Sains
dan
Matematika

p-ISSN: 2302-7290
e-ISSN: 2548-1835

Sains dan Matematika, Vol 10, No. 1, April 2025: 29-36

Gastropod Diversity in Pacar Pucang Laban Beach, Tulungagung Regency

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ABSTRACT

Tulungagung is a city that has a variety of beautiful beaches, one of which is Pacar beach. The condition of the beach which is still natural and clean makes this beach inhabited by a wide variety of marine biota, one of which is gastropods. The purpose of this study was to determine the diversity and relative abundance of Gastropods and the environmental conditions that affect Gastropods at Pacar Beach Pucang Laban, Tulungagung. Sampling used the transect method, by placing three transect lines. For each transect line was placed three square plots measuring 1x1 m2 each in each intertidal. Gastropods taken were gastropods that were found in each squared plot and in the substrate to a depth of 5 cm. The results of this study found 18 species belonging to 14 families. The results of the diversity obtained were based on the Shanon Wiener indeks are 2.461, which was dominated by the abundance of gastropods Clanculus atropurpureus and Conus (Lividoconus) lividus. The highest relative abundance came from the Trochidae family, Clanculus atropurpureus species of 20.97%, followed by the species Conus (Lividoconus) lividus from the Conidae family with a relative abundance of 17.74%.

Kata Kunci: keasaman; kedelai; kefir; organoleptik; telang.

ABSTRAK

Tulungagung adalah sebuah kota yang memiliki berbagai pantai indah, salah satunya adalah pantai Pacar. Kondisi pantai yang masih alami dan bersih membuat pantai ini dihuni oleh berbagai biota laut, salah satunya adalah gastropoda. Tujuan dari penelitian ini adalah untuk mengetahui keanekaragaman dan kelimpahan relatif gastropoda serta kondisi lingkungan yang mempengaruhi gastropoda di Pantai Pacar Pucang Laban, Tulungagung. Pengambilan sampel menggunakan metode transek, dengan menempatkan tiga garis transek. Untuk setiap garis transek, ditempatkan tiga plot persegi berukuran 1x1 m² di setiap intertidal. Gastropoda yang diambil adalah gastropoda yang ditemukan di setiap plot persegi dan di substrat hingga kedalaman 5 cm. Hasil penelitian ini menemukan 18 spesies yang termasuk dalam 14 famili. Hasil keanekaragaman yang diperoleh berdasarkan indeks Shanon Wiener adalah 2,461, yang didominasi oleh kelimpahan gastropoda Clanculus atropurpureus dan Conus (Lividoconus) lividus. Kelimpahan relatif tertinggi berasal dari famili Trochidae, spesies Clanculus atropurpureus sebesar 20,97%, diikuti oleh spesies Conus (Lividoconus) lividus dari famili Conidae dengan kelimpahan relatif sebesar 17,74%.

Key Words: *acidity; kefir; sensory; soy; butterfly pea.*

INTRODUCTION

Tulungagung Regency is one of the cities with a wide variety of beautiful coastal waters, one of which is Pacar Beach. Pacar Beach is located in Pucanglaban Village, Pucang Laban District. Tulungagung Regency spans an area of 1,056 km² and is geographically situated between the coordinates 111°43´-112°07´E and 7°51´-8°18´S (Regional Planning and Development Agency, 2013). The distance from the center of Tulungagung City to Pacar Beach is quite far, approximately 39 km, with a travel time of one and a half hours. This beach has a unique attraction because it is unlike other beaches. Pacar Beach has fairly large ocean waves, but the waves do not reach the shoreline because coral rocks break them. Additionally, Pacar Beach retains its natural beauty, featuring white, clean sand with a grainy texture and coral rocks along the shoreline (Milatiya, 2020). The natural and clean condition of the beach makes it home to a rich diversity of marine life, including gastropods.

