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Community distribution and utilization of gastropods in the Coastal Area of Liki Island, Sarmi District, Papua, Indonesia

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Abstract. *Sujarta P, Mailissa MG, Keiluhu HJ, Hadisusanto S, Yuiana S. 2022. Community distribution and utilization of gastropods in the Coastal Area of Liki Island, Sarmi District, Papua, Indonesia. Biodiversitas 23: 5001-5011.* Gastropods and snails are mollusk phylum animals with diverse species that inhabit and spread in various marine ecosystems. The main objective of this study was to determine the structure of gastropod communities and their utilization in the coastal area of Liki Island, Sarmi District, Papua, Indonesia. Samples of gastropods were collected through descriptive-quantitative surveys using the line-transects technique. In addition, information on the utilization of gastropods was collected from surveys with semi-structural interviews with selected respondents from Liki Island, the outermost island in East Indonesia, with a total area of 1318.54 ha. The result showed a total of 1812 living specimens from 63 species of gastropods from 23 families, collected from six sampling stations, with 182-603 specimens on average. There were five species of gastropods encountered in all sampling stations, namely *Conus litteratus* (family of Conidae), *Monetaria moneta*, *Monetaria annulus* (Cypraeidae), *Oxymeris crenulata* (Terebridae), and *Polinices flemingianus* (Naticidae). The highest Importance Value Index (IVI) belonged to *Nerita albicilla* (Neritidae) from Station 1 (IVI 58.45). In contrast, the lowest belonged to the species of *Nassarius limnaeiformis* (Nassariidae), *Oliva caerulea*, and *Oliva oliva* (Olividae) from Station 4 (each IVI 2.56), with the moderate value of Shannon-Wiener Diversity Index and low value of Dominance Index. People in the coastal area of Liki Island use 12 species of gastropod as wall ornaments and consume 12 species of gastropod, as well. In general, the people of Liki Island use gastropods wisely based on the socio-cultural characteristics of the local community.

Keywords: Community structure, gastropod, Liki Island, marine ecosystem, Sarmi, Papua

INTRODUCTION

The marine coastal area in Indonesia has an essential role and is strategically valuable, with the potential of natural resources and a major habitat of diverse marine lifeforms as coastal resources (Rumpeniak et al. 2019; Lukman et al. 2021). Different coastal ecosystems, such as ecosystems of seagrass, mangroves, and coral reefs, have major functions as places to live, for foraging, spawning, sheltering, and many activities of countless marine biota, including gastropods (Gres et al. 2019; Nopiansyah et al. 2021; Hilmi et al. 2022). Gastropods are animals with very high adaptability and are capable of surviving in various places (Nontji 2002; Susintowati et al. 2019).

Gastropods belong to the phylum of mollusks as one of the marine biotas with high species diversity and spread in various marine habitats (Sukawati et al. 2018; Suyadi et al. 2021). In general, gastropods play an important role ecologically and economically (Cumplido et al. 2022). Gastropods usually become a major indicator of ecological changes in biological communities, such as in mangroves, one of their habitats (Arifianti et al. 2021; Putri et al. 2021). Gastropod shells from some genera, such as *Cypraea*, *Murex*, and *Trochus*, have been commonly used for house ornaments. In contrast, other species like *Strombus luhuanus* are usually used as food sources of meat. Gastropods also have potential as biologically marker sources for medicine, exemplified by a toxin or venom substance from the species *Conus magus* that can be developed as an analgesic source from recent studies (Zulkifli and Nasution 2014; Galan et al. 2015; Persulessy and Arini 2018).

The Liki Island is the outermost island in the Eastern Indonesia Region, which is bordered by the Papua New Guinea area and faces the Pacific Ocean. The island is located within the administrative area of Sarmy District, Papua Province, and covers an area of about 1318.54 ha or 13.18 km^2 (Christopel 2015). The coastal area of Liki Island is rich in marine resources with various diverse substrates, including sand, a mixture of sandstone, sand-coral fractures, sand-gravels, corals, and a rocky area with a fairly wide distribution of seagrasses and mangrove vegetation. Coral reefs, mangroves, and seagrass beds around Liki Island can be categorized in good and healthy condition, with some seagrasses as *Halodule pinifolia, Halodule uninervis, Enhalus acoroides,* and *Cymodocea rotundata* can be found in the area (Mailissa et al. 2021). In

regards, a coastal area of Liki Island becomes a very suitable habitat for very diverse gastropods.

Living close to the sea, the people of Liki Island have used gastropods as food, equipment for traditional ceremonies, jewelry, ornaments, and a source of community income. People of Liki Island even have their traditional wisdom of *Abonfan Matilon*, the management of marine areas by temporarily closing or restricting certain areas from catching and collecting shellfish activities, especially on Lola species which belong to gastropods (Mailissa et al. 2021). This kind of local wisdom is similarly practiced by other local People in Papua as well, such as the *Sasisen* system in Biak Numfor Island and the *Tiyaitiki* system in the coastal area of Depapre. Both are models of marine ethno-conservation systems owned by Papuan people in conserving marine and coastal areas (Sujarta et al. 2021). However, the extent of the use of gastropods by local people and also diversity of gastropods in the coastal area of Liki Island is insufficiently known.

