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Ecological study of gastropod on seagrass ecosystem in small island sea North Maluku Indonesia

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ABSTRACT

The seagrass ecosystem is a habitat and food source for fish and other aquatic biota. One of the biota commonly found in seagrass beds is gastropods . This aim research was carried of identifying the composition of gastropod species, assessing ecological indices which include species density, species diversity, species dominance, species evenness, distribution patterns of gastropods and their use in the seagrass ecosystem on Maitara Island. Gastropod sampling was carried out at low tide. The gastropod samples determined based on morphological characteristics such as shell shape, shell color, shell mouth opening and spiral circle. Based on the research results, the composition of gastropod species found in the seagrass ecosystem is 32 species. The density of gastropod species was highest in the seagrass ecosystem on Maitara Island, at each different station. The highest density of gastropod species was Morula uva and Strombus luhuanus, while the lowest density was Trhocus maculatus, Littorina scabra and Nassarius sp. The diversity of gastropod species at all stations is classified as moderate. For the dominance index at all stations, there is no dominant species in the category. The evenness of species at station 1 and 4 is classified as more evenly distributed, while at stations 2 dan 3 it is classified as very evenly distributed. The overall distribution pattern of gastropods is classified as clustered and random. Totals 32 species of gastropods, 10 of them are used by the people of Maitara Island as food for consumption.

Introduction

The mollusk phylum, which includes gastropods and snails, is widely known for its strong ties to seagrass habitats. Fish and other aquatic biota can find food and shelter in seagrass ecosystems. In seagrass beds, gastropods are a common biota (Sunarti *et al.,* 2021; Batuwael & Rumahlatu, 2018 in Sunarti *et al.,* 2023).

Gastropods play a significant ecological and economic function in life. In terms of ecology, gastropods serve as both a natural food source for aquatic life and a steward of their surroundings. In the meantime, gastropod shells are economically utilized as a combination of industrial raw materials, building materials, or decorative materials (Ohorella, 2019; Kusnadi *et al.,* 2009 *in* Kaseger *et al.,* 2021; Kusnadi, 2009; Prajitno, 2009 *in* Sitanggang *et al.,* 2021; Anwari and Burhanuddin, 2019 *in* Potutu *et al.,* 2024; Haumahu *et al.,* 2024).

Additionally, gastropods are a group that can adapt to a wide range of habitats and ecosystems, including mangroves, coral reefs, seagrass environments, and sandy, muddy, or rocky substrates. Furthermore, gastropods support the sustainability of the surrounding aquatic life system by serving as early trophic-level decomposers in marine and coastal ecosystems (Gea & Hariono, 2022; Holand, 2008 in Kahembau *et al.,* 2023; Roring *et al.,* 2020 *in* Tetiwar *et al.,* 2024). The northern region of Tidore City, North Maluku Province, is home to the Maitara Island Sea. North Maitara, Central Maitara, South Maitara, and Main Maitara are the four communities that make up Maitara Island. The waters surrounding Maitara Island are home to a diverse and intricate coastal ecology that includes coral reefs, seagrass beds, and mangroves. Numerous species of macrobenthic fauna, particularly

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gastropods, have been discovered thanks to the occurrence of these three coastal environments.

In order to learn more about the ecological study of gastropods, including species density, species diversity, species evenness, species dominance, distribution patterns, and their use, research on gastropods in Maitara Island's waters was undertaken. Information regarding the presence of gastropod species in the seagrass ecosystem in the waters surrounding Maitara Island, North Maluku, is therefore anticipated to be provided.

Materials and Methods

Location and time

The research was conducted on Maitara Island, in 4 villages, namely Maitara Induk, Maitara Utara, Maitara Tengah and Maitara Selatan. The implementation period was 6 months, namely April-September 2024.

Sampling

A 50-meter horizontal transect including three transects—the front intertidal zone (ZIBD), the middle intertidal zone (ZIBT), and the back intertidal zone (ZIBB)—was first drawn as part of the research process. The tracks or transects were spaced 10 meters apart, and each transect was positioned at random among 10 1 x 1 m2 quadrants.

During low tide, gastropods were sampled. The samples were placed in plastic bags with quadrant and track labels. Additionally, in accordance with Dharma guidelines (1992), the gastropod samples were brought onshore in order to count the number of individuals of each species and identify this based on physical traits such as shell shape, color, mouth aperture, and spiral circles.

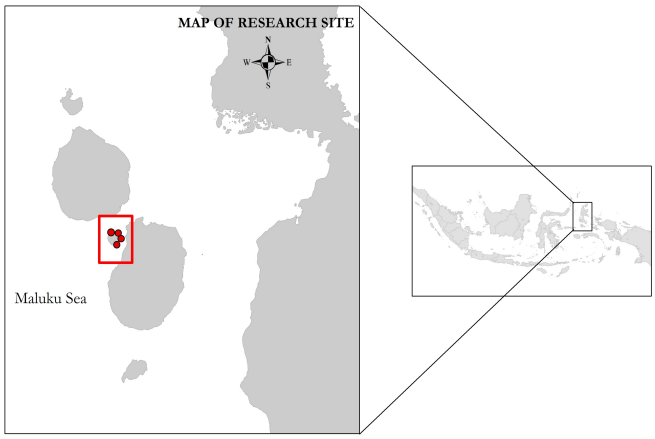


Figure 1. Research site in Maitara Island

Measurement of environmental factors such as water pH, salinity, and temperature. Three iterations of each parameter were performed for the water quality sampling.

