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Diversity, Evenness, and Richness of Mollusc on the Peh Pulo Beach, Blitar Regency

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Abstract
Molluscs are one of the most abundant invertebrate animals and live on various substrates. Peh Pulo Beach has a wide coastline, on the edge of the beach there are coral rocks, the sand is white, and the waves are big. Molluscs like to live in coral rock substrates. This research aims to determine the diversity, evenness, and richness of molluscs on Peh Pulo Beach. Sampling was carried out at three different stations using plots measuring 1x1 m which were chosen randomly. Mollusc samples were identified based on morphological characteristics and validated using the *WoRMS* database. The results of mollusc identification at Peh Pulo Beach showed that there were 37 species belonging to 23 families. They are classified in the classes Gastropods (32 species), Bivalves (3 species), and Polyplacophora (1 species). The diversity of molluscs in the Peh Pulo Beach area is at a moderate level. The evenness of molluscs in Peh Pulo Beach is similar and the richness of molluscs is at a semi-disturbed level. so appropriate management and conservation strategies for the sustainability of molluscs are needed. The results of this research can be a basis for consideration in determining mollusc conservation strategies in coastal areas.

Keywords: diversity, evenness, richness, mollusc, peh pulo

1. Introduction

Peh Pulo is one of the beaches on the south coast of Blitar Regency. Peh Pulo beach is locatedin Sumbersih Village, PanggungrejoDistrict, Blitar Regency. Peh Pulo beach is divided into three beaches consisting of Wedi Ombo beach, Wedi Ciut beach, and Wedi Kembar beach, the three beaches are located in one area. The three beaches have white sand, towering cliffs on each edge of the shoreline, and rows of islands across the shoreline. Peh Pulo beach has a wide coastline, the shoreline area is full of small rocks and seagrass beds. The waves on the beach are quite large, as is typical of the south coast of Java. The characteristic of Peh Pulo beach is that it is a beach with a group of islands scattered off the coast, the sand is white and rocky, and the waves are big. When the waves recede, coral rocks can be seen dominating the shoreline. Beaches with pristine white sand and diverse substrates provide a rich habitat for marine biota to live (Wulandari et al., 2022; Kurniawan, 2023). Marine biota that usually live on coral rocks are molluscs. The surface of rocks in the sea protects organisms from heat and predators and is a good substrate for the growth and development of various types of plants and animals, one of which is a Mollusc (Widiansyah et al., 2016).

Molluscs are a group of invertebrates that are classified as having a high abundance on land,in fresh waters, and in the sea. In marine ecosystems, there are very diverse types of Molluscs according to the existing habitat (Astiti, et al., 2021). There are more than 200,000 members

of this phylum spread throughout the world (Istiqlal, et al., 2013), and is the second-largest animal phylum after Arthropoda (Arbi, 2008; Rixky et al., 2024). The Mollusc phylum consists of seven classes, namely Aplacophora, Monoplacophora, Polyplacophora, Cephalopoda, Scaphopoda, Gastropoda, and Bivalvia.

Molluscs can live on various substrates, including sand, rock, and mudd substrates. Besides that, molluscs also have high adaptability to places and weather. Molluscs have good adaptability compared to other biota groups (Astiti, et al., 2021). The way of life of molluscsis that they stick, bury their shells or settle on the substrate (sessile), making their presence and distribution very influenced by changes that occur in the environmental ecosystem (Hartoni, 2013). The life of molluscs is influenced by environmental factors, both physical and chemical, that exist in their habitat (Maretta et al., 2019; Astiti, et al., 2021). Molluscs are animals that are sensitive to changes in water quality in their habitat so this can be used to determine population density and diversity of the Mollusca phylum (Athifah et al., 2019) and Molluscs can be used as indicators for determining water quality which provides better reactions (Fillah et al., 2022).

Various studies have been carried out on mollusc identification on the south coast of Java Island (Alfina et al., 2022; Fillah et al., 2022; Wulandari et al., 2022) so that the existence of the types and structures of mollusc communities in some coastal areas can be known. Research on the diversity and structure of the Gastropod community at Peh Pulo Beach has been carried out and succeeded in finding 11 species from the Gastropod class (Sari, K. & Purwanto, N., 2021; Kurniawan, 2023). However, there is no further research on Molluscs on Peh Pulau Beach. Therefore, research on the diversity, evenness, and richness of Molluscs needs to be carried out to provide education on the diversity of Mollusc types to the public and participate in assisting marine natural resource conservation activities as well as monitoring marine biota, especially Molluscs in the Peh Pulo Beach, Blitar Regency.