Marine and coastal ecosystems majorly contribute to maintaining the surrounding environment and supporting the community's economy. In addition, the natural resources and development of marine ecotourism can become an attraction for marine recreation, such as in the coastal area of Tablasupa and Tablanusu Village, Sub-district of Depapre, Jayapura (Sujarta et al. 2011, 2020; Sujarta 2015; Sujarta and Indriyani 2016). Therefore, detailed information and knowledge on gastropods in Liki Island are expected to provide similar support for coastal protection and conservation and the local community economy. This condition is important because related natural resources, attractive beaches, and dynamic conservation activities with local wisdom can improve all aspects of the economy for the local community.

The aims of this study were (i) to study the structure of gastropod communities on the coastal area of Liki Island, Sarmi District, Papua, Indonesia, and (ii) to determine the utilization of gastropods on the coastal area of Liki Island, Sarmi District, Papua. This research is very interesting to do on the coastal area of Liki Island because the data regarding the structure of the gastropods community and their utilization are not yet known. In addition, the local wisdom of the Liki Island community supports researchers in carrying out this research.

MATERIALS AND METHODS

Time and location

The research was carried out from November 2020 to June 2021. The material for this research includes the diversity of gastropods and information from the community about the utilization of gastropods in the coastal area of Liki Island, Sarmi District, Papua, Indonesia. Data collection was carried out at the coastal area of Liki Island, Sarmi, Papua (Figure 1). The people of Liki Island are mostly fishermen and have specific areas that can be used for marine ecotourism locations. Natural resources and the area are managed independently and traditionally by local indigenous people under the system of *Abonfan Matilon.*

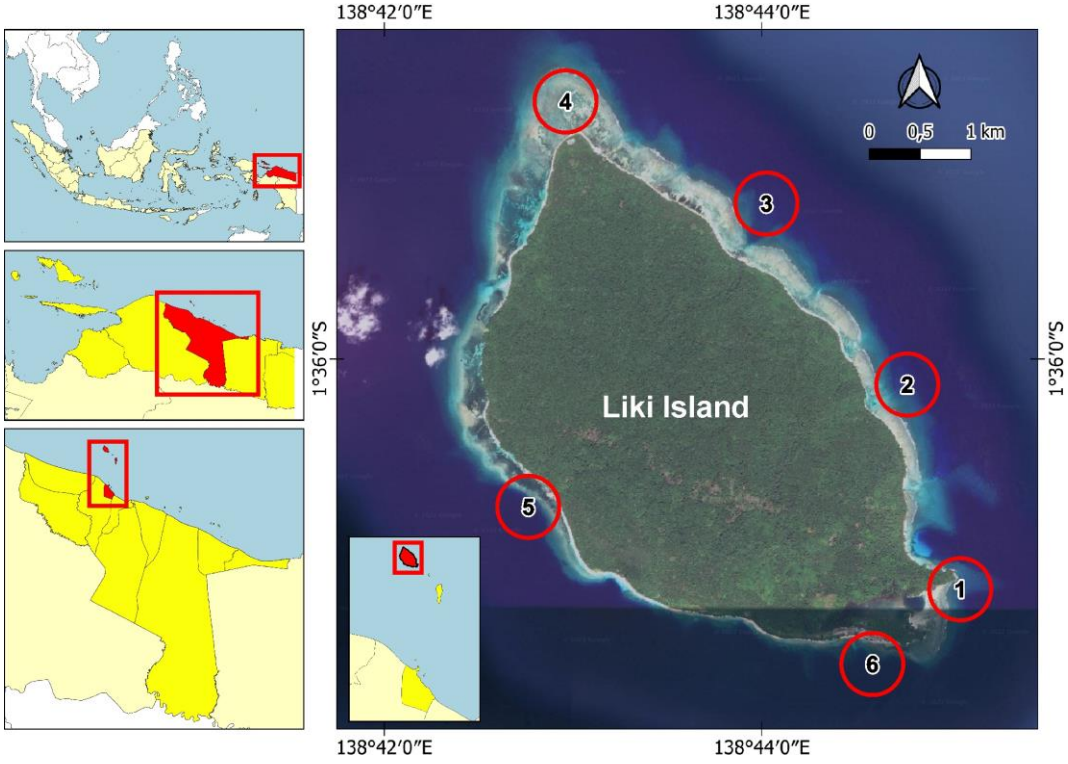

Figure 1. Sampling sites of gastropods at Liki Island, Sarmi District, Papua, Indonesia

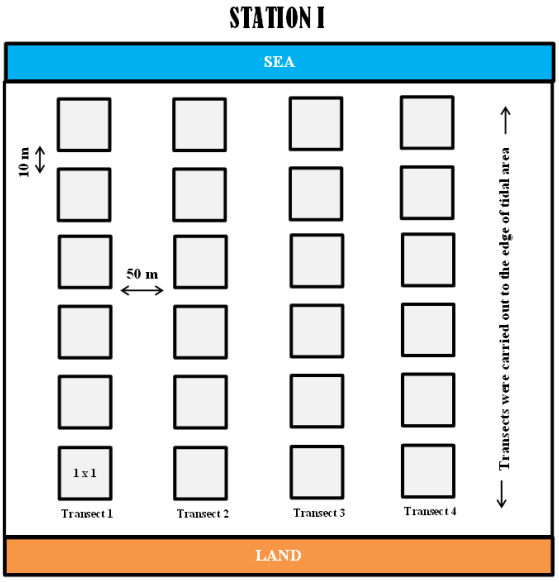

Figure 2. Position of transects and sampling plots on each observation station

Community structure of gastropods

The community structure of gastropods was determined through descriptive-quantitative surveys. Samples of gastropods were collected using line transects. Observation, recording, and counting on gastropods were carried out within 1x1 m^2 plots during low tide conditions. The distance between plots was 10 m, and the distance between transects was 50 m (Figure 2). The observed gastropods were from the water surface to 5-10 cm under the bottom substrate. Identification of gastropods was taken in the Laboratory of Zoology, Department of Biology, Cenderawasih University, Jayapura, using several kinds of literature, including the identification book of The Compendium of Seashells and the book of The World Registers of Marine Species 2020. The results of observation and identification were then tabulated and analyzed.