Data analysis

Data in biodiversity of gastropods on Maitara Island's seagrass ecosystem were then examined using the formula (Krebs, 1999) :

$$\mathbf{D = \frac{X}{A}}$$

Information :
D = Density of each species (Ind/m^2)
X = Number of individuals per species (Ind/m^2)
A = The area measured by quadrants (m^2)

Diversity of species (H')

The number of species and individuals in each species within a community are used to calculate the species diversity index, which is a measure of community richness. The Shannon and Wiener technique is applied in accordance with (Ludwig & Reynolds, 1988 *in* Rondo, 2015) to determine the degree of diversity:

$$H' = -\sum_{i:1}^{s} \frac{ni}{N} \ln \frac{ni}{N}$$

Information :
H = Diversity of species
ni = Number of individuals species-i
N = Total number of individuals
Criteria :
$H' < 1$ = Low species diversity
$1 \leq H' \leq 3$ = = Medium species diversity
$H' > 3$ = High species diversity

Dominance index (C)

When there is an unequal distribution of individuals and a propensity for one species to dominate, this is known as species dominance. Dominance index analysis using Rondo (2015):

$$C = \sum \left(\frac{ni}{N} \right)^2$$

Information :
C = Species dominance
ni = Number of individuals per species
N = Number of individuals of all species
Criteria :

If C approaches 0, it means that there is no dominant species and if the C value approaches 1, it means that there is one dominant species.

Equity index (E)

Species evenness is used to see the distribution of each organism in a habitat occupied. Species evenness is based on the formula (Wibisono, 2005):

$$E = \frac{H'}{H_{max}}$$

Information :
E = Equity Index
H' = Diversity of species
H_{max} = Ln S
S = Number of taxa/species

Criteria :
> 0,81 = Distribution species is very even.
0,61 – 0,80 = Distribution species is more even.
0,41 – 0,60 = Distribution species is even.
0,21 – 0,40 = Distribution species is quite even.
< 0,21 = Distribution species is uneven.

Distribution pattern

Data analysis using the Morisita index formula (Krebs, 1999) :

$$I_d = n\left[\frac{\sum x^2 - \sum x}{(\sum x)^2 - \sum x}\right]$$

Information :
Id = Index Morisita
N = Total number of plots
X = Number of individuals in each plot

Kriteria :
If Id = 1, then the distribution pattern is random
If Id > 1, then the distribution pattern is clustered
If Id < 1, then the distribution pattern is uniform

Results

Species composition

Based on research findings on Maitara Island at station 1 (Maitara Induk), the makeup of gastropod species found there were 16 species, including *Strombus luhuanus, Trochus maculatus, Neothais marginatra, Canarium urceus, Nerita plicata, Natica* sp *Nassarius pullus*, *Nassarius* sp, *Oliva tigridella oriole, Conus literatus, Conus virgo, Thais* sp, *Haliotis varia, Canarium labiatum, Eclogavena quadrimaculata* dan *Cypraea moneta.*

There were up to 8 different species of gastropods identified at station 2 (Maitara Utara), including *Nassarius pullus*, *Nerita plicata, Littorina scabra, Conus magus, Canarium urceus, Strombus luhuanus, Perdalinus testudinaria* dan *Canarium maculatum*. Station 3 (Maitara tengah), 4 species were obtained, namely *Strombus luhuanus, Conus literatus Cerithidea djadjariensis* dan *Littorina scabra*. 17 species were collected at Station 4 (Maitara selatan), including *Canarium urceus, Cerithium coralium, Cypraea annulus, Strombus mutabilis, Trhocus maculatus, Tritia reticulata, Polinices peselphanti, Littorina scabra, Nassarius globosus, Conus magus, Cypraea moneta, Morulla uva, Turritella terebra, Vexillum plicarium, Cerithium litteratum, Oliva vidua* dan *Strombus luhuanus.*

Density of gastropod species

The results calculating density of gastropod species at station 1 (Maitara Induk) Figure 2.

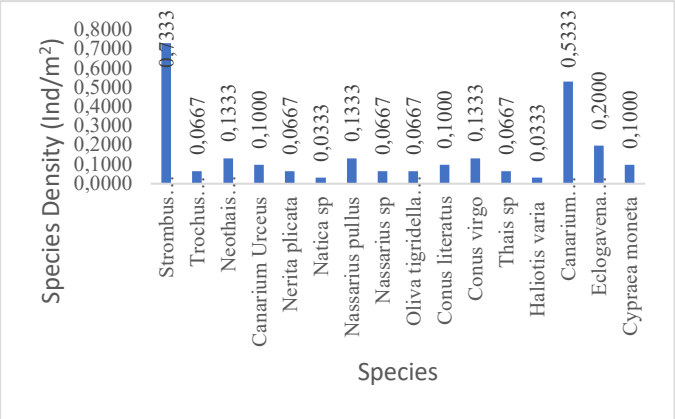


Figure 2. Density of gastropod species at station 1

Species have the highest density at station 1. *Strombus luhuanus* (0.7333 ind/m^2), *Canarium labiatum* (0.5333 ind/m^2), *Eclogavena quadrimaculata* (0.2000 ind/m^2). *Neothais marginatra, Nassarius pullus* and *Conus virgo* have the same density value, namely (0.1333 ind/m^2). *Canarium Urceus, Conus literatus* dan *Cypraea moneta* also has the same density value, namely (0.1000 ind/m^2). *Trochus maculatus, Nerita plicata, Nassarius* sp, *Oliva tigridella oriole* dan *Thais* sp also has the same density value, namely (0.0667 ind/m^2). The lowest density of gastropod species is found in species *Natica* sp dan *Haliotis varia* (0.0333 ind/m^2).