2. Methods

The research was carried out in May 2023 along the coast of Peh Pulo, Blitar Regency. The sampling technique used purposive sampling. Sampling was carried out at three different stations when sea water receded, determined based on the availability of Molluscs along the coast. At each station, three plots measuring 1x1 m were created which were chosen randomly (Suzile, et al., 2016). A map of mollusc sampling locations on the Peh Pulo coast, Blitar Regency can be seen in Figure 1.

Figure 1 Research Station Location Map

All types of live Molluscs contained in the plot were taken, labelled, and preserved with alcohol 70%. The type of substrate along the plot lines was also recorded. Mollusc samples were identified in the Laboratory to type level based on morphological characters and the identification book (Abbott, 1990; Dharma, 2005) and classification using web pages *MolluscaBase*. The validity of species names was also reviewed from the *World Register of Marine Species (WoRMS)* database. Analysis of Molluscs diversity using the Shannon-Wienerdiversity index (H') with the formula:

$$H' = - \Sigma P_i \ln P_i$$

Where H' is the value of the Shannon-Wiener diversity index, P*i* is the proportion of the i^{th} species (n*i*/N), n*i* is the number of individuals of the i^{th} species, and N is the total number of individuals of all types.

Table 1 Diversity index criteria Shannon-Wiener (Odum, 1971)

Diversity Index	Criteria
H'<1	Low
1,0≤H'≤3,0	Moderate
H'>3,0	High

The species evenness index was calculated using Pielou's evenness index. Pielou's evenness index is as follows:

$$E = H' / \ln S$$

In the above equation, H' is the Shannon-Wiener diversity index and *S* is the total number of species in a habitat (station). Species evenness ranges from zero to one. If E approaches zero (< 0,5) evenness among species is low, meaning that the individual wealth of each species is very different. If E approaches 1 (≥ 0,5) evenness between species is relatively even or the number of individuals in each species is relatively similar (Odum, 1971).

The pattern of species richness was calculated using the Margalef Richness index with the formula:

$D_{Mg} = S\text{-}1/ \ln N$

Where D_{Mg}: Margalef Richness index; *S*: the total number of species in a habitat (station); *N*:the number of individuals of all species. Rating range for Margalef Richness index from 1->5.

Table 2 Richness index criteria Margalef (Odum, 1971)

Richness index	Criteria
D_{Mg}>5	Integrated
D_{Mg}>2,05-5	Semi-disturbed
D_{Mg2}≤2,05	Disturbed

3. Result and Discussion

The sampling was carried out at three stations which were approximately 50-150 meters from Peh Pulo beach. At stations I and II, the substrate type is coral rock, sand covered with algae and moss, while at station III the substrate type is coral rock (Figure 2). The results of measuring water environmental parameters have shown that the temperature range at each station is 27.3-29.7°C, salinity is between 32.8-33.3‰, pH is between 8.23-8.93. In general, members of the Gastropods class were most commonly found in all sampling locations, compared to members of the Bivalvia and Polyplacophora classes. The beaches on the southern coast of Java Island have unique characteristics, namely that the currents and waves of seawater are greater than those of other coastal seas on Java Island (Minarrohman et al., 2017). These characteristics cause most of the southern coast to have sandy, rocky and coral substrates (Widiansyah et al., 2016). Substrate diversity supports a rich habitat for marine biota to live (Kurniawan, 2023).

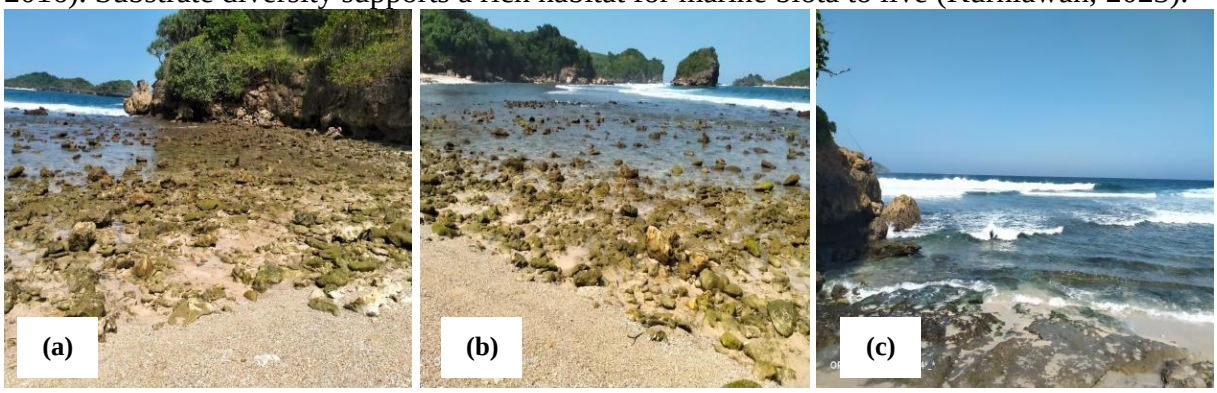
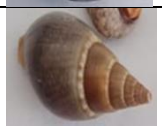