The island's total area is about 1,318.54 ha or 13.18 km^2. The sampling was carried out in 6 observation stations (Table 1), with 75 plots of 1x1 m^2 placed in 5 line transects (15 plots x 5 line transects = 75 plots). The selection of sampling location was based on geographical representation at the coastal area of Liki Island, Sarmi, Papua.

The community structure of the gastropod was determined based on the Importance Value Index (IVI) using the Brower and Zar formula (1977), including the calculation of relative density, relative abundance, and relative frequency.

Calculations on Species Density (Di) and Relative Density (RDi) were based on the formula:

$$D_i = \frac{Total\ number\ of\ individuals}{Total\ area\ sampled}$$

$$RD_i = \frac{Density\ of\ a\ species}{Total\ density\ of\ all\ species} \times 100\%$$

$$A_i = \frac{Total\ number\ of\ individuals\ of\ the\ species}{Total\ number\ of\ quadrats\ of\ occurence}$$

Table 1. Sampling sites of gastropods in coastal areas of Liki Island, Sarmi District, Papua, Indonesia

Location	Coordinates	Notes
Station 1	S: 01°37'15.18" E: 138°44'54.01"	Southeastern coastal of the island
Station 2	S: 01°36'19.24" E: 138°44'44.60"	Eastern coastal of the island
Station 3	S: 01°35'20.53" E: 138°43'53.38"	Northern coastal of the island
Station 4	S: 01°34'43.14" E: 138°42'59.85"	Northern coastal of the island
Station 5	S: 01°36'17.67" E: 138°42'33,05"	Western coastal of the island
Station 6	S: 01°37'29.49" E: 138°44'35,62"	Southeastern coastal of the island

$$RA_i = \frac{Abundance\ of\ a\ species}{Total\ abundance\ of\ all\ species} \times 100\%$$

Calculations on Species Frequency (F_i) and Relative Frequency (FR_i) were based on the formula:

$$F_i = \frac{Number\ of\ plots\ in\ which\ species\ occur}{Total\ number\ of\ study\ plots}$$

$$RF_i = \frac{Frequency\ of\ a\ species}{Frequency\ of\ all\ species} \times 100\%$$

Then Important Value Index (IVI) of each species was calculated as $IVI_i = RD_i + RA_i + RF_i$

The community structure of gastropod was determined by Shannon-Wiener Diversity Index (Odum 1993) based on the formula:

$$H' = -\sum \frac{number\ of\ individuals\ of\ each\ species}{number\ of\ individuals\ of\ all\ species} Ln \frac{number\ of\ individuals\ of\ each\ species}{number\ of\ individuals\ of\ all\ species}$$

The diversity index value was considered as low when H'<2, moderate when 2<H'<4, and high when H'>4 (Ludwig and Reynold 1988). Afterward, each Species' Dominance (C) was calculated using the value of the Simpson Dominance Index (Odum 1993) based on the formula:

$$C = \sum \left(\frac{number\ of\ individuals\ of\ each\ species}{number\ of\ individuals\ of\ all\ species} \right)^2$$

Species dominance was considered as low when the value of C was $0<C\leq0.50$, moderate when $0.50<C\leq0.75$, and high when $0.75<C\leq1.00$. The composition of gastropods was also calculated using Similarity Index (Odum 1993) based on the formula:

$$IS = \frac{2(Number\ of\ same\ species\ on\ both\ station\ compared)}{Number\ of\ species\ station\ 1 + Number\ station\ of\ Station\ 2} \times 100\%$$

Similarity Index value between stations was categorized as very dissimilar when IS≤25%, dissimilar when the IS was 25-50%, similar when the IS was 50-75%, and very similar when the value of IS was 75-100% (Nurjanah et al. 2013).

Measurement of water chemical-physical factors

The measurement of chemical-physical factors to determine the temperature, DO (Dissolved Oxygen), salinity, and pH of coastal waters in Liki Island were taken at each sampling station. The measurements were needed in order to support sampling data of gastropods from each station. It is known that environmental factors affect the distribution and can cause differences in gastropods' way of life (Septiani and Wiharyanto 2015; D'Souza et al. 2022).

Survey on the use of gastropods by local people of Liki Island

With the aim of finding out the use of gastropods by the local people of Liki Island, a survey was carried out accompanied by interviews with the local community. Several questions were asked to the community related to the diversity of gastropod species used, direct use of consumption, indirect use like for commodity to sell in the market, and also other uses. Finally, the survey results were tabulated to describe the gastropod use concerning traditional conservation practices by local indigenous people of Liki Island.

Data analysis

Observational and measurement data on gastropods were quantitative-descriptively analyzed. The community structure of the gastropod was determined based on the Importance Value Index (IVI) using the Brower and Zar formula (1977), including the calculation of relative density, relative abundance, and relative frequency. Data analysis of gastropods is shown in the form of tables and graphs. First, information data about the community is shown in the table, which is then analyzed descriptively.