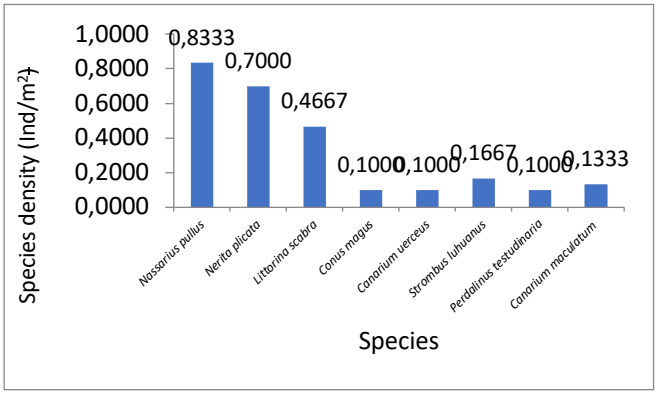


Figure 3. Density of gastropod species at station 2

The highest density at station 2 was found in species *Nassarius pullus* (0.8333 ind/m^2), *Nerita plicata* (0.7000 ind/m^2), *Littorina scabra* (0.4667 ind/m^2),

Strombus luhuanus (0.1677 ind/m^2) and *Canarium maculatum* (0.1333 ind/m^2). The lowest density of gastropod species is found in species *Conus magus, Canarium uerceus* dan *Perdalinus testudinaria* dengan nilai (0.1000 ind/m^2). Density of gastropod species at station 3 (Maitara tengah) in Figure 4.

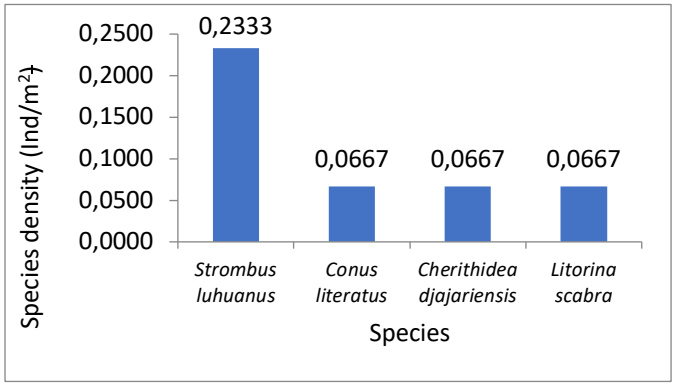


Figure 4. Density of gastropod species at station 3

The highest density at station 3 is found in species *Strombus luhuanus* (0.2333 ind/m^2). The lowest density is found in species *Conus literatus, Cherithidea djajariensis* dan *Littorina scabra* dengan nilai (0.0667 ind/m^2).

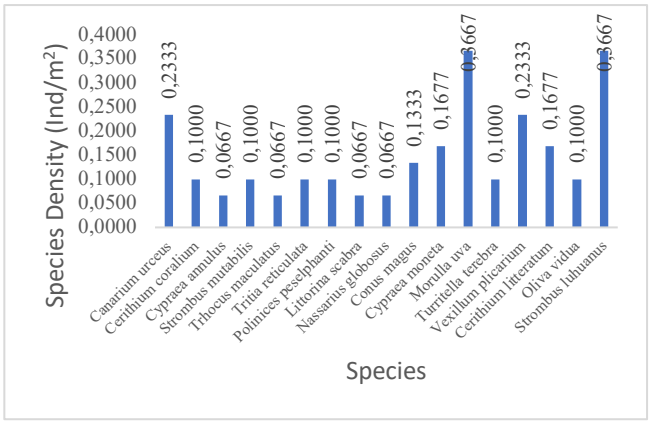


Figure 5. Density of gastropod species at station 4

The highest density at station 4 is found in species *Morula uva* dan *Strombus luhuanus* dengan nilai (0.3667 ind/m^2). *Canarium urceus* and *Vexillum plicarium* have the same value, namely (0.2333 ind/m^2). *Cerithium litteratum* (0.1677 ind/m^2) and *Conus magus* (0.1333 ind/m^2). *Cerithium coralium, Strombus mutabilis, Tritia reticulata, Polinices peselphanti, Turritella terebra* dan *Oliva vidua* have the same density value, namely (0.1000 ind/m^2). The lowest density is found in species *Trhocus maculatus, Littorina scabra* dan *Nassarius globosus* dengan nilai (0.0667 ind/m^2).

Diversity, dominance and equality

The results of the analysis of species diversity at station 1 obtained H' = 2.3104 with a dominance index value (C) = 0.1472 and evenness (E) = 0.7475 in Figure 6.