Gastropods play an important role both ecologically and economically. Some gastropods are economically valuable because their shells can be used for various expensive ornaments, such as *Cypraea, Murex,* and *Trochus*. In addition, some gastropods can also serve as a source of food, such as *Cyimbiola*, which is harvested for its meat. At the same time, ecologically, they can act as consumers, for example, Cellana radiata. Gastropods are animals that can live on various substrates, including rocky, sandy, and muddy substrates. Gastropods are one of the key components of aquatic ecosystems and play

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a significant role as bioindicators of ecosystem disturbances (Nafi'ah, 2019).

The number of gastropod species found is closely related to the presence of gastropods and their surrounding ecosystem. The diversity and abundance of gastropods in their habitat are highly dependent on both biotic and abiotic environmental factors (Wulansari & Kuntjoro, 2018). The presence of gastropods in one of the communities inhabiting the northern coast of Situbondo Regency is indirectly related to the water quality of the area. Gastropods play an important role in the ecosystem and participate in the food chain cycle as a food source for other animals.

There are also Gastropoda, which are used by humans as a source of animal protein (Subianto & Susilo, 2023). The results of Rahmasari et al. (2015) showed that on Jumiang Beach, which has a sandy substrate type, fewer Gastropoda species were found compared to those on a muddy substrate because the substrate conditions tended to be unstable and constantly moving. Mud substrates tend to have low oxygen levels, so organisms living in them must adapt (Mustofa et al., 2023). The lack of vegetation at Jumiang Beach also affects the number of gastropod species on the beach. This is because gastropods, which are detritivores, require suitable vegetation in their habitat.

Gastropods generally bury themselves in muddy substrates, specifically sandy clay coastal substrates suitable for their life and development (Budi et al., 2013). Habitat conditions with rocky substrates are suitable for the development of certain gastropod species. Therefore, these habitat conditions are dominated by gastropod groups that are tolerant to lower oxygen levels, resulting in fewer other gastropod groups being found in such habitats (Laily et al., 2022).

Based on initial observations conducted in October 2022, it was found that Pacar Beach has a high diversity of gastropods, which, according to residents, have not yet been scientifically identified. Currently, there has been no research specifically investigating gastropod species diversity at Pacar Beach. Therefore, additional scientific investigation is needed to elucidate gastropod diversity in this region. This research also provides information on gastropods as a source of information for further research by relevant agencies or parties and for the local community to pay more attention to the environment around them. The objectives of this study are to determine the diversity and relative abundance of gastropods as well as the environmental conditions that influence gastropods at Pacar Pucang Laban Beach, Tulungagung. The benefits of this study are to serve as a source of information on gastropod diversity in the ecosystem and as a reference for further research.

PROCEDURES

The research was conducted in October 2022. Sampling was conducted in the area of Pacar Beach, Pucang Laban District, Tulungagung (Figure 1). The identification of research objects was carried out at the Animal Taxonomy Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, University of Surabaya. The research method employed included a descriptive approach, incorporating observational techniques. The transect method was employed, with three transect lines positioned in a manner that followed the coastline.
Each transect line was subdivided into three sections: upper intertidal, middle intertidal, and lower intertidal. Within each transect line, three 1x1m2 quadrat plots were established, with each quadrat containing gastropods found in the substrate to a depth of 5 centimeters. The gastropods present in each quadrat plot were systematically sorted and enumerated according to their species. For each species, 2-3 individuals were selected for preservation in a collection bottle containing a 70% alcohol solution. These samples were then subjected to identification. Gastropod sampling was conducted on two occasions: October 1, 2022, and abundance of gastropods as well as the environmental conditions that influence gastropods at Pacar Pucang Laban Beach, Tulungagung. The benefits of this study are to serve as a source of information on gastropod diversity in the ecosystem and as a reference for further research.