RESULTS AND DISCUSSION

Community distribution of gastropod

The study on the coastal area of Liki Islarmi collected 1812 gastropods, with a range of 182-603 individual gastropods within 6 sampling stations, consisting of 63 species of gastropods from 23 families (Table 2). This species' number and distribution showed that gastropods have a very wide distribution area and are often found in intertidal areas (Saleky et al. 2019; Susintowati et al. 2019). The community structure of gastropods was strongly influenced by changes in environmental factors (Hitalessy et al. 2015; Septiani and Wiharyanto 2015; D'Souza et al. 2022). Environmental factors such as temperature, salinity, substrate type, and organic matter content cause the gastropods in the community structure to vary, thus forming different distribution patterns. Each species of gastropod has specific adaptability to respond to various conditions of environmental factors. The variety of environmental factors causes differences in the way of life, behavior, and distribution of gastropods.

Table 2. Community distribution of gastropods on each sampling location based on species diversity and individual numbers

Family	Species	Species number on Station					
		1	**2**	**3**	**4**	**5**	**6**
Conidae	*Conus coronatus*	8	10	5	3	-	1
	Conus eburneus	10	15	-	22	12	1
	Conus litteratus	12	65	5	24	11	6
	Conus virgo	8	-	10	15	8	15
	Conus flavidus	-	2	-	-	-	10
	Conus chaldaeus	-	19	-	-	-	4
	Conus generalis	-	12	-	2	-	-
	Conus coelinae	-	-	3	-	-	10
	Conus pulicarius	-	-	8	-	-	-
	Conus leopardus	-	-	-	21	8	-
	Conus striatus	-	-	-	7	-	-
	Conus stercusmuscarum	-	-	-	-	-	1
	Conus abbas	-	-	-	-	-	1
	Conus imperialis	-	-	-	8	-	-
Nassariidae	*Nassarius sufflatus*	2	-	3	18	-	-
	Nassarius limnaeiformis	1	-	1	1	-	-
	Nassarius acuticostus	1	-	3	-	-	12
	Nassarius echinatus	-	4	-	-	4	-
	Nassarius albescens	-	-	2	-	2	13
Olividae	*Oliva sericea*	41	-	-	5	-	-
	Oliva caerulea	-	-	-	1	-	-
	Oliva oliva	-	-	-	1	-	-
	Oliva fasciata	-	-	-	2	-	-
Strombidae	*Gibberulus gibberulus*	4	-	10	23	5	21
	Canarium mutabile	8	-	-	-	-	-
	Conomurex luhuanus	-	-	9	27	-	-
	Lambis lambis	-	-	-	-	1	-
Cypraeidae	*Cypraea tigris*	6	-	10	28	5	4
	Lyncina lynx	-	-	-	-	1	2
	Monetaria moneta	10	60	35	36	8	9
	Monetaria annulus	5	10	20	30	12	8
Costellariidae	*Vexillum fuscospicatum*	-	1	-	-	-	1
	Vexillum exasperatum	-	2	-	-	-	-
	Vexillum semifasciatum	-	-	1	-	-	-
	Pusia hansenae	-	-	-	4	2	-
Terebridae	*Oxymeris crenulata*	1	1	3	3	1	1
	Oxymeris dimidiata	-	-	-	-	1	-
	Variegata terebra	-	-	-	-	1	3
Pisaniidae	*Engina zonalis*	-	98	-	17	11	-
	Engina mendicaria	-	33	-	15	-	-
	Pollia undosa	-	-	15	-	5	1
Trochidae	*Trochus venetus*	-	24	-	-	-	-
	Chrysostoma paradoxum	1	-	-	2	-	-
Cerithiidae	*Cerithium punctatum*	3	-	-	-	-	-
	Rhinoclavis sinensis	-	-	-	5	-	10
Neritidae	*Nerita albicilla*	64	-	-	-	-	-
	Nerita polita	35	-	-	-	-	-
Tegulidae	*Tectus pyramis*	2	-	-	5	2	-
	Rochia nilotica	-	67	2	-	-	-
Naticidae	*Polinices flemingianus*	5	3	2	7	2	1
	Neverita josephinia	-	-	-	1	-	-
Columbellidae	*Pictocolumbella ocellata*	-	30	19	21	-	19
	Euplica scripta	-	-	-	-	-	8
Mitridae	*Strigatella retusa*	12	-	-	15	10	15
	Mitra mitra	-	-	-	-	-	3
Turbinellidae	*Vasum turbinellus*	-	105	15	-	-	17
Phasianellidae	*Phasianella solida*	-	-	-	-	105	-
Volutidae	*Fulgoraria hamillei*	3	-	1	1	-	-
Harpidae	*Harpa amouretta*	-	-	-	2	-	-
Marginellidae	*Prunum javii*	-	-	-	1	1	-
Muricidae	*Drupa ricinus*	-	-	-	-	1	-
Bullidae	*Bulla ampulla*	1	-	-	-	-	-
Turbinidae	*Turbo chrysostomus*	1	42	-	20	-	-
Total number of individuals		207	603	182	404	219	197
Number of plots that have the species		58	78	75	75	75	75

Notes: Numbers 1, 2,3,4,5, and 6 pointing the sampling stations of gastropods, the community structure in the table is arranged based on the number of species from the most to the fewest

Table 3. Community distribution of gastropods on each sampling station based on the Important Value Index (IVI)

