, together with their averages and standard deviations, were recorded as follows: arm length (PL) was highest at the eastern station (4.5 ± 0.7 cm) and lowest at the southern station (4.2 ± 0.6 cm); body height (TT) was highest at the eastern station (0.7 ± 0.2 mm) and lowest at the southern station (0.4 ± 0.2 mm); arm base width (LPL) was highest at the eastern station (1.0 ± 0.1 mm) and lowest at the northern station (0.9 ± 0.1 mm); overall diameter (DK) was highest at the southern station (8.2 ± 1.5 cm) and lowest at the northern station (8.4 ± 0.7 cm); body weight (BT) was highest at the southern station (7.5 ± 2.6 g) and lowest at the northern station (7.3 ± 1.4 g); and inter-arm distance (JAL) was highest at the southern station (5.6 ± 1.1 cm) and lowest at the northern station (5.1 ± 0.6 cm).

Differences in morphometric ratios of *Archaster typicus* among stations were likely associated with variations in sea star growth conditions at each location. Environmental factors and limited food availability may have contributed to reduced growth performance, while competition with other echinoderm species may also have affected access to food resources. Conversely, when sea stars dominate a particular seagrass habitat or ecosystem, their growth tends to be faster due to greater food availability, particularly organic detrital deposits commonly found in sandy substrates (Zulfa, 2015).

Seagrass

Based on the data obtained from observations at the three sampling stations, two seagrass species belonging to the family Hydrocharitaceae were identified in the waters of Malahing Hamlet, Bontang City. The two species recorded were *Thalassia hemprichii* and *Enhalus acoroides*. The results of species density calculations showed that the density of *E. acoroides* was 664 shoots/m² at the southern station, 784 shoots/m² at the eastern station, and 1040 shoots/m² at the northern station. The highest density of *E. acoroides* was recorded at the northern station, whereas the lowest density occurred at the southern station. In contrast, the density of *T. hemprichii* was 0 shoots/m² at the southern station, 220 shoots/m² at the eastern station, and 140 shoots/m² at the northern station. The highest density of *T. hemprichii* was therefore observed at the eastern station, while the southern station showed the lowest density with no individuals recorded.

According to the density scale of Braun-Blanquet (1965) as cited in Pane et al. (2021), the density of *E. acoroides* at all stations, ranging from 644–1040 shoots/m², falls into scale 5 (>175 individuals/m²), indicating a very dense seagrass condition. *E. acoroides* was commonly found growing in sandy-mud substrates and was the dominant seagrass species in the waters of Malahing Hamlet, Bontang City. Kiswara (2010) as cited in Suryanti et al. (2014) reported that seagrass shoot density and spatial expansion depend on species characteristics; therefore, species with larger morphology such as *E. acoroides* tend to exhibit higher density compared to smaller species such as *T. hemprichii*, which generally show lower density values.

The density of *T. hemprichii* ranged from 0–220 shoots/m². At the southern station, where no individuals were recorded, the density was categorized as scale 1 (<25 individuals/m²), indicating a very sparse condition. At the eastern station, with a density of 220 shoots/m², the species was categorized as scale 5 (>175 individuals/m²), indicating a very dense condition. Meanwhile, the northern station, with a density of 140 shoots/m², was categorized as scale 4 (125–175 individuals/m²), indicating a dense condition. According to Fauziyah (2004) as cited in Ruswahyuni et al. (2013), *T. hemprichii* can inhabit a wide variety of substrates ranging from coral rubble to soft substrates and even liquid mud; however, it is more commonly associated with hard substrates and may form monospecific communities on sandy bottoms. Consequently, the lower density of *T. hemprichii* at the northern and southern stations was likely related to the predominantly muddy substrate conditions at those sites.