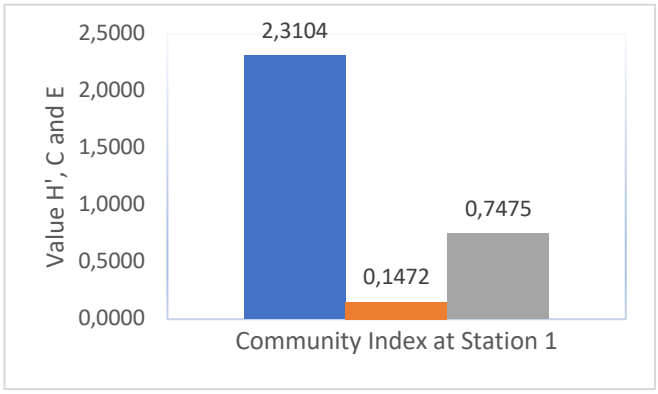


Figure 6. Diversity, dominance and evenness of station 1

The species diversity at station 2 was obtained H' = 1.7360 with a dominance index value (C) = 0.2186 and evenness (E) = 0.8323 in Figure 7.

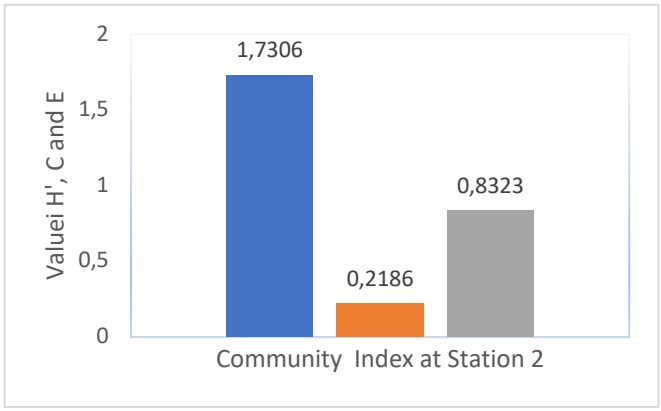


Figure 7. Diversity, dominance and evenness of station 2

Station 3 results of species diversity analysis obtained H' = 1.1972 with dominance index value (C) = 0.3609 and evenness (E) = 0.8636 in Figure 8.

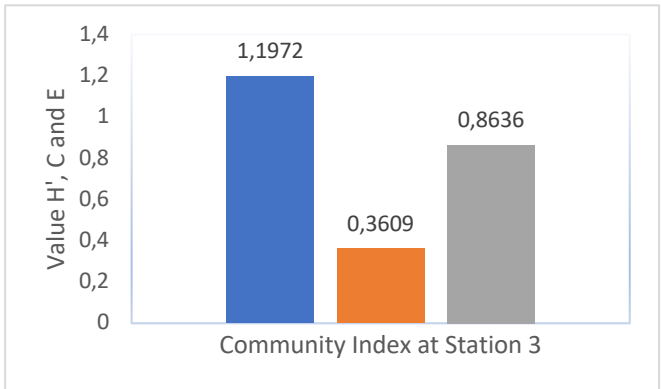


Figure 8. Diversity, dominance and evenness of station 3

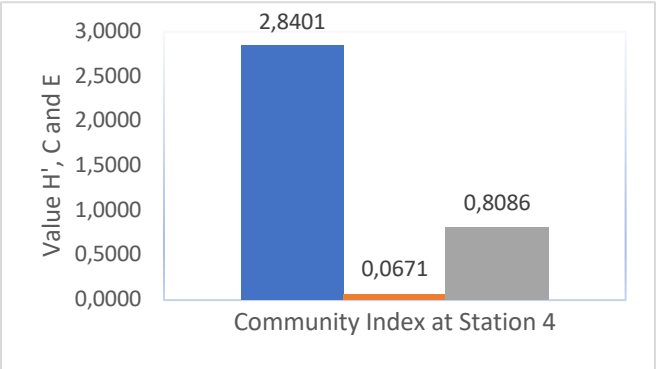


Figure 9. Diversity, dominance and evenness of station 4

Station 4 results of species diversity analysis obtained H' = 2.8401 with species dominance value C = 0.0671 and species evenness E = 0.8086 in Figure 9.

Environmental Parameters

The results of environmental parameter measurements including physical and chemical parameters in seagrass ecosystem on Maitara Island, which are spread across 4 stations in Table 1.

Table 1. Environmental Parameters

No	Parameters	Station 1	Station 2	Station 3	Station 4
1	Temperature	31°C	31°C	32 °C	32°C
2	Salinity	30‰	31‰	31‰	30‰
3	pH	6.1	6.1	6.1	6.1
4	Substrate	Mud	Sandy	Mud	Sandy

Discussion

Species composition

The substrate variations at stations 1, 2, 3, and 4 each of which has unique habitat characteristics are mostly to blame for the variations in species composition and abundance. There is little doubt that different substrate types have a significant impact on the species makeup of gastropods as well as the amount of organic matter that they consume. Furthermore, the existence of gastropods is also influenced by environmental conditions. This supports Dewiyanti (2004) assertion in Budiman *et al.* (2015) that substrate conditions influence the growth of mollusk communities and that gastropods prefer substrates made of mud, sand, and a small amount of clay.