Family	Species	Important Value Index (IVI)					
		1	**2**	**3**	**4**	**5**	**6**
Conidae	*Conus coronatus*	13.56	7.74	9.93	4.43	-	3.86
	Conus eburneus	16.37	9.82	-	14.71	16.75	3.86
	Conus litteratus	18.03	28.52	9.85	15.44	15.95	10.2
	Conus virgo	13.25	-	15.97	10.70	13.03	18.8
	Conus flavidus	-	6.38	-	-	-	14.4
	Conus chaldaeus	-	11.43	-	-	-	8.71
	Conus generalis	-	8.54	-	3.24	-	-
	Conus coelinae	-	-	6.53	-	-	14.07
	Conus pulicarius	-	-	12.43	-	-	-
	Conus leopardus	-	-	-	13.68	12.65	-
	Conus striatus	-	-	-	6.75	-	-
	Conus stercusmuscarum	-	-	-	-	-	3.86
	Conus abbas	-	-	-	-	-	3.86
	Conus imperialis	-	-	-	7.16	-	-
Nassariidae	*Nassarius sufflatus*	7.23	-	7.44	12.15	-	-
	Nassarius limnaeiformis	4.12	-	5.09	2.56	-	-
	Nassarius acuticostus	4.12	-	10.32	-	-	16.09
	Nassarius echinatus	-	4.78	-	-	8.32	-
	Nassarius albescens	-	-	7.2	-	5.56	17.58
Olividae	*Oliva sericea*	8.65	-	-	5.29	-	-
	Oliva caerulea	-	-	-	2.56	-	-
	Oliva oliva	-	-	-	2.56	-	-
	Oliva fasciata	-	-	-	3.24	-	-
Strombidae	*Gibberulus gibberulus*	8.52	-	16.48	14.29	9.75	25.69
	Canarium mutabile	13.01	-	-	-	-	-
	Conomurex luhuanus	-	-	15.61	17.03	-	-
	Lambis lambis	-	-	-	-	4.25	-
Cypraeidae	*Cypraea tigris*	10.2	-	16.79	16.93	9.52	7.65
	Lyncina lynx	-	-	-	-	4.25	5.13
	Monetaria moneta	14.83	24.63	41.37	19.82	9.84	13.09
	Monetaria annulus	9.89	12.16	26.34	17.52	12.65	16.08
Costellariidae	*Vexillum fuscospicatum*	-	3.35	-	-	-	3.87
	Vexillum exasperatum	-	3.82	-	-	-	-
	Vexillum semifasciatum	-	-	4.09	-	-	-
	Pusia hansenae	-	-	-	4.57	5.56	-
Terebridae	*Oxymeris crenulata*	4.12	3.35	11.32	4.43	4.22	3.87
	Oxymeris dimidiata	-	-	-	-	4.22	-
	Variegata terebra	-	-	-	-	4.25	6.37
Pisaniidae	*Engina zonalis*	-	37.48	-	12.1	15.7	-
	Engina mendicaria	-	17.55	-	10.83	-	-
	Pollia undosa	-	-	20.4	-	9.51	3.87
Trochidae	*Trochus venetus*	-	13.46	-	-	-	-
	Chrysostoma paradoxum	4.12	-	-	3.25	-	-
Cerithiidae	*Cerithium punctatum*	7.15	-	-	-	-	-
	Rhinoclavis sinensis	-	-	-	5.28	-	13.12
Neritidae	*Nerita albicilla*	58.45	-	-	-	-	-
	Nerita polita	35.83	-	-	-	-	-
Tegulidae	*Tectus pyramis*	5.63	-	-	8.75	7.64	-
	Rochia nilotica	-	27.97	7.2	-	-	-
Naticidae	*Polinices flemingianus*	9.89	4.30	7.2	6.47	7.64	3.89
	Neverita josephinia	-	-	-	2.53	-	-
Columbellidae	*Pictocolumbella ocellata*	-	16.25	25.34	13.47	-	22.81
	Euplica scripta	-	-	-	-	-	12.06
Mitridae	*Strigatella retusa*	17.34	-	-	11.0	15.27	18.58
	Mitra mitra	-	-	-	-	-	18.57
Turbinellidae	*Vasum turbinellus*	-	38.48	21.64	-	-	20.67
Phasianellidae	*Phasianella solida*	-	-	-	-	86.86	-
Volutidae	*Fulgoraria hamillei*	7.45	-	9.03	7.5	-	-
Harpidae	*Harpa amouretta*	-	-	-	3.24	-	-
Marginellidae	*Prunum javii*	-	-	-	2.56	4.22	-
Muricidae	*Drupa ricinus*	-	-	-	-	4.25	-
Bullidae	*Bulla ampulla*	4.12	-	-	-	-	-
Turbinidae	*Turbo chrysostomus*	4.12	19.99	-	13.24	-	-
	Total IVI	300	300	300	300	300	300
	Number of gastropod species	24	20	21	34	24	27