Based on the results of relative density calculations, *E. acoroides* exhibited the highest relative density values, ranging from 78% to 100% across all sampling stations. In contrast, *T. hemprichii* showed the lowest relative density values, ranging from 0% to 22%. *E. acoroides* was the dominant seagrass species at all stations, with the highest relative density recorded at the southern station (100%), followed by the eastern station (88%) and the northern station (78%). Conversely, *T. hemprichii* exhibited the lowest relative density values among all stations. The highest relative density of *T. hemprichii* was recorded at the eastern station (22%), followed by the northern station (22%), whereas no individuals were recorded at the southern station, resulting in a relative density value of 0% (Figure 2).

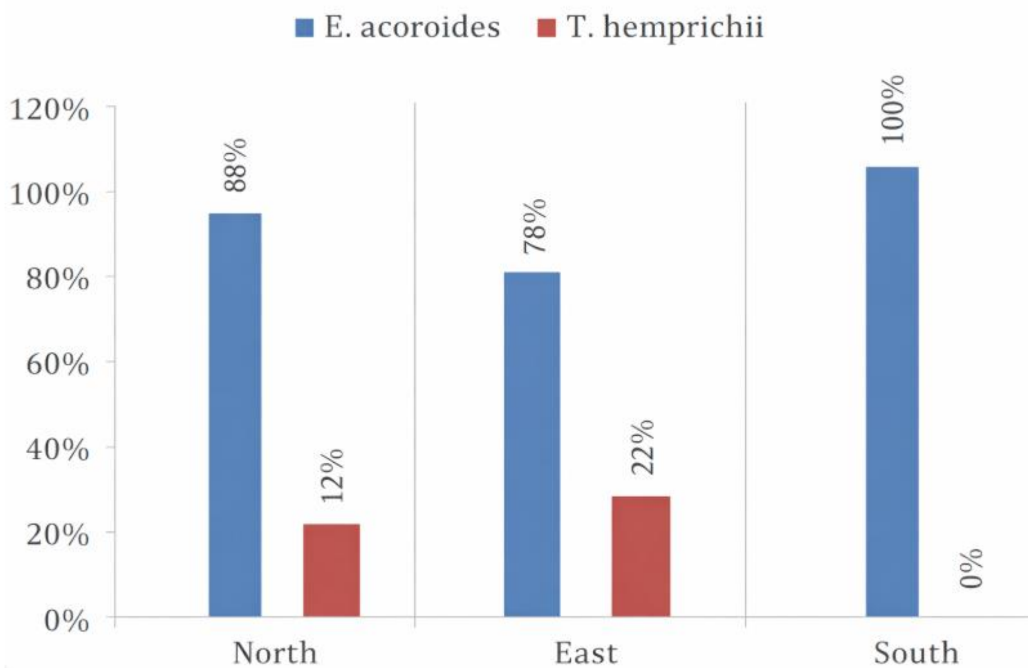

Figure 2. Relative density of seagrass species at each station

Habitat Characteristics of *Archaster typicus*

Based on field observations, the study area consisted of two distinct habitat characteristics: seagrass beds and sandy flats. Observations among stations indicated that sandy flat areas, characterized by open sandy substrates, were predominantly found at the northern and western stations. The total sand substrate composition at these stations reached 78.00% at the northern station and 73.00% at the western station.

Sandy-mud sediments were predominantly associated with seagrass habitats. The seagrass species identified within these sandy-mud substrates were *E. acoroides* and *T. hemprichii*. These species were widely distributed and grew abundantly in areas characterized by sandy-mud substrates. This finding is consistent with Takaen and Azkab (2010), who reported that *E. acoroides*, *T. hemprichii*, and *Syringodium isoetifolium* commonly grow on sandy-mud substrates and dead coral rubble in open intertidal areas located far from the shoreline and continuously inundated by seawater.

Archaster typicus is relatively common in shallow-water habitats. The species observed in this study was associated with seagrass beds, sandy substrates, and muddy substrates. This sea star species was relatively easy to encounter and was most frequently found in sandy habitats. Similar findings were reported by Irawan (2014) as cited in Frisca (2020) in the littoral waters of the eastern coast of Bintan Island, where *A. typicus* was consistently found at all sampling locations sharing similar sandy littoral coastal habitats.

