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Marine gastropod at the intertidal zone of Rutong Village, Ambon Island as an indicator of water quality

Gastropoda laut pada zona intertidal Negeri Rutong, Pulau Ambon sebagai indikator kualitas perairan

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Abstrak.
Studi tentang keragaman gastropoda laut di perairan Maluku sebagai indikator kualitas lingkungan masih sangat terbatas. Penelitian ini bertujuan untuk mempelajari komposisi spesies dan menganalisis kepadatan ekologi, kelimpahan, dan frekuensi kehadiran gastropoda laut serta menganalisis indeks ekologi gastropoda pada zona intertidal Desa Rutong, Pulau Ambon, Maluku. Sebanyak 53 spesies gastropoda laut ditemukan pada zona intertidal Desa Rutong yang termasuk dalam 41 genera, 22 famili dan 6 ordo. Muricidae, Neritidae dan Tegulidae merupakan famili dari gastropoda laut yang memiliki kepadatan ekologi dan kelimpahan tertinggi. Beberapa spesies yang dominan ditemukan pada lokasi sampling adalah *Nerita patula, Rochia nilotica, Tenguella granulata, Nassarius pullus, Clypeomorus battilariaeformis, Monetaria annulus, Monodonta calanifera* dan *Conus miles*. Pada umumnya gastropoda laut yang ditemukan memiliki penyebaran yang terbatas. Indeks keragaman Shannon-Wiener (H`) dari gastropoda laut berkisar 1,56 - 3,46, termasuk dalam kategori sedang sampai tinggi. Sebaliknya indeks Evenness Pielou`s dari gastropoda laut termasuk kategori stabil, nilai E berkisar 0,61-0,95. Sebaliknya indeks dominansi Simpson (D) berkisar 0,05 - 0,30, termasuk kategori rendah. Perairan pantai Desa Rutong dapat dikategorikan sebagai perairan yang mengalami polusi yang moderat sampai ringan.

Kata kunci: Gastropoda laut, keragaman spesies, zona intertidal, Negeri Rutong

Abstract.
Studies on marine gastropod diversity as an indicator of water quality in Maluku province are rare. The research objectives are to study marine gastropod species composition and analyze its ecological density, abundance and frequency of occurrence, as well as to analyze an ecological index at the intertidal zone of Rutong village, Ambon Island, Maluku. 53 species of marine gastropods found in the intertidal zone, belonging to 41 genera, 22 families and 6 order. Muricidae, Neritidae and Tegulidae were marine gastropod families with higher ecological density and abundance. Some dominant species known as key species in this region were Nerita spatula, Rochia nilotica, Tenguella granulate, Nassarius pullus, Clypeomorus battilariaeformis, Monetaria annulus, Monodonta calanifera and Conus miles. Generally, the species of marine gastropods in this study area have limited distribution. Shannon-Wiener diversity index (H`) of marine gastropods is in a medium to high category, which varies between 1.56 to 3.46. Meanwhile, Pielou's evenness index (J`) is in the stable category, in which the value was from 0.61 to 0.95 Whereas, Simpson's dominance index varied from 0.05-0.30, which is in the low category. The coastal water of Rutong village can be categorized as moderately polluted waters to unpolluted waters.

Keywords: Marine gastropod, species diversity, intertidal zone, Rutong village

1. INTRODUCTION

The waters of Rutong village are semi-enclosed. Water quality is influenced by the activity of humans inhabiting coastal areas. Local community activities such as throwing domestic waste into the sea, making the waters of Rutong village rubbish dumps and development activity land-based around the Ambon area have resulted in a high volume of sediment entering the sea during the rainy season.

These human activities are the trigger factor in the anthropogenic process that occurs on Ambon Island and its surroundings, and they influence the water quality of

the southern part of Ambon Island. This will further affect the health of the marine environment. A healthy ocean is characterized by clear waters (goal 9 of IKLI) and high biodiversity (goal 10 of IKLI) (Nikijuluw *et al.* 2023). Nowadays, no information is available on this region's water quality.

Gastropods belong to the phylum Mollusca. Mollusca are the second largest phylum after Arthropoda in rich species, estimated at 80.000-100.000 described species. Of the seven molluscan classes, gastropods consisted of more than 80% species (Strong *et al.* 2008; Baharuddin *et al.* 2018) . Gastropods are animals that have soft bodies and are covered by a single coiled and calcareous shell with various shape, color and size (Pechenik 2016). Gastropods play an important role in marine ecosystems, especially in the marine food chain. Gastropods are natural food for many fishes and birds. Gastropod also has an economically important as a source of protein, medicine, dye and decoration (Baharuddin *et al.* 2018).

Gastropods can be used as bioindicators of water quality because gastropods exhibit extremely limited mobility or sessile organisms. Gastropods are algae feeders, carnivores, deposit feeders and detritivores. These organisms are abundant in the intertidal zone and widely distributed because of their wide adaptation (Strong *et al.* 2008; Pechenik 2016). Gastropods are living organism that are sensitive to the change of water quality in the area in which they lives, so it can influence the density and population diversity of this class (Strong *et al.* 2008; Baharuddin *et al.* 2018).

