NOTE

Diversity of gastropods in Kapas Island, Indonesia

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ABSTRACT. Gastropods are one of the constituents of benthic communities in waters and are found throughout the world, ranging from shallow, sandy, coral reefs to deep seas. Gastropods have several advantages, one of the most relevant is that they can be used as bioindicators of pollution. The purpose of this study was to determine the diversity and abundance of gastropods in Kapas Island, Indonesia. This research was conducted for two months on the coast of Kapas Island, Indonesia. Gastropod collection was carried out at 10 observation stations using three transect lines toward the sea and divided into three parts, namely upper intertidal, middle intertidal, and lower intertidal on each transect line. The distance between stations was ~ 150 m. Ninety plots of 1 m^2 were set. Abundance and diversity were analyzed qualitatively. Results showed that gastropods consisted of 9 genera and 14 species. Among them, *Cerithium* sp. had the highest individual abundance (40.15%). The diversity index of gastropods in Kapas Island was 2.07 (medium diversity).

Key words: Abundance, intertidal gastropods, marine environment.

Diversidad de gasterópodos en la Isla Kapas, Indonesia

RESUMEN. Los gasterópodos son uno de los constituyentes de las comunidades bénticas en las aguas y se encuentran en todo el mundo, desde arrecifes de coral arenosos hasta mares profundos. Los gasterópodos tienen varias ventajas, una de las más relevantes es que pueden ser utilizados como bioindicadores de contaminación. El propósito de este estudio fue determinar la diversidad y abundancia de gasterópodos en la Isla Kapas, Indonesia. Esta investigación se llevó a cabo durante dos meses en la costa de la Isla Kapas, Indonesia. La recolección de gasterópodos se llevó a cabo en 10 estaciones de observación utilizando tres líneas de transecta hacia el mar, divididas en tres partes, a saber, intermareal superior, intermareal medio e intermareal inferior, para cada línea de transecta. La distancia entre estaciones fue de ~ 150 m. Se establecieron 90 parcelas de 1 m^2 cada una. La abundancia y la diversidad se analizaron cualitativamente. Los resultados mostraron nueve géneros y 14 especies de gasterópodos. Entre ellos, *Cerithium* sp. tuvo la mayor abundancia individual (40,15%). El índice de diversidad de gasterópodos en la Isla Kapas fue de 2,07 (diversidad media).

Palabras clave: Abundancia, gasterópodos intermareales, ambiente marino.

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Marine Gastropoda has a variety of species found from intertidal to deep sea areas, often attached to substrates such as coral reefs, wood, aquatic plants, and immersed in sediments (Ratna et al. 2016). Gastropods are one of the constituents of benthic communities and are found all over the world, from shallow sandy and coral reefs to deep waters. Gastropods can also be

used as bioindicators of pollution because they feed on detritus and more abundant where the environmental has better conditions. Economicaly, gastropods are consumed as food, and the shells are used as an industrial raw materials for accessories, necklaces and tapestries, as well as being consumed by other gastropods (Parorrongan et al. 2018).

Previous research related to the diversity of intertidal organisms in Tolitoli Regency has been carried out on starfish in Bajugan beach (Putri and Potoboba 2022) and on gastropods in the village of Binontoan (Yanti et al. 2022). Coastal areas with abundant gastropods can be found in the Tolitoli district, Central Sulawesi. Kapas Island is a distinctive marine area for tourism, where gastropods are extensively harvested for local consumption and as economic support for inhabitants (BPS 2017). Overexploitation is a possible consequence of uncontrolled extractive activities in the island (Parorrongan et al. 2018). Based on this information, diversity and abundance become one of the benchmarks for assessing the sustainability of marine ecosystems. In order to determine the status of these aquatic organisms, the diversity and abundance of gastropods in Kapas Island were evaluated.