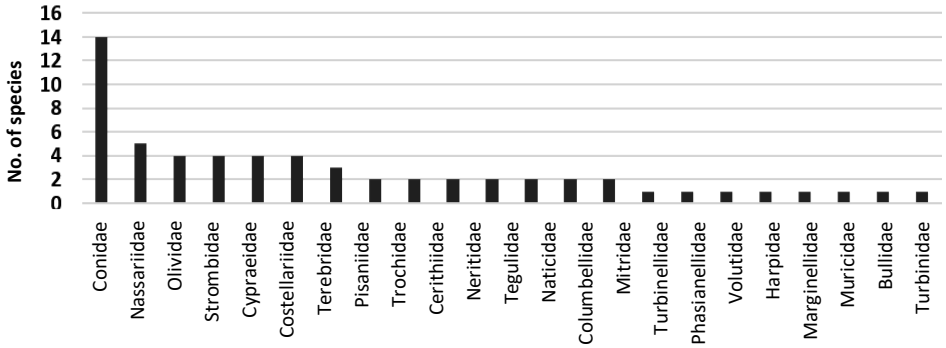

Figure 3. Number of gastropod species based on family

There were five species of gastropods found in all sampling stations (Table 2, Table 3), namely *Conus litteratus* (Family of Conidae, IVI 9.85-28.52), *Monetaria moneta* (Cypraeidae, IVI 9.84-41.37), *M. annulus* (Cypraeidae, IVI 9.89-26.34), *Oxymeris crenulata* (Terebridae, IVI 3.35-11.32), and *Polinices flemingianus* (Naticidae, IVI 3.89-9.89). These species were commonly encountered in intertidal areas and showed adaptation to the substrate type and other environmental factors. One of those species, *Monetaria annulus, usually known as 'ring cowrie,' is* normally found in the intertidal and inhabits sandy and muddy - coastal areas, as well as reef flats with seagrasses or coral fractures (Aji et al. 2018; Saleky et al. 2019). The presence of the gastropods community and their distribution patterns generally occur because of the variability of environmental factors such as nutrition availability, substrate type, associations with other species, temperature and pH condition, and also oxygen content. The difference in environmental conditions ultimately affects a species that tend to look for habitats within its tolerance limit of environmental factors (Nybakken 1992; Zaidi et al. 2021; D'Souza et al. 2022; Hilmi et al. 2022).

All families of gastropods encountered on Liki Island (Figure 3) were known as common families of the coastal area (Dharma 1988; Meyer 2003; Islami 2009; Li et al. 2010; Bouchet et al. 2017; Bula et al. 2017; Fedosov et al. 2017; Aji et al. 2018; Mornaten 2019; Tebiary et al. 2022). In the coastal area, gastropods can be easily encountered in their habitat type. Gastropods generally live in mangrove areas, with the muddy or waterlogged substrate attached to roots or stems, some even climbing the mangrove tree (Dharma 1988; Bula et al. 2017; Mornaten 2019; Hilmi et al. 2022). Of all the family, gastropods from Conidae are the most numerous and most often found compared to other gastropod families. Conidae, known as 'cone snail,' is a predatory gastropod, usually active at night and hiding in rocks or sand during the day. It also has toxic effects and is harmful to humans (Islami 2009). Conidae has about 500 species worldwide, mainly distributed in Indo-Pacific, including tropical waters, the Indian Ocean, the Pacific Ocean, and Australia. Additionally, *Conus* sp. (Conidae) and *Cypraea* sp. (Cypraeidae) have become more common to be found in further areas to the sea (Saleky et al. 2019).

Besides Conidae, there were five other families commonly found on Liki Island, namely Nassarridae, Olividae, Strombidae, Cypraeidae, and Costellariidae. These families were adapted to the various substrate types in Liki Island coastal area and had their own specific characteristics. Nassariidae is known as 'nassa mud snail,' or 'mud snail,' which can be found worldwide, usually inhabiting shallow marine water with sandy or muddy substrates (Li et al. 2010). Olividae, known as 'olive shell' or 'olive snail', can be found worldwide as well, living on the sandy substrate in the subtidal and intertidal areas (Bouchet et al. 2017). Strombidae, usually known as 'true conch,' are usually found in tropical and subtropical waters, associated with shallow reefs and seagrass beds. Finally, cypraeidae or 'cowrie' consists of members which usually active at night and feed on the coral sponge (Meyer 2003). Gastropod species from Strombidae and Cypraeidae are also known for their high economic value (Aji et al. 2018). Costellariidae is known as 'ribbed matters, the family of carnivorous gastropods, which are most diverse in the tropical Indo-Pacific area at the depth interval of 0-200 m (Fedosov et al. 2017).

The Importance Value Index (IVI) values varied between species among different sampling stations (Table 3). For example, the highest IVI of gastropod species in Liki Island reached 58.45, belonging to *Nerita albicilla* (Neritidae) from Sampling Station 1. The lowest IVI was 2.56 in Sampling Station 4, from *Nassarius limnaeiformis* (Nassarridae), *Oliva oliva* and *O. caerulea* (Olividae). The greater the number of individuals of a species in a certain habitat, the greater the IVI value, which means a higher role of the species in the community (Hitalessy et al. 2015). Accordingly, the great IVI value of *Nerita albicilla* can show the highest role in the community. Habitat of genus *Nerita* is usually in mangrove trunks and roots, with muddy and rocky substrates, lives in groups, and sticks to rocky substrates (Chapperon et al. 2013; Mornaten 2019). Basically, the type of substrate greatly influences gastropod distribution (Souisa et al. 2019).