Considering that the changes or disturbances in the marine environment will certainly affect the structure of the gastropod community. The existence and distribution of gastropods are strongly influenced by abiotic and biotic factors such as food sources, environmental conditions, predators and competition. Pressure and environmental changes affect the total family and composition of organisms. Changes in the structure of gastropod community can act as an indicator of pressure or disturbance in an ecosystem (Pawar and Al-Tawaha 2017).

Research in ecology and biodiversity of gastropod community has been widely conducted in Maluku Province, including Ambon Island (Rumahlatu and Leiwakabessy 2017; Supusepa 2018; Supusepa and Hulopi 2018; Supusepa and Saleky 2022;

Haumahu and Uneputty 2022a; Haumahu and Uneputty 2022b; Haumahu *et al.* 2023a; Haumahu *et al.* 2023b; Haumahu and Uneputty 2023; Natan *et al.* 2023); Saparua Island (Islami *et al.* 2018); Nusalaut Island (Islami 2015) and Haruku Island (Persulessy and Arini 2018; Uneputty *et al.* 2018; Haumahu *et al.* 2014; Haumahu and Uneputty 2018; Uneputty *et al.* 2019; Uneputty *et al.* 2021; Haumahu and Uneputty 2021; Marasabessy 2022; Haumahu *et al.* 2023a) gastropods were found on the rocky shore, sandy shore and seagrass bed, which shows that they are important organisms in marine ecosystems.

Research on gastropod community structure at the Rutong intertidal zone, as well as its status of water quality, is scarce. Therefore, this study was conducted to identify species composition, estimate its ecological density, abundance and frequency of occurrence and analyze the ecological index of the marine gastropod communities. Because the marine gastropod diversity can be used as a bioindicator of water quality (Nikijuluw *et al.* 2023). The results of this study can be used to determine water quality based on gastropod community structure in Maluku province and to obtain new information on marine gastropod species diversities.

2. RESEARCH METHODS

2.1. Field work

The research was conducted at the intertidal zone of Rutong village, Ambon Island, in September 2023 with 3 sampling stations (**Figure 1**). Sampling was carried out using random sampling methods (Khouw 2016) with a 5 x 5 meter quadrant plot. Sampling was conducted at the low tide during the day. The number of plots at each location was 5 plots, so the total number of plots was 15 plots.

All gastropod specimens were identified, enumerated and recorded in the field. The specimens were collected, fixed with 10% formalin, placed in a labeled plastic bag and brought to the Marine Science Laboratory, Faculty of Fisheries and Marine Science, Pattimura University, Ambon, for further identification.

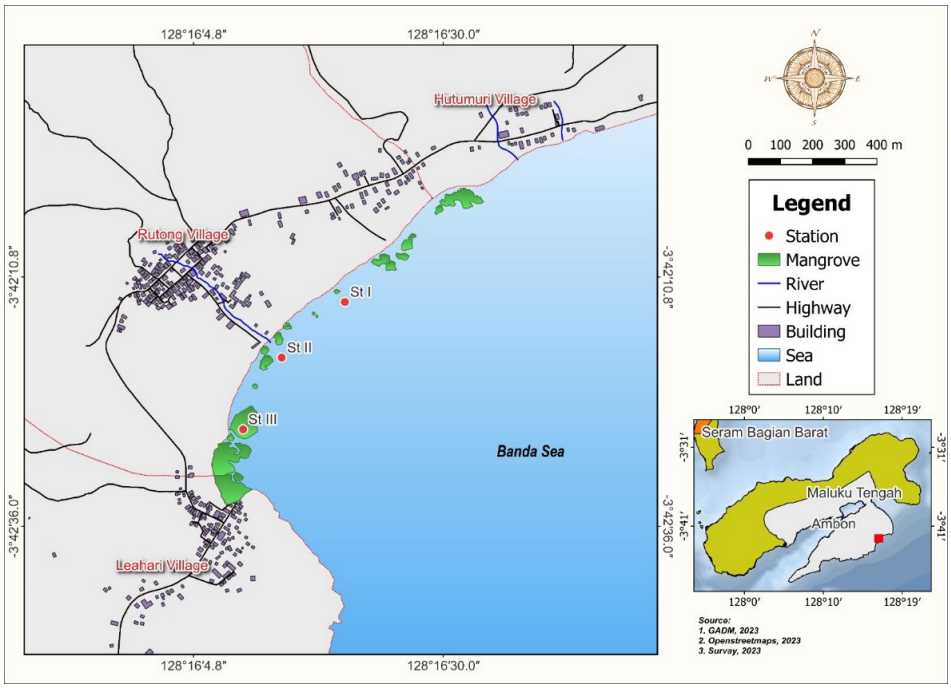

Figure 1. Research location.