Each transect line was subdivided into three sections: upper intertidal, middle intertidal, and lower intertidal. Within each transect line, three 1x1m2 quadrat plots were established, with each quadrat containing gastropods found in the substrate to a depth of 5 centimeters. The gastropods present in each quadrat plot were systematically sorted and enumerated according to their species. For each species, 2-3 individuals were selected for preservation in a collection bottle containing a 70% alcohol solution. These samples were then subjected to identification. Gastropod sampling was conducted on two occasions: October 1, 2022, and October 14, 2022, from 3:00-6:00 p.m. WIB, at the farthest ebb tide. The measurement of environmental parameters (water temperature,

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substrate pH, salinity, substrate type) was carried out on the habitat.

Gastropods were identified through observation of their morphological characteristics, which included shell shape, mouth shape on the shell, shell length, and shell tip shape. The identification guidebook used was Dharma (2005). The diversity index (H') was calculated using the Shannon-Wiener index (Odum 1993), as follows:

$$H' = -(Pi\ Ln\ Pi)$$

Description :
H'= Species diversity index
Pi = ni/N
ni = Number of individuals of each species

N = Number of all individuals with the following criteria :

H > 3,0 : High diversity
1 < H < 3 : Medium diversity
H < 1 : Low diversity

According to Odum (1993), the relative abundance of species can be analyzed using the following equation:

$$KR = \frac{ni}{N} x100\%$$

Keterangan :
KRi = Relative abundance
ni = Number of individuals of the i-th species
N = Total individuals of all species.

RESULTS AND DISSCUSION

The beach in the Tulungagung area has fairly large waves. However, the waves do not reach the shore because coral reefs break them, and it is difficult to find the lowest tide due to Tulungagung's geographical location, which borders the Indian Ocean (Regional Planning and Development Agency, 2013). The results of the research conducted identified 18 species belonging *to 14 families (Table 1). The gastropods that dominate the beach are Clanculus atropurpureus and 17 other species, namely Conus (Lividoconus) lividus, Cypraea (Erosaria) moneta, Neritina pulligera, Morula uva, Cypraea caputserpentis, Nerita (Ritena) costata, Mitrella intexta, Heliacus areola areola, Cellana testudinaria, Cellana radiata radiata, Vexillum (Pusia) cancellarioides, Rhinoclavis articulata, Coralastele punctocostatus, Conus (Virroconus) sponsalis, Conus (Virroconus) ebraeus and Conus (Rhizoconus) distans.*

Clanculus atropurpureus is described as having a brown shell with a smooth surface and small spots in the middle to the tip of the body, dominated by brown with a single white line across the shell and white at the tip. The shell twists to the right (dextral) with a narrow mouth. *Conus (Lividoconus) lividus* has a shell height of 1 cm and a diameter of 0.5 cm. The shell tip forms a blunt tower, brown in color, with a grayish hue on each whorl. The shell rotation is right-handed (dextral), the shell shape is flattened, and the shell mouth is oblong. The shell description of *Conus lividus* has a length of up to 3.5 cm and a width of approximately 2 cm. *Conus lividus* has a conical shell with a short, rounded apex.

Fikriyanti et al. (2018) stated that the high or low diversity index is caused by various factors, namely the abundance of certain species or individuals compared to other species, substrate conditions, and ecosystem conditions in coastal areas, which are the main habitat of almost all aquatic fauna. The lowest gastropod diversity was found in sandy coastal areas. This is because the substrate does not support the life of several gastropod species (*Rhinoclavis articulata*, and *Mitrella intexta*), making it difficult for them to survive. Sandy substrates do not provide a place for organisms, especially gastropods, to attach themselves.