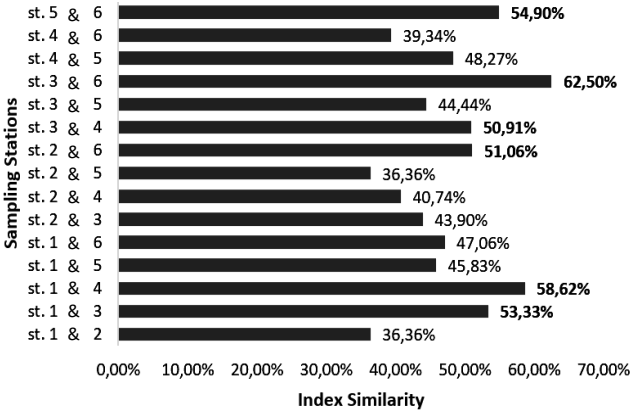

Figure 4. Similarity Index of gastropods between sampling stations

The presence of gastropod species between sampling stations showed varying conditions, which were indicated by varying Similarity Index (Figure 4). The highest similarity occurred between Station 3 and Station 6, at IS value of 62.5%. Both sampling stations showed around 15 same species of gastropods viz; *Conus coronatus*, *C. litteratus*, *C. virgo*, *C. coelinae*, *Nassarius acuticostus*, *N. albescens*, *Gibberulus gibberulus*, *Cypraea tigris*, *Monetaria moneta*, *M. annulus*, *Oxymeris crenulate*, *Pollia undosa*, *Polinices flemingianus*, *Pictocolumbella ocellata* and *Vasum turbinellus* (Table 3). Other stations comparations also showed high similarity with SI values of more than 50%, namely Station 1 and 4 (IS: 58.62%), Station 5 and 6 (IS: 54.90), Station 1 and 3 (IS: 53.33%), Station 2 and 6 (IS: 51.06%), and Station 3 and 4 (50.91%). Therefore, it is considered that two locations with a similarity index above 50% to 75% have similar conditions and criteria (Nurjanah et al. 2013). All comparations of sampling stations in Liki Island have great IS between 50%-75%, which can also be interpreted that the sampling stations being close to each other, so they have similarities in gastropod diversity, besides the similarity of environmental conditions.

Diversity and dominance of gastropod species

The gastropod diversity index was used to determine the level of gastropod diversity present at sampling stations. The value of the gastropod diversity index on Liki Island was in the range of 2.15-3.15 (Table 4), indicating a moderate category of diversity, and the gastropod communities were evenly distributed in all sampling stations. The distribution of gastropods is mainly affected by substrate (Persulessy and Arini 2018), and the result showed that all sampling stations were in the same condition. However, station 4 has a higher diversity index value than other stations due to its 34 species of gastropods encountered in the station. Gastropod species generally show good adaptability to changes in environmental factors in their habitat (Sari et al. 2020). Additionally, the high diversity of gastropods indicates suitable environmental conditions to support gastropod life (Yahya et al. 2015; Zaidi et al. 2021).

On the other hand, a dominance index describes the level of territorial domination or control by a community over its environment. The index usually comes contrary to the diversity index; it has a high value when it is low, and vice versa, it has a low value when it is high. The Dominance Index of gastropods on Liki Island was in a range of 0.05-0.25 (Table 4), with the highest Dominance Index, was at Station 5 when compared to other Stations. It means that there was domination from some gastropod communities on the station. For example, the result showed that 'pheasant snail' *Phasianella solida* was more dominant at Station 5 than other species. The station seemed suitable to become *P. solida's* habitat due to its sandy substrate and seagrass bed. Hitalessy et al. (2015) also stated that seagrass vegetation is known to affect the distribution of gastropods; nevertheless, the dominance index value at the Liki Island sampling station shows a fairly low value, indicates that there is no single species of gastropod that dominates the distribution of gastropods. Gastropod observations on Liki Island generally showed a fairly high diversity of gastropod species with varied Important Value Index, moderate Diversity Index, and low Dominance Index (Table 2 and Table 3).

In general, water conditions on all sampling stations in Liki Island were suitable for marine life and within normal conditions (Table 5). All parameters of water quality were still within the normal threshold of water quality standards set by the Decree of the Minister of Environment (Kepmen LH) No 51/2004 concerning Seawater Quality Standards, with the normal range of temperature is between 28°-30°C, salinity between 32-35 ppt, Dissolved Oxygen (DO) more than 5 mg/L and water pH between 7-8.5. Among all those parameters, the temperature usually becomes essential in affecting the number of gastropods in a habitat. Water temperature of more than 30°C can reduce the number of gastropods rather than under 30°C (Assuyuti et al. 2017; Rozirwan et al. 2021).

Utilization of gastropod species by Liki Island community

People in Liki Island ordinarily collect gastropods for meat consumption and use gastropod shells for various purposes (Figure 5). Gastropod meat is generally used to meet food needs because it has high nutritional value (Saleky et al. 2016; Abdillah et al. 2019).

Gastropods species commonly used by people of Liki Island for consumption are *Conus litteratus, C. abbas, C. virgo, C. stercusmuscarum, C. imperialis, C. leopardus*, and *C. eburneus* (Conidae), *Gibberulus gibberulus*, *Canarium mutabile* and *Conomurex luhuanus* (Strombidae), *Tectus niloticus* (Tegulidae) and *Turbo chrysostomus* (Turbinidae). In addition, gastropod shells are widely used as materials for various decorations in many places (Galan et al. 2015; Persulessy and Arini 2018; Slamet et al. 2021). The shells of gastropods on Liki Island are used as accessories such as bracelets, necklaces, brooches, wall ornaments and hangings, curtains, home decorations, and usually as a complement to traditional events on Liki Island. Gastropods species commonly used by people of Liki Island for decorations are *Monetaria moneta* and *M. annulus* (Cypraeidae), *Nerita albicilla* and *N. polita* (Neritidae), *Engina zonalis* (Pisaniidae), *Bulla*

ampulla (Bullidae), *Strigelata retusa* and *Mitra mitra* (Mitridae), *Oxymeris crenulata* and *O. dimidiata* (Terebridae), *Prunum javii* (Marginellidae), and *Tectus niloticus* (Tegulidae).