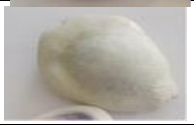
Figure 2 Types of substrates at three stations (a) appearance of substrate types at stationI; (b) appearance of substrate types at station II; (c) appearance of substrate types at station III

The number of Mollusc found in this study was 37 species from three classes, namely Polyplacophora, Gastropods, and Bivalvia. The number of species found at each station can be seen in Table 2. The beach intertidal zone substrate consisting of rocks and sand was an ideal habitat for various types of marine gastropods (Kurniawan, 2023).

Table 3 Results of Mollusc Identification on Peh Pulo Beach

Class	Family	Species	Station I	Station II	Station III	Species Documentation
Polyplacophora	Chitonidae	*Acanthopleura gemmata*	-	1	-	
Gastropoda	Neritidae	*Nerita polita*	4	6	8	
Gastropoda	Neritidae	*Nerita plicata*	12	15	20	
Gastropoda	Muricidae	*Coralliophila clathrata*	1	-	-	
Gastropoda	Neritopsidae	*Neritopsis parisiensis raricostatus*	6	4	4	
Gastropoda	Babyloniidae	*Babylonia spirata*	2	-	-	
Gastropoda	Neritidae	*Nerita costata*	3	3	2	
Gastropoda	Neritidae	*Nerita tessellata*	2	-	-	
Gastropoda	Nassariidae	*Nassarius olivaceus*	2	2	-	
Gastropoda	Littorinidae	*Littoraria undulata*	3	8	-	
Gastropoda	Nassariidae	*Nassarius acutus*	1	-	-	
Gastropoda	Buccinidae	*Lussivolutopsius memmi*	2	-	-	
Gastropoda	Nassariidae	*Nassarius (Plicarcularia) fraudulentus*	2	4	-	

Gastropoda	Nassariidae	*Tritonia varicosa*	-	5	-	
Gastropoda	Conidae	*Conus ammiralis var. coronatus*	2	-	-	
Gastropoda	Conidae	*Conus (Virroconus)ebraeus*	1	3	-	
Gastropoda	Conidae	*Conus coronatus*	1	2	-	
Gastropoda	Conidae	*Conus (Virgiconus)frigidus*	2	1	-	
Gastropoda	Trochidae	*Trochus maculatus*	1	2	-	
Gastropoda	Trochidae	*Trochus radiatus*	1	2	-	
Gastropoda	Turbinidae	*Trochus tectus*	-	1	-	
Gastropoda	Architectonicidae	*Trochus areola*	2	1	-	
Gastropoda	Eoacmaeidae	*Eoacmaea javanica*	-	2	1	
Gastropoda	Pyramimitridae	*Hortia sp.*	1	4	-	
Gastropoda	Bulimulidae	*Bulimus guadalupensis*	5	7	-	

Gastropoda	Cypraeidae	*Monetaria annulus*	4	1	-	
Gastropoda	Cypraeidae	*Monetaria moneta*	2	2	-	
Gastropoda	Pisaniidae	*Engina mendicaria*	1	2	-	
Gastropoda	Mitridae	*Strigatella litterata*	2	2	-	
Gastropoda	Mitridae	*Strigatella paupercula*	1	3	-	
Gastropoda	Volutidae	*Voluta zebra*	-	2	-	
Gastropoda	Truncatellinidae	*Truncatellina cylindrica*	1	3	-	
Gastropoda	Nassariidae	*Tritia cuvierii*	2	1	-	
Gastropoda	Muricidae	*Morula sp.*	-	3	-	
Bivalvia	Glycymerididae	*Pectunculus grayanus*	3	-	-	
Bivalvia	Veneridae	*Gafrarium (Roemeriana) savignyi*	3	-	-	
Bivalvia	Cardiidae	*Tridacna squamosa*	2	-	-	