This research was conducted for two months off the coast of Kapas Island, Tolitoli Regency, Central Sulawesi Province, Indonesia (1° 16′ 58″ N-120° 47′ 57″ E). Gastropods were collected at 10 sampling stations (Figure 1). For each station, three transect lines of 50 m and 150 m in width were established towards the sea, perpendicular to the shoreline, divided into three levels, namely upper, middle, and lower intertidal. The distance between stations was ~ 150 m. A total number of 90 plots (quadrats) of 1 × 1 m were randomly selected (English et al. 1997). Gastropods found in each plot were identified, sorted and numbered, and three individuals for each species were preserved in formalin 70% (Rukmana and Purnomo 2019). All specimens were deposited at the Madako Tolitoli University Laboratory. Environmental observations included the substrate type and *in situ* water temperature and pH.

Gastropods were identified to the lowest taxonomic level using identification books (Dharma 1988) and journals (Bula et al. 2017; Haumahu and Uneputty 2018; Rukmana and Purnomo 2019; Liline et al. 2021) based on morphological characteristics such as shape, color, and shell. The validity of species names was also checked from the World Register of Marine Species (WoRMS) database.

Frequency of incidence (FoI) was estimated using the equation:

$$\text{FoI} = \frac{Ni.St}{N.St} \times 100$$

where, *Ni.St* is the total number of locations where the species *i* was found, *N.St* is the total number of sampling locations (Romimohtarto and Juawana 2001). Frequency value ranges are 0-25% (very rare), 25-50% (rare), 50-75% (moderate), and > 75% (frequent/absolute). Gastropod abundance was calculated using the formula:

$$Ki = \frac{ni}{A}$$

where *Ki* is the individual abundance (density) (ind. m^{-2}), *ni* is the number of each species (individual), and *A* is the transect area (m^2). The calculation of gastropod diversity was done using the Shannon-Wiener diversity index (H'):

$$H' = -\sum Pi\ (LNPi)$$

where *Pi* is the proportion of the i^{th} species, and *LN* represent the logarithm of *Pi*. The Shannon-Wiener diversity index is classified into three levels: H' < 1 (low species diversity), 1 ≤ H' ≤ 3 (medium species diversity), and H' > 3 (high species diversity) (Brower et al. 1990).