The gastropods were identified to species level following keys by Dharma (2005) and the World Register of Marine Species (https://www.marinespecies.org/) were referred for the correct gastropod names. Physical parameters of water at each plot, such as temperature measured using handheld temperature, salinity measured by refractometer, pH measured by pH meter and dissolved oxygen was measured by DO meter.

2.2. Data Analysis

Ecological density, abundance and frequency of occurrence of marine gastropods were calculated based on Khouw (2016) as follow **Equation 1, Equation 2** and **Equation 3**.

$$Ecological\ density\ (ind.m^{-2}) = \frac{Number\ of\ individu\ of\ i\ species}{Total\ area\ of\ plot\ where\ species\ i\ was\ found} \quad \text{.....(1)}$$

$$Abundance\ (ind.) = number\ of\ individual\ of\ i\ species\ x\ total\ area \quad \text{.....(2)}$$

$$Frequency\ of\ occurence\ (\%) = \frac{Ni.St}{N.St}\ x\ 100 \quad \text{.....(3)}$$

Notes:

Ni.St = The total number of plots where the species i was found.

N.St = The total number of sampling plots.

The Shannon-Wiener diversity indices (H') are used to describe species/genera diversity and species/genera richness within marine gastropods of research (Krebs 2009; Odum and Barrett 2005) as follow **Equation 4**. The Shannon diversity is classified as three categories: low (H`<2); moderate (2<H`<4); and high (H`>4) (Magurran 2005).

$$H` = \sum_{i=1}^{s} Pi \ln Pi \quad \ldots\ldots(4)$$

Notes:

H` = The value of the Shannon-Wiener diversity index

Pi = The proportion of i^{th} species

ln = The natural logarithm of Pi

s = The number of species in the community

The evenness index of the species was calculated using Pielou`s evenness index (Bakus 2007), as written as **Equation 5**. Species evenness index ranges from zero to one, with zero signifying no evenness and one is a complete evenness.

$$J` = H`/H`_{max} \quad \ldots\ldots (5)$$

Notes:

H` = The Shannon-Wiener diversity index

$H`_{max}$ = The natural logarithm of species richness.

The dominance index of marine gastropods was calculated using Simpson dominance index (Magurran and McGill 2011) as follow as **Equation 6**.

$$D = \sum(\frac{ni}{N})^2 \quad \ldots\ldots(6)$$

Notes:

D = The value of Simpson dominance index

ni = The number of individuals of i^{th} species

N = The total number of individuals of gastropod found

To determine water quality based on marine environment health indicator, the gastropod species diversity index is used following the Shannon-Wiener criteria (**Table 1**).

Table 1. Shannon-Wiener criteria.

Shannon-Wiener Index	Category
<1	heavy polluted waters
1.0 ≤ H` < 2.0	moderate polluted waters
2.0 ≤ H` < 3,0	lightly polluted waters
3.0 ≤ H` < 4,0	very lightly polluted waters
H` > 4.0	unpolluted waters (clean waters)

Source: Magurran and McGill (2011)

3. RESULT AND DISCUSSION

3.1. Water quality parameters

The analysis of the water quality parameters (**Table 2**) showed that the average temperature in the study site was 28.87^{0}C, the average salinity was 18.68 psu, the pH was 8.37 and the average dissolved oxygen was 10.46 ppm. Salinity in this location was low because there is a river flow through the seawater, which decreased seawater salinity around this area. The pH value was in a stable range to support the ecological processes of gastropods (Haumahu *et al.* 2016). On the other hand, the value of dissolved oxygen was high due to the water conditions being quite heavy because of the strong wind. This in turn causes water to stir and increase oxygen level (Nybakken and Bertness 2009). Natan *et al.* (2023) found that during low tide, water temperature at Rutong village varied from 27-30 °C; salinity ranged between 26-33 psu and pH varied from 6-7. This means that temperature and pH were not significantly different, while salinity found in this study was lower than that found by Natan *et al.* (2023). This is because the weather was bad during the sampling, with heavy rain during the day.

Table 2. The average value of temperature (^{0}C), salinity (psu), pH and dissolved oxygen (DO, ppm) at the Rutong intertidal zone

Station	Temperature (^{0}C)	Salinity (psu)	pH	DO (ppm)
1	28.5±0	23.5±0.71	8.29±0.06	10.90±0.14
2	28.60±0.56	17.53±3.02	8.28±0.03	10.37±0.24
3	29.5±0.00	15.00±6.97	8.55±0.21	10.65±0.21
Average	**28.87**	**18.68**	**8.37**	**10.64**

3.2. Marine gastropod species composition

A total of 53 species of marine gastropod found in the intertidal zone of Rutong village, belonging to 41 genera, 22 families and 6 order (**Table 3**). Neogastropoda is the order which has high number of species (20 species), followed by Littorinimorpha (12 species) especially Cypraeidae family (6 species) and the order of Trochida (8 species). The higher number of marine gastropods from Neogastropoda due to Neogastropoda is dominant gastropod found in benthic environments in tropical seas. From the total of 60.000 species of marine gastropod, Neogastropoda has higher number of species or has high species richness (about 16.000 living species) including

Conidae, Muricidae, Volutidae, Terebridae and Buccinidae (Cunha *et al.* 2009; Geiger 2006).