Clanculus atropurpureus exhibits a brown shell characterized by a smooth surface adorned with diminutive spots extending from the midsection to the apex of the shell. The predominant coloration is brown, accented by a singular white stripe traversing the shell and a white hue at the tip. The shell twists to the right (dextral) with a narrow mouth. *Conus (Lividoconus) lividus* has a shell height of 1 cm and a diameter of 0.5 cm. The shell tip forms a blunt tower, brown in color, with a grayish hue on each whorl. The shell rotation is right-handed (dextral), the shell shape is flattened, and the shell mouth is oblong. The shell description of *Conus lividus* has a length of up to 3.5 cm and a width of Table 2 shows that the Gastropoda Diversity Index (H') value at Pacar Beach, Pucang Laban Tulungagung, is 2.461 overall. According to the Shannon-Wiener Diversity Index calculation, this range indicates that the diversity of Gastropoda at Pacar Beach, Pucang Laban Tulungagung, is categorized as moderate diversity because 1 < H' < 3. The diversity of Gastropoda at Pacar Beach, Pucang Laban Tulungagung, can be considered high because it has a higher diversity index than the diversity index of Gastropoda at several other beaches in East Java.

Figure 2. Various types of gastropods found in Pacar Pucang Laban Beach Tulungagung. Keterangan 1. *Conus* (Lividoconus) *lividus* 2. *Conus* (Virroconus) *ebraeus* 3. *Conus* (Rhizoconus) *distans* 4. *Conus* (Virroconus) *sponsalis* 5. *Rhinoclavis articulata* 6. *Mitrella intexta* 7. *Vexillum* (Pusia) *cancellarioides* 8. *Morula uva* 9. *Nerita* (Ritena) *costata* 10. *Neritina pulligera* 11. *Clanculus atropurpureus* 12. *Cypraea caputserpentis* 13. *Cellana testudinaria* 14. *Cellana radiata* 15. *Coralastele punctocostatus* 16. *Heliacus areola* 17. *Cypraea* (Erosaria)

Table 1. Types of gastropods found in Pacar Pucang Laban Tulungagung Beach

Family	Species	Quantity
Conidae	*Conus (Lividoconus) lividus*	11
	Conus (Virroconus) ebraeus	1
	Conus distans	1
	Conus sponsalis	1
Neritidae	*Nerita (Ritena) costata*	2
	Neritina pulligera	5
Cypraeidae	*Cypraea caputserpentis*	3
	Cypraea (Erosaria) moneta	9
Nacellidae	*Cellana testudinaria*	2
	Cellana radiata radiata	2
Cerithiidae	*Rhinoclavis articulata*	1
Columbellidae	*Mitrella intexta*	1
Costellariidae	*Vexillum (Pusia) cancellarioides*	2
Muricidae	*Morula uva*	4
Trochidae	*Clanculus atropurpureus*	13
Calliostomatidae	*Coralastele punctocostatus*	2
Architectonicidae	*Heliacus (Heliacus) areola areola*	2
Costellariidae	*Vexillum (Pusia) cancellarioides*	1
Total		**62**

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Table 2. Diversity index of gastropods in Tulungagung Pacar Beach

Species	Pi	*Ln* Pi	H′
Clanculus atropurpureus	0,20967742	-1,5622	0,3276
Conus (Lividoconus) lividus	0,17741935	-1,7292	0,3068
Cypraea (Erosaria) moneta	0,14516129	-1,9299	0,2801
Neritina pulligera	0,08064516	-2,5177	0,203
Morula uva	0,06451613	-2,7408	0,1768
Cypraea caputserpentis	0,0483871	-3,0285	0,1465
Nerita (Ritena) costata	0,03225806	-3,434	0,1108
Mitrella intexta	0,03225806	-3,434	0,1108
Heliacus areola areola	0,03225806	-3,434	0,1108
Cellana testudinaria	0,03225806	-3,434	0,1108
Cellana radiata radiata	0,03225806	-3,434	0,1108
Vexillum (Pusia) cancellarioides	0,01612903	-4,1271	0,0666
Rhinoclavis articulata	0,01612903	-4,1271	0,0666
Coralastele punctocostatus	0,01612903	-4,1271	0,0666
Conus (Virroconus) sponsalis	0,01612903	-4,1271	0,0666
Conus (Virroconus) ebraeus	0,01612903	-4,1271	0,0666
Conus (Rhizoconus) distans	0,01612903	-4,1271	0,0666
Total			**2,461**