In addition to the variations in species composition at stations 1, 2, 3, and 4, it turns out that one species the *Strombus luhuanus* species is present at every site. This is due to the species' capacity to adapt to a variety of substrates, including sandy, muddy, and muddy sand. This explains why the species at the four locations are identical.

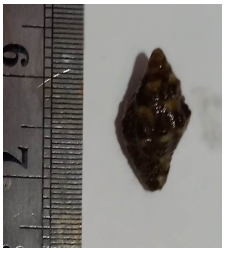
There are 32 species of gastropods in the seagrass ecosystem on Maitara Island, which is distributed among 4 stations. These species include *Strombus luhuanus, Trochus maculatus, Neothais marginatra, Canarium urceus, Nerita plicata, Natica* sp, *Nassarius pullus, Nassarius* sp, *Oliva tigridella oriole, Conus literatus, Conus virgo, Thais* sp, *Haliotis varia, Cerithidea djadjariensis, Canarium labiatum, Eclogavena quadrimaculata, Cypraea moneta, Littorina scabra, Conus magus, Perdalinus testudianria, Canarium maculatum, Cerithium coralium, Cypraea annulus, Strombus mutabilis, Tritia reticulata, Polinices peselphanti, Nassarius globosus, Morula uva, Turritella terebra, Vexillum plicarium, Cerithium litteratum* dan *Oliva vidua* (Figure 10).

The results of the description of the types of gastropods in the seagrass ecosystem on Maitara Island can be described as follows:

1. *Strombus luhuanus* has a 5 cm length and a conical body form. The body has orange markings on its white surface. The pinnacle is reached by three spiral rings. The lip of the shell mouth is extremely thick, and the aperture is not overly large. This species grows on substrates of sandy, muddy, and muddy sand that are covered in seagrass *Thalassia hemprichii* dan *Enhalus acoroides.*
2. *Trochus maculatus* possesses a triangular or pyramid-shaped shell with tapering at the tip. The base of the shell has a diameter of 3.5 cm and a height of 2.5 cm. The design of the body whorl is dark red-brown with a hint of white. The opening is quite small and circular, and the shell's surface is pimpled. discovered residing on muddy and sandy sand substrates that are covered in seagrass *Thalassia hemprichii* dan *Enhalus acoroides.*
3. *Neothais marginatra* possesses a robust shell and blunt spines on every part of its body. It is 1.8 cm long and has a black color with a hint of yellow. The lip is wavy, and the aperture is not overly large. inhabits soils of muddy sand that are covered in seagrass. *Thalassia hemprichii.*
4. *Canarium urceus* has a grayish white shell on the surface of its body with a little black on the base. Its tower is tapered and its body is long 2.5 cm, and its aperture is elongated and not too wide. Lives on sandy or muddy sand substrates overgrown with seagrass of the species Thalassia hemprichii.