Table 3. Marine gastropod species composition at Rutong intertidal zone, Ambon Island.

Oder	Family	Genera	Species
Cycloneritida	Neritidae	*Nerita*	*Nerita patula* Récluz, 1841
			Nerita chamaeleon Linnaeus, 1758
	Lottiidae	*Patelloida*	*Patelloida saccharinoides* Habe & Kosuge, 1966
Lepetellida	Haliotidae	*Haliotis*	*Haliotis varia* Linnaeus, 1758
Trochida	Trochidae	*Monodonta*	*Monodonta canalifera* Lamarck, 1816
			Monodonta labio (Linnaeus, 1758)
		Trochus	*Trochus maculatus* Linnaeus, 1758
	Tegulidae	*Rochia*	*Rochia nilotica* (Linnaeus, 1767)
		Tectus	*Tectus fenestratus* (Gmelin, 1791)
	Turbinidae	*Lunella*	*Lunella cinerea* (Born, 1778)
		Astrea	*Astrea calcar* (Linnaeus, 1758)
		Turbo	*Turbo bruneus* (Röding, 1798)
Neogastropoda	Pisaniidae	*Engina*	*Engina zonalis* (Lamarck, 1822)
			Engina mendicaria (Linnaeus, 1758)
		Pollia	*Pollia undosa* (Linnaeus, 1758)
	Columbellidae	*Pardalinops*	*Pardalinops testudinaria* (Link, 1807)
	Muricidae	*Tylothais*	*Tylothais aculeata* (Deshayes, 1844)
		Tenguella	*Tenguella granulata* (Duclos, 1832)
		Drupella	*Drupella margariticola* (Broderip, 1833)
		Reishia	*Reishia bitubercularis* (Lamarck, 1822)
		Nassa	*Nassa serta* (Bruguière, 1789)
	Nassaridae	*Nassarius*	*Nassarius pullus* (Linnaeus, 1758)
			Nassarius reeveanus (Dunker, 1847)
			Nassarius limnaeiformis
			Nassarius niger (Hombron & Jacquinot, 1848)
	Melongenidae	*Volema*	*Volema myristica* Röding, 1798
		Pugilina	*Pugilina morio* (Linnaeus, 1758)
	Mitridae	*Mitra*	*Mitra edentula* Swainson, 1823
		Nebularia	*Nebularia eremitarum* (Röding, 1798)
		Strigatella	*Strigatella pica* (Dillwyn, 1817)
		Pseudonebularia	*Pseudonebularia tabanula* (Lamarck, 1811)
	Olividae	*Oliva*	*Oliva guttata* Fischer von Waldheim, 1808
Caenogastropoda	Conidae	*Conus*	*Conus marmoreus* Linnaeus, 1758
			Conus miles Linnaeus, 1758
	Volutidae	*Cymbiola*	*Cymbiola vespertilio* (Linnaeus, 1758)
Littorinimorpha	Cerithiidae	*Clypeomorus*	*Clypeomorus batillariaeformis* Habe & Kosuge, 1966
	Potamididae	*Terebralia*	*Terebralia sulcata* (Born, 1778)
			Terebralia palustris (Linnaeus, 1767)
	Littorinidae	*Littoraria*	*Littoraria scabra* (Linnaeus, 1758)
			Littoraria melanostoma (Gray, 1839)
			Littoraria undulata (Gray, 1839)
	Cypraeidae	*Monetaria*	*Monetaria moneta* (Linnaeus, 1758)
		Luria	*Luria isabella* (Linnaeus, 1758)
		Staphylaea	*Staphylaea limacina* (Lamarck, 1810)
		Monetaria	*Monetaria annulus* (Linnaeus, 1758)
		Naria	*Naria helvola* (Linnaeus, 1758)
		Erronea	*Erronea cylindrica* (Born, 1778)
	Strombidae	*Conomurex*	*Conomurex luhuanus* (Linnaeus, 1758)
		Gibberulus	*Gibberulus gibberulus* (Linnaeus, 1758)
		Canarium	*Canarium labiatum* (Röding, 1798)
			Canarium mutabile (Swainson, 1821)
	Bursidae	*Lampasopsis*	*Lampasopsis cruentata* (G. B. Sowerby II, 1835)
	Cymatidae	*Monoplex*	*Monoplex pilearis* (Linnaeus, 1758)
Total 6	**22**	**41**	**53**

Cypraeidae and Muricidae families also are gastropods with high number of species compare to other families in this study area. This is because Cypraeidae and Muricidae are marine gastropods generally inhabit coral flat at the coastal zone (Cunha

et al. 2009; Strong *et al.* 2008). Neritidae, such as *Nerita*, usually inhabit marine environment, while *Neritina* and *Clithon* commonly found at estuarine and fresh water (Geiger 2006; Poutiers 1998). Neritidae family has low number of species compare to that from this family found at Oma village (Haumahu and Uneputty 2018; Haumahu *et al.* 2023a).