Relationship Between Seagrass Density and Sea Star Density

The correlation test results presented in Figure 3 showed a simple linear regression equation of:

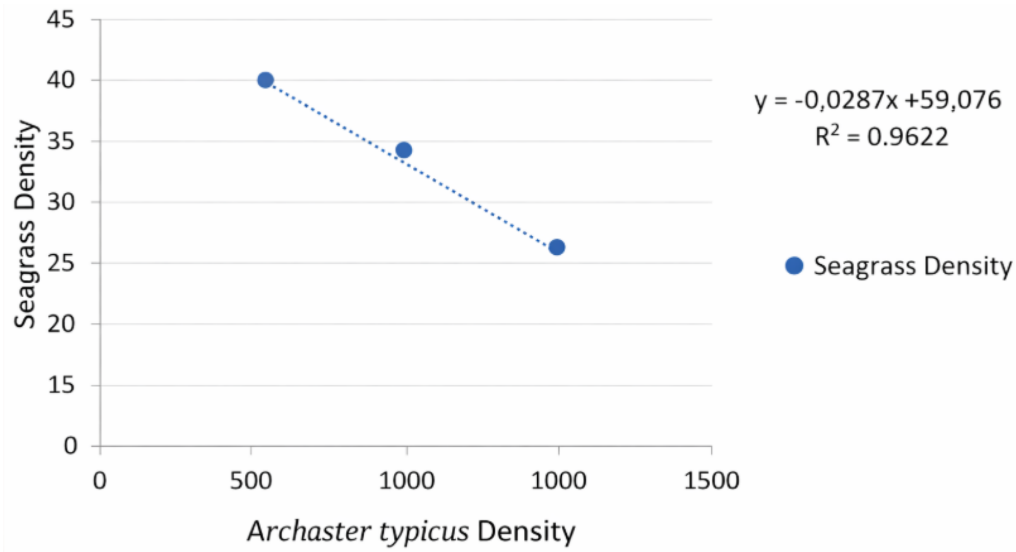

Figure 3. Relationship between seagrass density and *Archaster typicus* density

with a coefficient of determination (R^2) value of 0.9622, indicating that seagrass density had a very low level of relationship with sea star density and exhibited a negative correlation. According to Sugiyono (2007) as cited in Astuti (2018), correlation values ranging from 0.00–0.199 are categorized as very low. These results indicate that higher seagrass density was not followed by an increase in sea star density.

This finding is consistent with Colin and Arneson (1995), who stated that *A. typicus* tends to prefer sandy substrates with low seagrass cover or even areas entirely lacking seagrass vegetation. In addition, sandy substrates generally provide abundant food availability for this species.

CONCLUSION

Archaster typicus demonstrated a strong habitat preference for sandy substrates with low seagrass cover. The density of this species varied among sampling stations, with the highest density recorded at stations dominated by sandy substrates. This finding confirms that substrate characteristics are the primary factor influencing the distribution and density of *A. typicus*, whereas seagrass density does not appear to be directly associated with the presence of this species.

In addition, the morphometric analysis revealed variations in the size and body shape of *A. typicus* among the study locations. These differences were most likely influenced by environmental conditions, food availability, and the level of competition with other benthic organisms. Such morphometric variation reflects the adaptive strategies of the species in response to differing habitat conditions, particularly with respect to growth and survival capability within coastal ecosystems.

From an ecological perspective, this study highlights the importance of seagrass ecosystems as providers of habitat and resources for various marine organisms, although *A. typicus* was found to be more dominant in sandy areas. Information regarding the relationship between seagrass density and the density of *A. typicus* provides a useful scientific basis for coastal resource management. These findings may support conservation efforts aimed at preserving seagrass ecosystems and their associated biodiversity, particularly in the coastal waters of Malahing, Bontang.

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