Strombus luhuanus


Trochus maculatus


Neothais marginatra


Canarium urceus


Nerita plicata


Natica sp


Nassarius pullus


Nassarius sp


Oliva tigridella


Conus literatus


Conus virgo


Thais sp


Haliotis varia


Cerithidea djadjariensis


Canarium labiatum


Eclogavena quadrimaculata


Cypraea moneta


Littorina scabra


Conus magus


Perdalinus testudinaria


Canarium maculatum

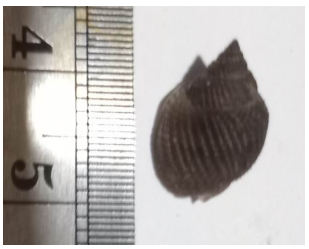

Cerithium coralium


Cypraea annulus


Strombus mutabilis


Tritia reticulata


Polinices peselphanti


Nassarius globosus


Morula uva


Cerithium literatum


Turritella terebra


Vexilum plicarium


Oliva vidua

Figure 10. Gastropod species in seagrass ecosystems

5. *Nerita plicata* has a thick, semi-circular shell with a length of 1.5 cm. The body whorl is yellowish white and has grooves covering the surface of its body. The shell's mouth opening or aperture is round and small. Lives on sandy or muddy sand substrates overgrown with seagrass species *Thalassia hemprichii*.
6. *Natica* sp has a round and half shell with a thick and strong shell structure. The color of the shell is black with a little irregular cream color. On the side of the body there is a spiral circle that rotates clockwise. The aperture is round and small and has a body size of 3 cm. Found on muddy sand substrates overgrown with seagrass from the species *Thalassia hemprichii*.
7. *Nassarius pullus* has a strong shell and a somewhat oval shape with a length of 2 cm. The back is gray to blackish, with transverse lines throughout the body and the sutures are clearly visible. There are 3 spiral circles leading to the apex. The aperture or opening of the shell mouth is not too wide and the lip is very thick. This species is found attached to seagrass with a muddy sand substrate.
8. *Nassarius* sp has a body shape that is somewhat round oval with a length of 3 cm. The back is black and feels slippery when touched. The sutures are clearly visible and there are 3 spiral circles leading to the apex. The aperture or opening of the shell mouth is not too wide. This species is found attached to seagrass with a muddy sand substrate from the species *Thalassia hemprichii*.
9. *Oliva tigridella oriole* has an oval body shape, black and shiny on the surface of the body and slippery and white towards the inner shell rotation. The shell is thick and has a length of 3 cm. The peak of the spire is sharp while the opening of the shell mouth is elongated and narrow. Found on muddy sand substrates overgrown with seagrass from the species *Thalassia hemprichii*.
10. *Conus literatus* has a cone-shaped shell. The color of the shell is white to yellowish with a black checkered pattern and is arranged regularly on the surface of its body starting from the base of the shell to the top. Has an aperture or opening of the shell mouth that is elongated and narrow and has a body size of 6 cm. Found on muddy sand substrates overgrown with seagrass of the species *Thalassia hemprichii*.
11. *Conus virgo* has a conical or cone-shaped shell. The color of the shell is bright to dark orange. There is a black line that is located vertically from the base of the shell to the top of the shell. The mouth opening of the shell is elongated and narrow. Has a body size of 7 cm. Found on muddy sand substrates overgrown with seagrass species *Thalassia hemprichii*.
12. *Thais* sp has a shell that is tapered at the top, and is thick and strong. The color of the shell is black and there are protrusions like blunt thorns on the surface of its body. Has a body size of 1.5 cm. Found on muddy sand substrates overgrown with seagrass of the species *Thalassia hemprichii*.
13. *Haliotis varia* has a flat, slightly convex and shiny shell with a slight yellowish brown pattern. There are seven holes on the surface of the shell. The inside of the shell is rainbow-colored, silvery white to pink. Has a body size of 3.5 cm. Found living on muddy sand substrates overgrown with seagrass species *Thalassia hemprichii*.
14. *Cerithidea djadjariensis* has an elongated conical shell and at the top is rather blunt. The surface of the shell has spiral lines starting from the spire to the top. There are regular intersecting lines so that it looks like a box and is dark brown. The aperture is oval and has a body size of 4 cm. Found living on muddy substrates overgrown with seagrass from the species *Enhalus acoroides*.
15. *Canarium labiatum* has a conical shell shape with a high cone-shaped peak and a visible spiral groove towards the peak of the spire. The body whorl has axial ribs. The body color is black with a grayish white pattern. The body length is 3 cm and the aperture is elongated and rather wide. Found on muddy sand substrates overgrown with seagrass species *Thalassia hemprichii*.
16. *Eclogavena quadrimaculata* has a shiny and gray shell with 3-4 tires that cross its body. Has 4 black spots and each has 2 on both ends. Has a shell length of 1.5 cm with. The shape of the shell is round and oval. The lip gap on the shell is long and narrow and serrated. The

outer and inner lips are white and serrated. Found living on muddy sand substrates overgrown with seagrass of the species *Thalassia hemprichii.*

17. *Cypraea moneta* memiliki The shiny oval shell shape, on the back is yellowish, while on the dorsal base is white. The shell measures 2 cm, on the aperture or mouth opening of the shell is narrow, elongated and serrated. Found living on muddy sand substrates overgrown with seagrass species *Thalassia hemprichii.*
18. *Littorina scabra* has a round shell shape on the body whorl and tapers at the top. The color of the shell is black with an irregular white pattern or motif. The length of the shell is 1 cm with a slightly rounded shell mouth opening and the shape or direction of the shell rotation to the right or dextral. Found living on muddy sand substrates overgrown with seagrass species *Enhalus acoroides.*
19. *Conus magus* has a cylindrical shell that is slightly elongated and black in color with irregular white patterns on the surface of its body. The length of the shell is 1.5 cm with a lower peak of the Tower. The aperture or opening of the mouth of the shell is long and not too wide. Found living on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii.*
20. *Perdalinus testudianria* has a shiny, cream-colored shell with irregular black patterns on the surface of its body. The length of the shell is 1.5 cm. The shape of the shell is round and oval. The lip gap on the shell is long and narrow and serrated. The outer and inner lips are cream-colored. Found living on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii.*
21. *Canarium maculatum* has a yellowish cream colored shell with irregular black patterns on the surface of its body. The length of the shell is 2.5 cm. The shape of the shell is conical and tapers at the top. The opening of the shell mouth is elongated and not too wide. The outer and inner lips are white and thick. Found living on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii*
22. *Cerithium coralium* has a cone-like shell measuring 3 cm. The color of the shell is cream and there are blunt black spines on the entire surface of the shell. The aperture is rather round and small. Found on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii.*
23. *Cypraea annulus* has a shiny shell and is grayish brownish on the back, while on both sides it is white. The length of the shell is 1.8 cm and the shape is oval. The aperture is long and narrow and serrated. The outer and inner lips are white. Found living on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii.*
24. *Strombus mutabilis* has a conical shell and there are 3 spiral grooves leading to the top. The base color of the shell is yellow with a little brown pattern on the surface of its body. The length is 2.5 cm and the aperture or opening of the shell mouth is elongated and rather wide. Found living on sandy substrates overgrown with seagrass from species *Thalassia hemprichii.*
25. *Tritia reticulata* has a thick shell and is oval in shape, slightly elongated. The texture of the shell feels rough because of the lines that run across the surface of the shell. The sutures are clearly visible as many as five rounds towards the blunt peak of the tower. The color of the shell is reddish brown with a shell size of 1.5 cm. The aperture part is round and small. Found on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii.*
26. *Polinices peselphanti* has a round shell shape and is orange cream in color. The apex is rather thick while the mouth of the shell is rounded and not too wide. The length is 2 cm. Found on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii.*
27. *Nassarius globosus* has an oval and small shell and is blackish brown in color. The length is 1.5 cm. There are lines that protrude outward on the entire surface of the shell. The sutures are clearly visible towards the apex as many as three rounds. The opening of the shell mouth is round and small. Found on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii.*
28. *Morula uva* has a biconical shell with a length of 1.5 cm. There are blunt protrusions (tubercles) all over the surface of the shell. The shell is black, while the blunt protruding spines are cream colored. The shell's mouth opening is small. Found on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii.*