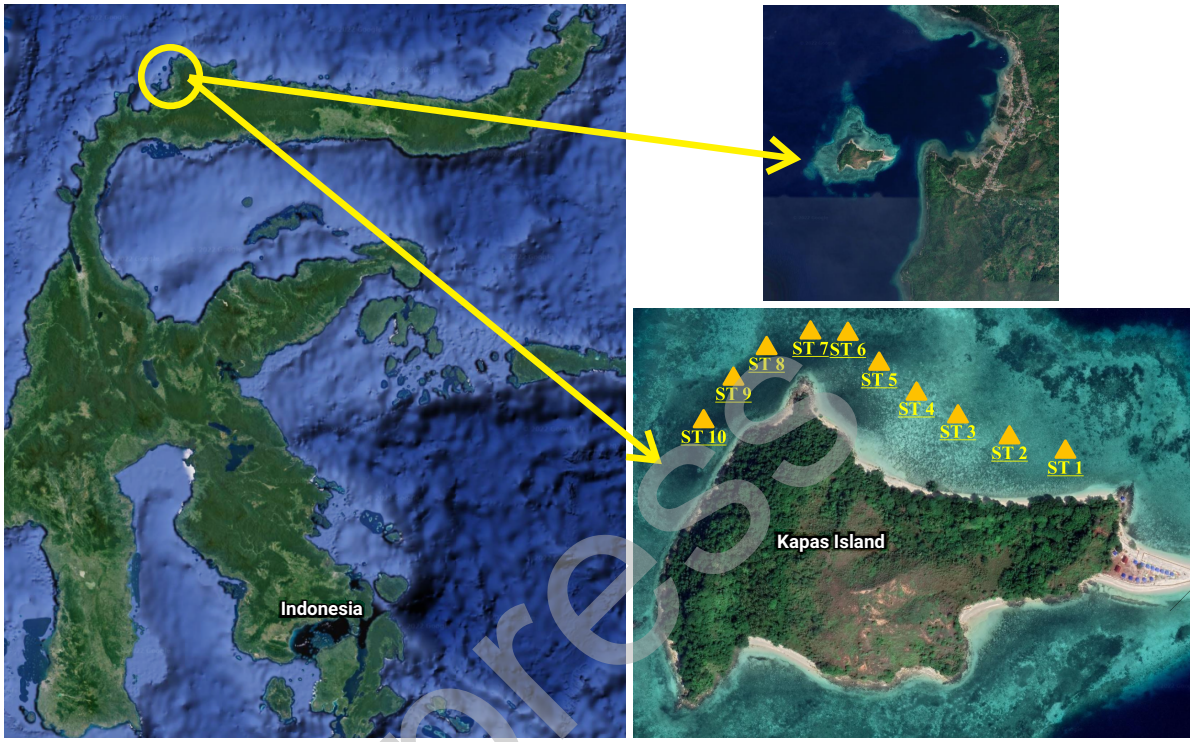

Figure 1. Gastropod collection sites at Kapas Island, Indonesia.

Results indicate that gastropods collected in Kapas Island consisted of 9 genera and 14 species (Table 1; Figure 2). The diversity of gastropods in Kapas Island was medium (H' = 2.09), which means that the gastropod ecosystem is in a balanced condition. Gasteropod abundance showed that the highest was *Cerithium* sp., while *Oliva* sp. was the lowest (Figure 3). Frequency of incidence was moderate for *Nerita exuvia*, *Cellana radiata*, and *Cerithium* sp., while the other species had variable frequencies (rare and very rare) (Figure 4). Water quality (temperature, salinity, pH) and substrate were suitable for the habitat of gastropods (Liline et al. 2021) (Table 2).

Ecologically gastropods act as detritus feeders, so they can be used as bioindicators of waters where, the higher the abundance of gastropods, the better the condition of the waters (Bula et al. 2017).

Rukmana and Purnomo (2019) collected different gastropods in Toraja Bird Beach, Madura, namely, *Trochus maculates*, *Nerita spengleriana, N. plicata*, *C. annulus*, *Cypraea moneta*, *Nassarius margaritiferus*, *N. olivaceus*, *Polinices mamilla*, *Engina incarnata*, and *Phos hirasei*.

The most common species variation found was the Genus *Nerita*, with five species (*N. spengleriana*, *N. polita*, *N. plicata*, *N. exuvia*, and *N. albicilla*). According to Liline et al. (2021), seven species of *Nerita* were found in Ambon (Latuhalat, Hutumuri, and Suli villages), namely *N. maxima*, *N. costata*, *N. plicata*, *N. spengleriana*, *N. gossa*, *N. albicilla*, and *N. chamaeleon*. Same authors described this location as an intertidal area with sandy, rocky, and clay substrates, suitable for the habitat of gastropods. Haumahu and Uneputty (2018) identified ten species of *Nerita* on rocky substrates in the intertidal area of Oma Village, Haruku Island.

Table 1. Diversity of gastropods in Kapas Island, Indonesia (ni = number of species, N = total number of species, ln = logarithm of ni/N).

No	Species	ni	N	ni/N	ln	Diversity
1	*Nerita exuvia*	72	959	0.0751	-2.5892	-0.1944
2	*Nerita polita*	31	959	0.0323	-3.4319	-0.1109
3	*Nerita spengleriana*	92	959	0.0959	-2.3441	-0.2249
4	*Nerita albicilla*	38	959	0.0396	-3.2283	-0.1279
5	*Nerita plicata*	15	959	0.0156	-4.1578	-0.0650
6	*Cellana* sp.	102	959	0.1064	-2.2409	-0.2383
7	*Cellana radiata*	46	959	0.0480	-3.0372	-0.1457
8	*Menathais* sp.	56	959	0.0584	-2.8405	-0.1659
9	*Conus ebraeus*	5	959	0.0052	-5.2565	-0.0274
10	*Oliva* sp.	4	959	0.0042	-5.4796	-0.0229
11	*Strombus luhuanus*	31	959	0.0323	-3.4319	-0.1109
12	*Faunus ater*	40	959	0.0417	-3.1770	-0.1325
13	*Cerithium* sp.	385	959	0.4015	-0.9126	-0.3664
14	*Cypraea moneta*	42	959	0.0438	-3.1282	-0.1370
						2.07