Table 4. Diversity index and dominance index of gastropod from each sampling station on Liki Island, Sarmi District, Papua, Indonesia

Index	Sampling station					
	1	2	3	4	5	6
Gastropod Diversity Index	2.47	2.47	2.67	3.15	2.15	2.93
Gastropod Dominance Index	0.14	0.11	0.09	0.05	0.25	0.06

Table 5. Chemical-physic condition of coastal water on Liki Island, Sarmi District, Papua, Indonesia

Factors	Sampling station					
	1	2	3	4	5	6
Temperature (°C)	30-32.9	28.9-29.8	30.5-31	29.2-30	28.9-30.1	28.4-30
Salinity (‰)	31-35	34-35	34-34.4	34-35	31-35	35-36
Dissolved oxygen (mg/L)	6.5-6.9	6.3-6.9	8.2-8.5	6.8-7.4	7-7.9	6.5-7
pH (ppm)	7.3-7.7	7.4-7.8	7.5-7.6	7.2-7.5	7-7.3	7.3-7.4

Figure 5. Gastropod species are commonly utilized by people on Liki Island (Source: research documentation). A. *Conus litteratus*; B. *Conus virgo*; C. *Conus stercusmuscarum*; D. *Conus imperialis*; E. *Conus leopardus*; F. *Conus eburneus*; G. *Gibberulus gibberulus*; H. *Canarium mutabile*; I. *Conomurex luhuanus*; J. *Tectus niloticus*; K. *Turbo chrysostomus*; L. *Conus abbas*. Bar = 1 cm.

Table 6. Knowledge of gastropod conservation management by Liki Island Community

Explored aspects	Respondent answer (%)	
	Yes	No
Knowledge of species of gastropods	93	7
Knowledge of utilization of gastropod	75	25
Knowledge of the economic value of gastropod	74	26
Knowledge of conservation of gastropod	91	8

Conservation management of gastropods based on local wisdom

It is widely accepted that there is a positive correlation between gastropod diversity and marine environmental conditions (Dharma 1988; Meyer 2003; Islami 2009; Li et al. 2010; Bouchet et al. 2017; Bula et al. 2017; Fedosov et al. 2017; Saleky et al. 2017; Aji et al. 2018; Mornaten 2019). Various types of environments in the coastal area of Liki Island provide suitable conditions and habitat types for many species of gastropods. Gastropod habitats are generally in the littoral zone, including tidal areas (Nurhayati et al. 2021), where they can attach to seagrass and mangroves' roots, stems, and leaves (Rahman et al. 2021). Most gastropods are also immersed in sandy mud substrates (Dharma 1988; Bula et al. 2017; Saleky et al. 2019). The results of gastropod diversity samplings (Table 3 and Table 4) with their use on the coastal area of Liki Island have not shown a threatened status; this can be related to the knowledge of gastropods conservation management by the community (Table 6). The basic knowledge about the potential habitat of gastropods and gastropod species was also included in the aspects explored in interviews regarding gastropods in the Liki Island community (Table 6).

The survey results on gastropods in the Liki Island community showed that 93% of the respondents already knew about gastropods with the local name *Lola*. This knowledge is closely related to the major livelihoods of Liki people as fishermen, who usually know perfectly about marine life. Knowledge of the species and habitats of gastropods is then significantly associated with three other aspects: the utilization of gastropods daily, the economic role of gastropods, and gastropod conservation practices by the local community. Although observations and surveys already noted the consumption and utilization of gastropods by Liki Island, nonetheless, people on Liki Island have their customary rules to harvest gastropods not daily and only as needed. This practice of local wisdom has become an important basis for gastropod conservation activities on Liki Island. People on Liki Island also practice local wisdom in protecting and managing marine life, known as *Abonfan Matilon* (Mailissa et al. 2021). During *Abonfan Matilon*, certain coastal areas and marine waters around the island will be closed from fishing activities and collecting gastropods, specifically 'Lola' or known as *Trochus* spp. (Trochidae). This management model is expected to support Liki Island's survival and sustainable use of gastropods. In the long term, this effort can prevent the risk of damage to coastal ecosystems and the scarcity of gastropods, which will require high costs and a long time to recover. Utilization of gastropods unwisely, without considering the sustainability aspect, often leads to threats that can result in a decrease in abundance of species and population size, as well as species diversity, and finally, change gastropod community to become more uniform (Saleky et al. 2019). Furthermore, the cost of restoring damaged habitats and communities of gastropods will be greater than the need to maintain a conservation area (Hunter 1996; Brauer 2003).

This study shows that the development research on coastal, socio-cultural, and management of natural resources used directly by humans is indispensable (Domínguez-domínguez et al. 2019; Zhong et al. 2020). Overall, this study's findings can be considered a basis for determining marine conservation ethno-policies and systems, especially in the coastal area of Papua. Furthermore, the results of this study prove that local wisdom can be applied in conserving natural resources.

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