A total of 10 species of *Nerita* from Neritidae found at intertidal zone of Oma village, i.e, *Nerita polita, Nerita patula, Nerita maxima, Nerita plicata, Nerita albicilla, Nerita chamaeleon, Nerita exuvia, Nerita undata, Nerita costata* and *Nerita signata* (Haumahu and Uneputty 2018). This difference is because of the different of type of substrate. The substrate at the intertidal zone of Rutong village is dominated by sandy substrate associated with seagrass bed and reef flat. Rocky substrate only exists at the upper part of intertidal zone (supralittoral zone) in which dominated by pebbles. Meanwhile, the substrate at intertidal zone of Oma village is made up of gravel sand and large stones (Haumahu *et al.* 2023a).

There were some species found in specific habitats on this sampling site. *Nerita patula* is dominant in rubble associated with sand. *Monetaria annulus, Clypeomorus battilaeriformis and Tenguella granulata* are commonly found in reef flats. *Nassarius pullus* is dominant in sandy substrate. Whereas *Rochia nilotica* is an inhabited reef flat associated with sandy substrate and seagrass. *Nerita albicilla* is usually found in open area of coastal zone with high waves. Unfortunately, this species was not found in this study, because the region is semi-enclosed with water.

Species richness of marine gastropod in this study was lowest compared to the previous study conducted in Maluku province. A total of 65 species and 78 species of marine gastropod found at intertidal zone of Ambon Island, respectively (Rumahlatu and Leiwakabessy 2017; Haumahu and Uneputty 2022b), whereas 85 species of marine gastropod found in Saparua Island (Islami *et al.* 2018). Moreover, a total of 92 species of marine gastropod found in Haruku Island (Oma village) (Haumahu *et al.* 2023a). Haumahu and Uneputty (2022a) in the previous study at the intertidal zone of Rutong Village found only 23 species of marine gastropod in this study area on November 2020. Natan *et al.* (2023) also found 47 genera of marine gastropod which consisted of 74 species from Rutong village at sampling May to December 2016. These differences are due to different sampling times and environmental conditions. When

the sampling was carried out at Rutong village, the water level on the tidal scale was 0.5. In addition, the high and low level of species richness of marine gastropod found indicating that the adaptability of marine gastropod to varying environmental conditions.

Gastropod is an organism that has high adaptability, so that this animal is able to survive in various habitats or location with widely distribution. The distribution of organisms in relation to habitat is very important factor in ecology. Distribution and aggregation pattern are strongly influenced by physical and biological factor such as sediment characteristic, water movement, seasonal, competition, predation, reproduction and recruitment (Shou *et al.* 2009).

3.3. Ecological density, abundance and frequency of occurrence

Ecological density is density which refers to a total area of habitat available to the species. Natural biotic component is characterized by a few species that are common, which represented by large number of individuals or biomass and large number of species that are rare in time and space (Krebs 2009).

Ecological density of marine gastropod at intertidal zone of Rutong village varied between 1.00 ind.m^{-2} and 11.7 ind.m^{-2}. At Rutong 1, the ecological density varied from 1.00 ind.m^{-2} to 11.7 ind.m^{-2}. At Rutong 2, the value ranges from 1.00 ind.m^{-2} to 12 ind.m^{-2}. Meanwhile, at Rutong 3, the value varied from 1.00 ind. m^{-2} dan 10.50 ind. m^{-2} (**Figure 2**).