The abundance of gastropods on Kapas Island was dominated by *Cerithium* sp. (40.15%). Kapas Island is also dominated by sandy-clay and slightly rocky substrates. Results of this study are in agreement with those of Hafish et al. (2022) in Lembar Bay, West Nusa Tenggara, where *Cerithium* sp. was the most common species (16.76%). The main habitat of this species is the tropics with shallow waters and sandy substrates (Hafish et al. 2022). According to Ratna et al. (2016) and Chusna et al. (2017), good water conditions and nutrient content are factors that favor the abundance of gastropods.

The diversity index (H') can be interpreted as a systematic description of the community facilitating the process of analyzing information about types and numbers of organisms. The diversity index (H') of the average gastropod on Kapas Island was 2.0 (medium). Diversity values from this study were similar to those of Rukmana and Purnomo (2019), with diversity ranging from $1 \leq H' \leq 3$ (medium) in Toraja Bird Beach, Sumenep Madura; while Hafish et al. (2022) obtained lower diversities (0.36-1.17) in Lembar Bay. One of the reasons for these differences in diversity values may be due to the different environmental and water quality characteristics of each study site. According to Bula et al. (2017) gastropods diversity is influenced by pollution, water physicochemical factors, and aquatic substrates.

The water quality of Kapas Island showed salinity, temperature, and pH values adequate for the life of gasteropods (Sandewi et al. 2019). According to Adi et al. (2014), Chusna et al. (2017) and Bula et al. (2017), gastropod the diversity and abundance of gastropods is influenced by water pollution and physicochemical factors, such as, temperature, salinity, current, pH, oxygen, substrates and depth, as well as competition, predation, and the availability of sufficient nutrients.