29. *Turritella terebra* has a cone-like shell that is twisted upwards with a shell length of 4 cm. The color of the shell is light brown. The sutures are clearly visible up to the top. The opening of the shell mouth is round and small. Found on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii*.
30. *Vexillum plicarium* has a conical shell with a high spire tip. Sutures are clearly visible as many as seven circular lines towards the top of the tower. Black in color with a shell length of 4.5 cm. The shell mouth opening is rather elongated and not too wide. Found on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii*.
31. *Cerithium litteratum* has a cone-like shell with a shell size of 2 cm. The base color of the shell is white with black patterns on the surface of its body. There are also blunt spines on the surface of the shell. The sutures are clearly visible as many as five lines towards the top of the tower. The aperture is rather round and small. Found on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii*.
32. *Oliva vidua* has a smooth and shiny shell with a length of 3 cm. The basic color of the shell is grayish black with a cream-colored pattern found on the entire surface of its body. There is a white color leading to the inner shell rotation. The peak of the tower is short and sharp while the opening of the shell mouth is elongated and narrow. Found on sandy substrates overgrown with seagrass of the species *Thalassia hemprichii*.

Density

The size of a population in a single unit of space is known as its density. The number of people in a given area is used to compute the population (Nybakken, 1992). At station 1 (Maitara Induk), the species *Strombus luhuanus* had the highest gastropod species density (0.7333 ind/m2), while the species *Haliotis varia* and *Natica sp.* had the lowest species densities (0.0333 ind/m2).

At station 2 (Maitara Utara), the species *Nassarius pullus* had the highest gastropod species density (0.833 ind/m2), whereas *Conus magus*, *Canarium urceus*, and Perdalinus testudinaria had the lowest species densities (0.1000 ind/m2). The species Strombus luhuanus had the highest gastropod species density at station 3 (Maitara Tengah), measuring 0.2333 ind/m2, while the species *Conus literatus, Cherithidea djajariensis*, and *Littorina scabra* had the lowest species densities, measuring 0.0667 ind/m2. *Morula uva* and *Strombus luhuanus* had the highest gastropod species density at station 4 (Maitara Selatan), measuring 0.3667 ind/m2, while *Cypraea annulus, Trochus maculatus, Littorina scabra*, and *Nassarius globosus* had the lowest species density, measuring 0.0667 ind/m2.

With the exception of station 2, the species Strombus luhuanus has the greatest density value at nearly every station, including 1, 3, and 4. This demonstrates that the species can adapt to a wide range of habitats, increasing its capacity for reproduction. When compared to other species, the large number of individuals of the species identified at the three locations further supports this. The species with the lowest density number, on the other hand, indicates that its range in nature is more constrained because it can only adapt to specific kinds of habitats.

Differences in species density are believed to be closely linked to each gastropod species' ability to adapt to its environment, particularly the type of substrate it uses as a living medium and its capacity to associate with seagrass beds and food sources (Sunarti *et al.,* 2021). The high number of individuals of each species observed is the reason for the high density of gastropod species, according to Haumahu *et al.* (2024). Conversely, low ecological density gastropod species result from substrate conditions that do not facilitate their growth and presence.

Diversity, dominance and equality

A measure of a body of water's health based on its biological constituents is called diversity. High diversity, a huge number of creatures, and the absence of dominance of one or more types of organisms are characteristics of favorable marine environments.

H' = 2.3104 was the result of the species diversity analysis conducted at station 1 (Maitara Induk). H' was found to be 1.7306 at station 2 (Maitara Utara), 1.1972 at station 3 (Maitara Tengah), and 2.8401 at station 4 (Maitara Selatan). According to Rondo (2015), the diversity is moderate if the value obtained is $1 \leq H' \leq 3$. The overall species diversity on Maitara Island at the four sites falls into the moderate range based on the values found. This demonstrates how stable Maitara Island's ecology is. The moderate category of the diversity index value shows that the absence of seagrass species and density results in a shortage of food on the substrate, which is a natural

food source for gastropods connected to the seagrass ecosystem. The number of species in the community also has a significant impact on species diversity. A moderate diversity value indicates adequate productivity, reasonably balanced ecosystem conditions, and moderate ecological pressure, according to Afnani & Rahayu (2024).

At station 1 (Maitara Induk), the species dominance study yielded a value of C = 0.1472. The species dominance value for station 2 (Maitara Utara) is C = 0.2186. According to the analysis, the species dominance value C = 0.0671 at station 4 (Maitara Selatan) and the dominance value C = 0.3609 at station 3 (Maitara Tengah).

According to Rondo (2014), a C value of 0 indicates the absence of a dominant species, whereas a value of 1 indicates the presence of a dominant species. According to this assertion, the group of no dominant species includes the dominance index at every station. The value of the obtained species diversity has an impact on the dominance index value. Odum (1996) asserts that the species diversity index and the dominance index are negatively correlated, meaning that a high species diversity index indicates the absence of dominating species in a given area and a low species diversity index indicates the presence of a dominant species.