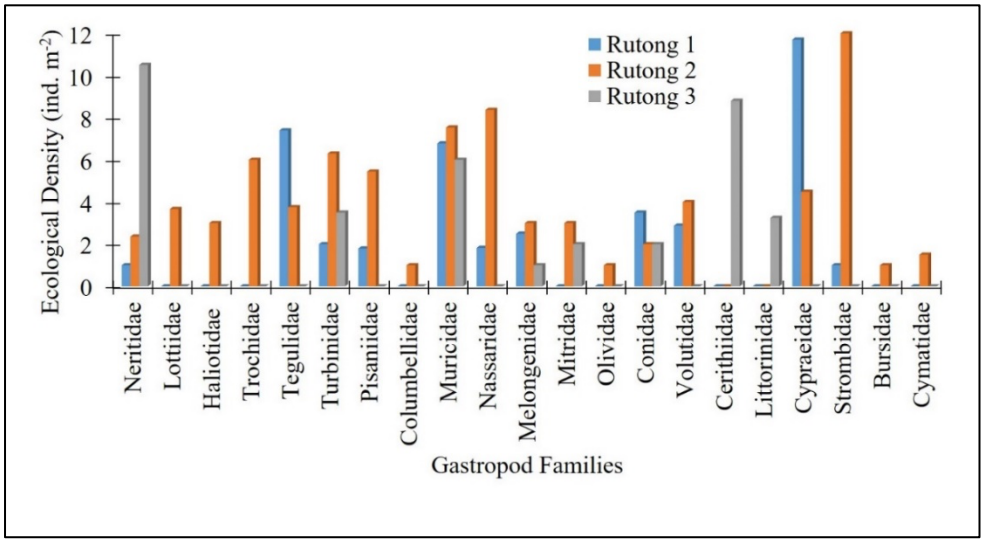

Figure 2. Ecological density of marine gastropod found in Rutong intertidal zone.

It can be seen from **Figure 2** that the families of Cypraeidae and Tegulidae have higher value of ecological density at Rutong 1 compared to another station in this study area. *Luria isabella* and *Monetaria moneta* were marine gastropods from Cypraeidae which have higher ecological density. This is because these species commonly found at the substrate of dead coral mixed with sand. Substrate at Rutong 1 is dominated by dead coral and sand associated with seagrass. Whereas the substrate at Rutong 2 and Rutong 3 are dominated by seagrass and gravel. *Luria isabella* and *Monetaria moneta* commonly found at rocky intertidal zone and coral flat substrate (Shou *et al.* 2009). At Rutong 2, Strombidae, Nassaridae and Muricidae have high value of ecological density.

Strombidae was represented by *Gibberulus gibberulus* and *Conomurex luhuanus*. This is because these species also found at sandy substrates mixed with coral and associated with seagrass. These species, eventought only found in some sampling plots, are relatively higher. Consequently, its ecological density is also higher.

In addition, gastropod from Nassaridae also has high value of ecological density in this sampling station. This is due to the higher number of individuals from these families (90 individual) which found on three sampling plots. At Rutong 3, Neritidae has a high value of ecological density, which represented by *Nerita patula*. *N. patula* commonly inhabits the upper intertidal zone and usually found at substrate consisted of gravel sand.

The abundance of gastropod varied between 1250 individual and 15000 individuals in total area of 5000 m^2 (**Figure 3**). Cypraeidae has the greatest value of abundance in Rutong 1 (14625 individual). This family was represented by *Luria isabella, Monetaria moneta* and *Naria helvola*. Marine gastropod which has high value of abundance in Rutong 2 was represented by family Strombidae (15000 individual) especially from *Gibberulus gibberulus*. Strombidae is marine gastropod commonly found with high abundance at the shallow water of seagrass ecosystems (Poutiers 1998). The families of Cerithidae and Neritidae have the greatest abundance in Rutong 3 (1000 individuals and 10625 individuals, respectively). Cerithidae family represented by *Terebralia palustris. Terebralia palustris* found with high abundance in Rutong 3 because almost this species found in mangrove community and at the substrate consist of coral mixed with sand. Neritidae represented by *Nerita patula,* which found at the upper intertidal zone (Haumahu *et al.* 2023b).

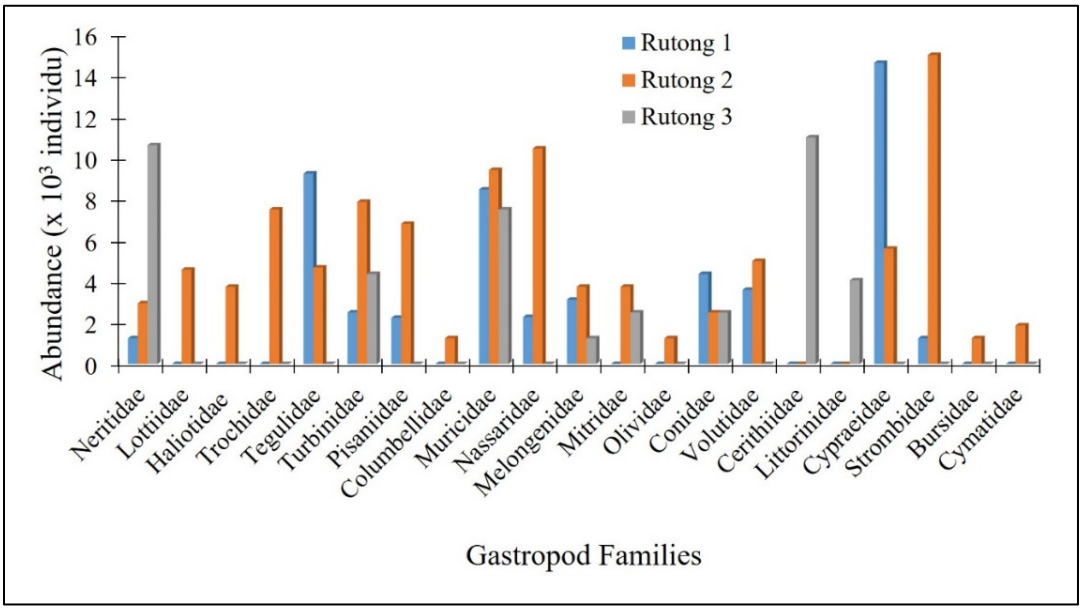

Figure 3. Abundance of marine gastropod found in Rutong intertidal zone.