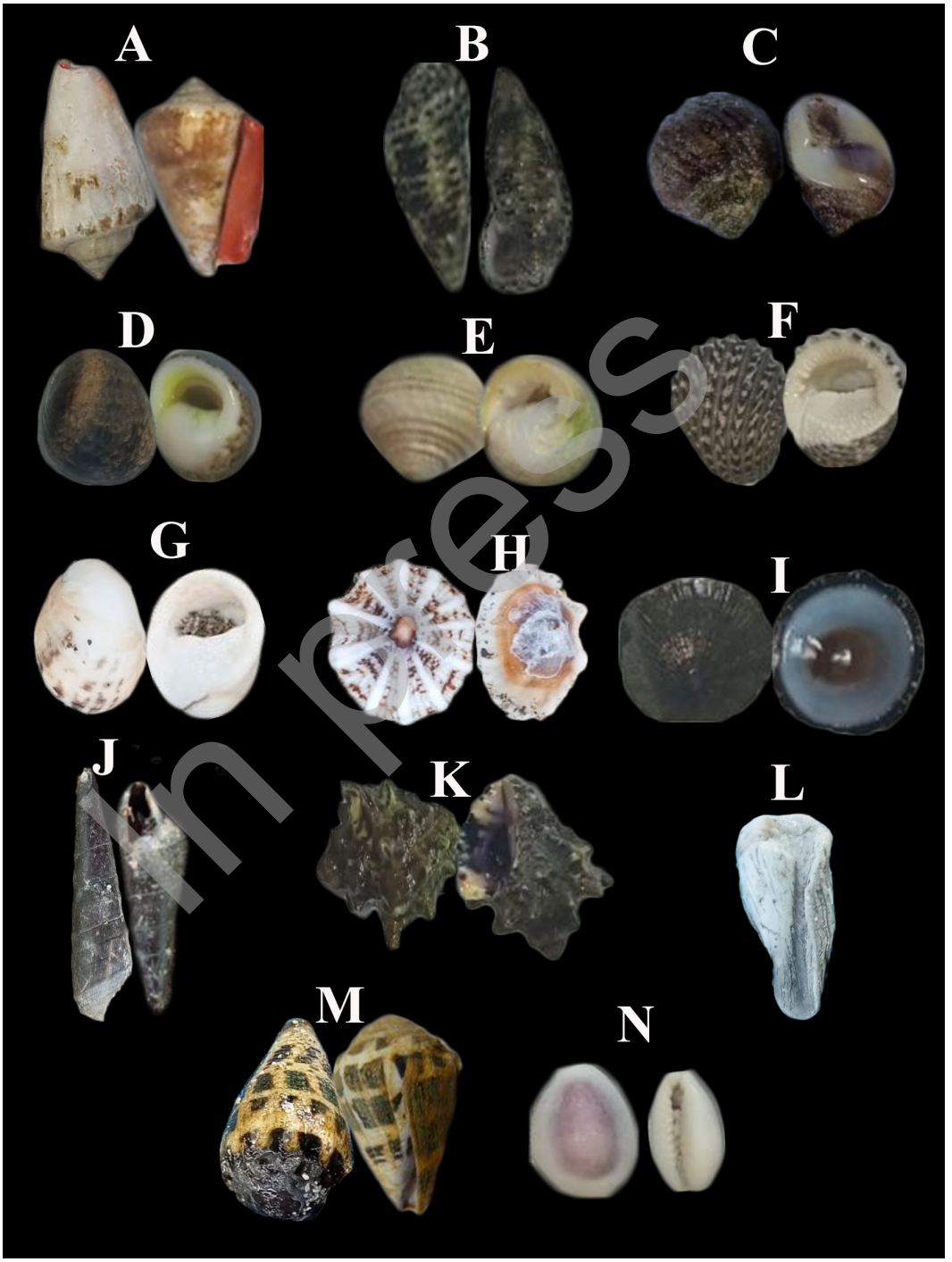

Figure 2. Gastropods collected in Kapas Island. A) *Strombus luhuanus*. B) *Cerithium* sp. C) *Nerita spengleriana*. D) *Nerita polita*. E) *Nerita plicata*. F) *Nerita exuvia*. G) *Cellana* sp. H) *Cellana radiate*. I) *Nerita albicilla*. J) *Faunus ater*. K) *Menathais* sp. L) *Oliva* sp. M) *Conus ebraeus*. N) *Cypraea moneta*.