At station 1 (Maitara Induk), the species evenness (E) analysis yielded a value of 0.7475. Station 2 (Maitara Utara) yielded the value E = 0.8323. The value E = 0.8636 was found at station 3 (Maitara Tengah). Station 4 (Maitara Selatan) yielded the value E = 0.8086. According to Wibisono (2005), a more even distribution of species is indicated by evenness values between 0.61 and 0.80, while a distribution of species that is more even is indicated by values more than 0.81.

According to the findings of the species evenness analysis, the distribution of each gastropod species was more uniform in each habitat at stations 1 and 4, while it was extremely uniform at stations 2 and 3. Since the distribution of individuals is essentially the same, the evenness value indicates that the gastropods on Maitara Island at all locations are in a stable community condition. The type of habitat that tends to be uniform at each station is one of the elements that contributes to the generally uniform distribution of gastropods. This is consistent with Gea *et al.* (2020) assertion that a balanced distribution of gastropod species is made possible by the presence of comparatively uniform environmental circumstances.

Distribution pattern

The overall distribution pattern of gastropods in Maitara Island's seagrass habitat is both random and clustered. The species' ability to interact among individuals, which is also a reproductive strategy, is demonstrated by the clustered distribution pattern. Additionally, the existence of gastropods on Maitara Island is influenced by factors such as food supply and habitat suitability. Two variables contribute to the gastropods' clustered distribution pattern (Dinata *et al.,* 2022). The ability of gastropod individuals to interact within a community is the first factor. The second aspect is that gastropods inhabit ecosystem.

The pattern random distribution indicates that a limited number of species and homogeneous substrate variables determine the existence of gastropod species in nature. This is supported by field data, which show that the gastropods with a random distribution pattern in each observation plot were located on homogeneous substrates with only one species of seagrass overgrowth. They also proved to be extremely rare in abundance. According to Odum (1996), when environmental conditions are extremely uniform, a random distribution pattern appears in nature. Because the species is extremely rare and there are only a few individuals in each observation plot, Dinata *et al.* (2022) claim that the random distribution pattern of gastropods is the result.

Utilization of gastropods

Out of the 32 species of gastropods that have been discovered, 10 species are known to be consumed by the indigenous population on Maitara Island. *Canarium urceus, Natica sp., Nassarius sp., Strombus luhuanus, Conus litteratus, Conus virgo, Cerithidea djadjariensis, Canarium maculatum, Strombus mutabilis, and Vexilum plicarium are some of these species. Cyparea moneta, Cyparea annulus*, and *Eclogavena quadrimaculata* are among the gastropod species that can be used as toys for kids.

Environmental parameters

The results of environmental parameter measurements in the seagrass ecosystem on Maitara Island, obtained temperatures ranging from 31-32ºC, salinity 30-31‰ and water pH 6.1. Water quality is also one of the factors that can affect the distribution of biota such as temperature, salinity and water pH. The suitability of environmental conditions allows organisms to continue their lives.

According to Sunarti *et al.* (2021), water temperatures between 31 and 35 ºC are ideal for gastropod life. When Magfiroh & Triajie (2024) studied the coastal waters of Labuhan, Sepulu,

Bangkalan, they found that the temperatures ranged from 29.5-34.7 °C. The seagrass ecosystem on Maitara Island's water temperature readings indicate that the temperature range is still within the range that gastropods can tolerate to survive.

The ideal salinity range for gastropod life, according to Rumpeniak *et al.* (2019), is between 30 and 32 %. According to Sitanggang *et al.* (2019), the ideal salinity range for gastropod life is between 30-31 ‰, based on the findings of their study on the seagrass ecosystem in the seas of Gangga North Minahasa. According to Sunarti *et al.* (2021) studies on Moti Island, the ideal salinity range for gastropod life is between 30-31 %. Additionally, Sunarti *et al.* (2023) claimed that the salinity range of 29 to 31‰ is ideal for gastropod life based on the findings of their study on Donrotu Island. This indicates that gastropods can still survive in the salinity range found in Maitara Island's seagrass habitat.

The pH value suitable for gastropod life based on the research results of Rumpeniak *et al.* (2019), ranges from 6.19-7.12. This means that the pH value obtained in the seagrass ecosystem on Maitara Island, namely 6.1, is still suitable for the survival of gastropods.

Overall, it can be concluded that the environmental parameter values pertaining to temperature, salinity, and pH that were derived from the research findings are highly conducive to the existence of gastropods in the seagrass ecosystem on Maitara Island. This is undoubtedly supported by studies conducted by the aforementioned researchers on the environmental factors affecting gastropod organisms that reside in seagrass areas across Indonesia.

Conclusion

The composition of gastropod species found in the seagrass ecosystem on Maitara Island as a whole amounted to 32 species. The density of gastropods found varied in each species at each location. The diversity of gastropod species at all stations was classified as moderate. The dominance index at all stations was included in the category of no dominant species. The evenness of species at stations 1 and 4 was classified as more even, while stations 2 and 3 were classified as very even. The distribution pattern was clustered and random. A total of 32 gastropod species, 10 of which were used as food by the Maitara Island community.

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