Frequency of occurrence means that the ratio between the presence of one species at sampling plot and total sampling plots in one sampling area. Frequency of occurrence represents species distribution along study areas. Frequency of occurrence of marine gastropod at Rutong intertidal zone varied between 10% and 62.5% (**Figure 4**). This means that marine gastropod in this area only found at 10% to 62% of total sampling area.

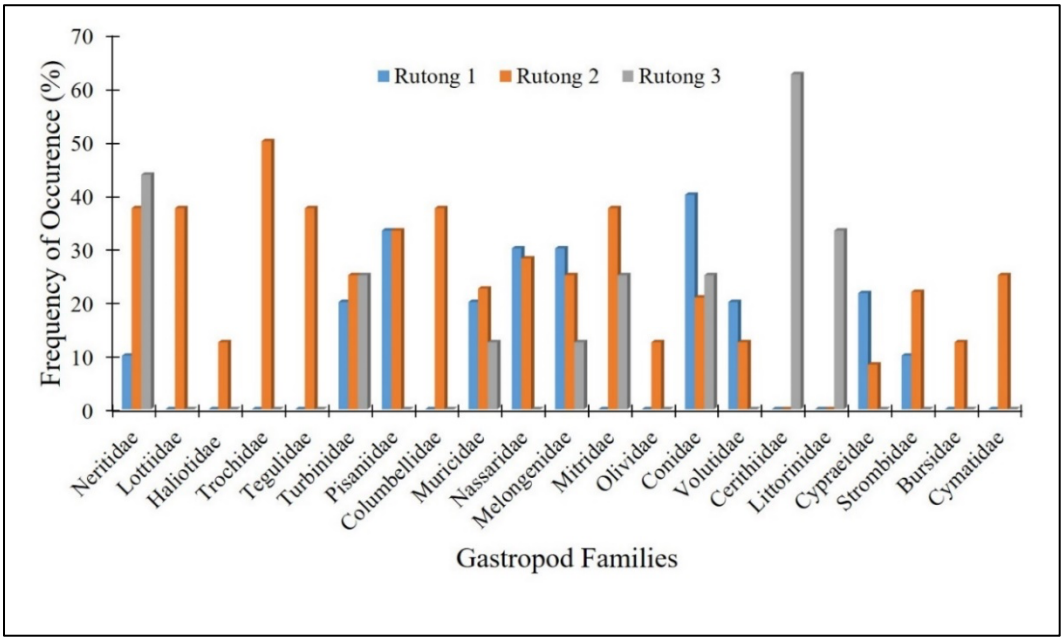

Figure 4. Frequency of occurrence of marine gastropod found in Rutong village.

The greatest value of frequency of occurrence of marine gastropod at Rutong 1 was represented by Conidae (40%). Compared to another marine gastropod species in Rutong 1, *P. undosa* is the species which has the greatest value of frequency of occurrence (70%), so it can be said that this species is distributed widely. Frequency of occurrence of marine gastropod at Rutong 2 varied from 12.5% to 50%. It means that mostly marine gastropod species have narrow distribution, because those species only found at some sampling plots.

In general, there were some species of marine gastropod found at 40-50% of total sampling area. These species were *N. patula, P. sacharinoides, P. testudinaria, T. aculeata, N. niger, G. gibberulus* and *Conus miles.* Based on its habitat characteristic, each species usually inhabit different habitat as well as different types of substrate (Cob *et al.* 2009; Shou *et al.* 2009). The frequency of occurrence of marine gastropod at Rutong 3 ranged between 12.5 % and 62.5%.

This results also showed that the distribution of the species is narrowed distribution, because those species cannot be found at whole sampling area and only at some sampling plots. *N. chamaeleon, T. sulcata* and *T. palustris* were marine gastropod species which have the greatest frequency of concurrency at Rutong 3*.* These species commonly found at upper part of intertidal zone in associated with mangrove trees (Saleky *et al.* 2023).

3.4. Ecological index of marine gastropod

Species diversity is influenced by two factors, namely the number of species (species richness) and the distribution of total number of individuals among those species (species evenness). High species diversity represents both a high number of species and high species evenness. High species diversity is an indicator of stability of marine environments and communities (Magurran 2005; Bakus 2007) and also unpolluted water (Panggabean *et al.* 2020).

Ecological index of marine gastropod at Rutong intertidal zone (**Table 4**) showed that Shannon-Wiener diversity index (H`) ranges between 1.56 to 3.46. The highest value found in Rutong 2. This value of diversity index was categorized as moderate to high diversity. This is because the highest number of species and the proportion of an individual of each species were moderate to uniform distribution (Magurran and McGill 2011).