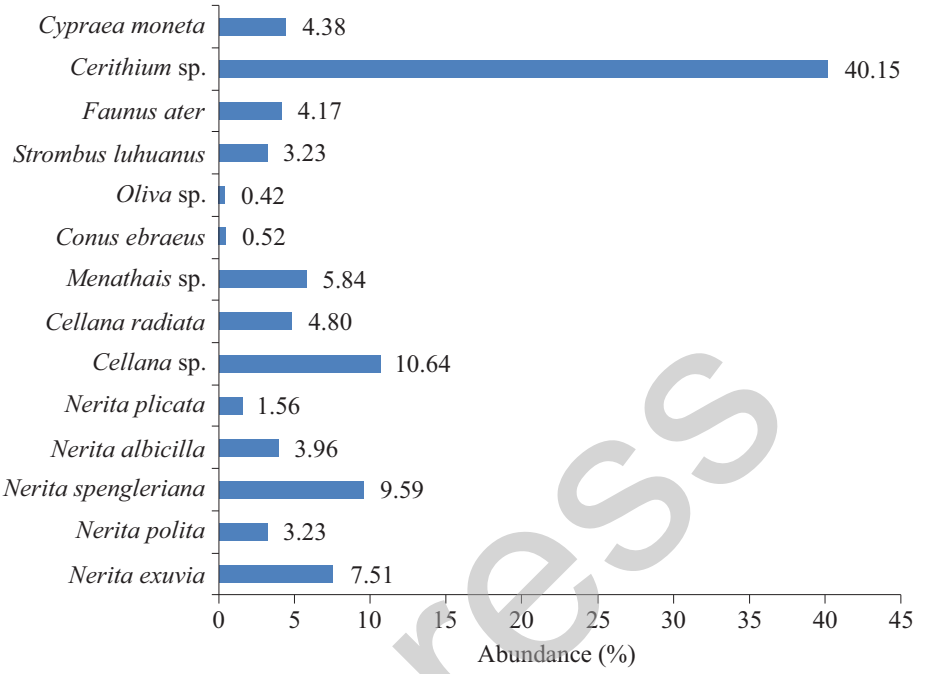

Figure 3. Gastropods abundance in Kapas Island, Indonesia.

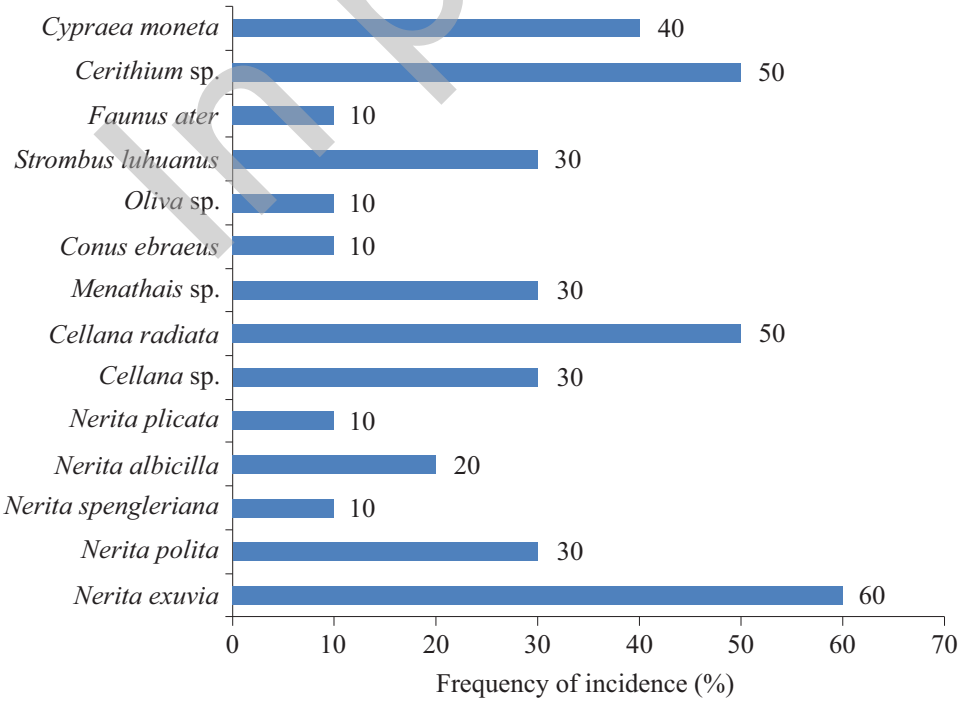

Figure 4. Frequency of incidence of gastropods in Kapas Island, Indonesia.

Table 2. Environmental parameters of each station in Kapas Island, Indonesia.

Observation station	Salinity	Temperature (°C)	pH	Substrate
Station I	30	29	8.4	Sand
Station II	30	30	8.5	Sand
Station III	29	29	8.5	Sand, Rock
Station IV	30	30	8.5	Sand, Rock
Station V	30	30	8.5	Sand
Station VI	30	29	8.5	Sand
Station VII	30	28	8.5	Sand, Clay
Station VIII	29	29	8.5	Sand
Station IX	30	29	8.4	Rock
Station X	30	29	8.5	Sand, Clay

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