Based on the results of relative abundance (RA) calculations for Gastropoda at Pacar Pucang Laban Beach, Tulungagung, the highest relative abundance (RA) was found in *Clanculus atropurpureus*, with a relative abundance (RA) of 20.97%. The species with the lowest relative abundance (RA) were *Vexillum (Pusia) cancellarioides*, *Rhinoclavis articulata*, *Coralastele punctocostatus*, *Conus (Virroconus) sponsalis*, *Conus (Virroconus) ebraeus*, *Conus* and *(Rhizoconus) distans* is 1.61%. The high abundance results from the wide distribution of these species, which are more evenly distributed in the observation area and are, therefore, more frequently encountered. These species are also highly adaptable due to their shell structure, which enables them to survive on unstable sandy substrates and in areas with high wave currents. Additionally, the high relative abundance (KR) value is due to *Clanculus atropurpureus* being a herbivorous species that feeds on algae or plant debris attached to coastal rock substrates. The abundance of food sources allows species with the highest values to adapt well to low or no competition (Parorrongan et al., 2018).

Table 4. The measurement results of physico-chemical parameters and the analysis of sediment structure types were conducted at Pacar Pucang Laban Beach in Tulungagung Regency

Parameters	Value
Temperature of the water (℃)	27
pH of the substrate	6,0
Type of substrate	Sedimentary

Based on measurements of physical-chemical parameters and analysis of sediment structure types at Pacar Pucang Laban Beach, Tulungagung Regency, the water temperature was found to be 27°C. According to Odum (1993), temperature is a limiting factor for the growth and spread of living organisms, as the temperature of an environment can influence the metabolic processes of organisms. The optimal temperature for gastropods to metabolize is within the range of 25–35°C (Suwondo et al., 2006). Thus, the temperature at Pacar Beach is still within the optimal range, resulting in a diverse range of gastropods found there.

Acidity (pH) is necessary to maintain the survival of aquatic organisms. This is because pH can affect the type and availability of nutrients and the toxicity of microorganisms. In general, gastropods can survive optimally at a pH range of 5-8 (Rahmasari et al., 2015). The observed pH value of the substrate at Pacar Beach was 6.0, which is still within the optimal range for the growth and distribution of gastropods on that beach. In addition to water temperature and substrate pH, substrate type also influences gastropod diversity in a water body. According to Bu*di et al. (*2013), gastropods are animals with a unique habit of burrowing into mud. Therefore, the conditions at Pacar Beach are highly conducive to optimal gastropod distribution due to its muddy sand substrate.

Based on the results of the analysis conducted, it can generally be stated that the diversity of

gastropods at Pacar Beach falls into the moderate category. This is supported by the environmental conditions of Pacar Beach, which is still relatively clean as it is a beach in Tulungagung District that has recently been opened to the public. However, despite this, the gastropod diversity index at Pacar Beach is only 2.461, which can be considered fairly low. Therefore, if Pacar Beach is developed into a tourist beach open to the public in the future, there is a high potential for a decline in gastropod diversity at Pacar Beach within a relatively short period. Gastropod diversity is closely linked to environmental conditions. When these conditions improve, we see an increase in gastropod diversity. Conversely, if the environment worsens, gastropod diversity tends to decrease.

CONCLUSION

Based on the results of the research and analysis conducted, it can be concluded that a total of 14 families consisting of 18 species of gastropods were found at Pacar Pucang Laban Beach, Tulungagung. The diversity index obtained was 2.461, dominated by the abundance of gastropods from three families, namely the Conidae family at 24.19%, Trochidae at 20.96%, and Cypraeidae at 19.35%. The gastropod diversity at Pacar Beach is supported by several environmental conditions, including a water temperature of 27°C, substrate pH of 6.0, and a sandy-muddy substrate type.

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