Table 4. Ecological index of marine gastropod at Rutong intertidal zone.

Parameter	Rutong 1	Rutong 2	Rutong 3
S	21	40	13
J`	0.95	0.94	0.61
H`	2.89	3.46	1.56
D	0.05	0.03	0.30
N1	18.06	31.79	4.77
N2	16.06	26.48	3.33

Noted: S: number of species; J: evenness index; H`: Shannon-Wiener diversity index; D: Simpson dominance index; N1: common species; and N2: rare species.

Evenness index (J`) of marine gastropod at Rutong intertidal zone ranges from 0.61 to 0.95. The greatest value of evenness index of marine gastropod found in Rutong 1 (J` = 0.95), while the lowest value was in Rutong 3 (J` = 0.61). Generally, this evenness index of marine gastropod in this study is in the high category or in a stable community.

This means that the distribution of an individual of each marine gastropod species are nearly uniform distributed (Magurran 2005; Odum and Barrett 2005). Evenness index (J`) ranges form zero to one, if J` is closed to one means that the distribution of an individual between species is uniform, while the value of J` is closed to zero means no uniform distribution of the species (Bakus 2007; Krebs 2009).

Simpson dominance index (D) of marine gastropod at Rutong intertidal zone varied from 0.05 to 0.30. Dominance index of marine gastropods in this research is in low category (Krebs 2009), which means that there is no species dominated the gastropod community in this sampling site. The Simpson dominance index varied from zero (0) to one (1). If D = 1, means the greatest dominance of gastropod communities, while D = 0, means the lowest dominance. The Simpson dominance index in this study showed low dominance and moderate to high diversity.

In natural environment, most communities have a characteristic species structure that consist of few species that are abundance and a large number of species that are uncommon (rare species) (Odum and Barrett 2005). Marine gastropod species at Rutong intertidal zone, which in rare category, varied between sampling sites. There were 19 species of gastropod in rare category found at Rutong 1, while 32 rare species found at Rutong 2, and 5 rare gastropod species found at Rutong 3. These rare gastropod species contribute to the gastropod species diversity at Rutong intertidal zone. The same thing also happens to the common category species (N2) which

contribute to the dominant gastropod species. There were 17 species of marine gastropod found at Rutong 1 which is in common category, while 27 common gastropod species found in Rutong 2, and 4 common gastropod species found at Rutong 3.

In order to determine water quality at based on diversity index of marine gastropods (Magurran and McGill 2011), the result showed that water quality of Rutong intertidal zone is in the category of moderate polluted water (1.0<H`≤2.0) to very lightly polluted (3.0≤H`≤ 4.0). It can be seen from the Shannon diversity index (Table 3) that Rutong 3 was categorized as moderate polluted water, while Rutong 1 and Rutong 2 were categorized as very lightly polluted water. This was supported by Simpson dominance index which was no dominance species in gastropod community.

The correlation between water quality and ecological abundance of marine gastropods at Rutong intertidal zone (**Table 5**) showed that temperature, salinity, pH and dissolved oxygen have negative effect on ecological abundance. Dissolved oxygen has a negative significant correlation to abundance of marine gastropods in this study area. Meanwhile, salinity has an important effect on the distribution and survival of marine gastropods. The value of salinity in this study area was low (the value ranges from 15 to 23.5 psu) (**Table 2**). This is because of the inflow from the river to the sea. These results showed that the water quality of Rutong village is relatively clean and able to support the live of marine organisms that inhabit this location.

Table 5. The correlation between water quality and ecological abundance of marine gastropods at Rutong intertidal zone.

Parameters	Temperature (^{0}C)	Salinity (psu)	pH	DO (ppm)	Ecological abundance
Temperature (^{0}C)	1,00				
Salinity (psu)	-0,79	1,00			
pH	0,99	-0,71	1,00		
DO (ppm)	-0,06	0,66	0,07	1,00	
Ecological abundance	-0,52	-0,11	-0,62	-0,82	1,00

4. CONCLUSION

Total of 53 species of marine gastropods found at Rutong intertidal zone belonging to 41 genera, 22 families and 6 order. The number of species varied between sampling stations. The gastropod species belonging to the family Muricidae and

Neritidae have the greatest value of ecological density, while Muricidae, Neritidae and Tegulidae have the greatest value of abundance. Generally, the distribution of marine gastropods at Rutong intertidal zone was limited distribution. Diversity of marine gastropods in this research is categorized as low diversity to moderate diversity. Evenness index was in the high category and dominance was in the low category. The water quality of Rutong village is relatively clean and able to support the live of marine organisms that inhabit this location. Based on this research, it can be suggested to the government of Rutong Village that management strategy needed to conserve this marine gastropod communities as well as to maintain water quality in this region. The further research was needed to assess biological aspect of dominant gastropod species in this region such as growth pattern, reproduction and sex ratio.

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