Data analysis shows that the number of species and families at station I (31 species, 19 families) is greater than at station II (28 species, 17 families) and station III (5 species, 2 families), so the species diversity index at station I (H' =3.18) higher than

other stations(Table 3). The high species diversity at station I causes the Evenness index (E=0.88) and Richness index (D_{Mg}=6.91) at station I to also be higher than at station II and station III. However, the number of individuals at station II (92 individuals) was greater than the number of individuals at station I (77 individuals) and station II (35 individuals) (Table 3).

Table 4 The number of Species, Individuals, Families, Diversity Index, Evenness Index,Richness Index of Molluscs on Peh Pulo Beach

Aspect	Station I	Station II	Station III	Average
The number of species	31*	28	5	-
The number of individuals	77	92*	35	-
The number of families	18*	17	2	-
Diversity index (H')	3.18*(High)	3.05 (High)	0.81(Low)	2.35 (Moderate)
Evenness index (E)	0.88*(Similar)	0.85 (Similar)	0.23 (Different)	0.65 (Similar)
Richness index (D_{Mg})	6.91*(Integrated)	5.97 (Integrated)	1.13(Disturbed)	4.67 (Semi disturbed)

*Note. * = highest*.

1. Diversity

Based on the sampling stations, it was known that the species diversity index at station I (H'= 3.18) and station II (H'= 3.05) was included in the high criteria, while station I (H'= 0.81) hasa relatively low species diversity index. Station I and Station II were locations that had sand and coral rocky substrates covered by algae and moss. Molluscs grew in groups on substrates that were riched in nutrients (Ginantra et al., 2020). In general, the distribution of organism populations in nature generally has a clustered distribution pattern and it was very rare to find a uniform pattern. Factors that caused a species to live in groups were the abundance of food, physical and chemical factors, and the condition of the substrate also played a role in influencing the distribution patterns of Molluscs. Whereas, species diversity at station III

(H'=0.81) < 1 has shown that species diversity was low. The mollusk species found at station III were dominated by the Neritidae family and a small portion of the Eoacmaeidae family. This was in line with the research results of (Islami, 2017; Persulessy & Arini, 2019) who reported that most types of N. *zonalasi* and N. *albacilla* were found on rocky and coral substrates such as the characteristics of the substrate at station III. The size of the diversity value was not only related to how many types were found but also related to how evenly distributed the number of individuals in each type was.

2. Evenness

Species evenness at station I (E=0.88) ≥ 0.5 means that the number of individuals in each species was relatively the same. At station I there were 77 individuals from 31 species from the families Neritidae, Muricidae, Neritopsidae, Babyloniidae, Littorinidae, Nassariidae, Buccinidae, Conidae, Trochidae, Architectonicidae, Pyramimitridae, Bulimulidae, Cypraeidae, Pisaniidae, Mitridae, Truncatellinidae, Glycymerididae, Veneridae, and Cardiidae. In line with this, the species evenness at station II (E=0.85) ≥ 0.5 which also reflects the relatively equal number of individuals in each species at station II. The species at station II were 92 individuals from 28 species from the families Chitonidae, Neritidae, Neritopsidae, Littorinidae,

Nassariidae, Conidae, Trochidae, Turbinidae, Architectonicidae, Eoacmaeidae, Pyramimitridae, Bulimulidae, Cypraeidae, Pisaniidae, Mitridae, Muricidae, and Truncatellinidae. The condition of the bottom water substrate, such as the texture and composition of the sediment, influences the composition of the fauna (Ríos-Jara et al., 2009; Batomalaque et al., 2010). The presence of macroalgae in the sediment also influencesMollusc activity (Marsden et al., 2009). However, on the contrary, station III with the coral rock substrate type, showed an evenness of species (E=0.23) < 0.5, which means it is includedin the low category. Because at station III only 5 types of species were found from 3 different families, namely Neritidae, Neritopsidae, and Eoacmaeidae. The type of bottom-water substrate at each different station also influenced the spatial distribution of aquatic fauna. An aquatic environment in stable conditions will show a balanced number of individuals from all existing species, whereas a changing aquatic environment will cause low species distribution and tend to have dominant individuals.

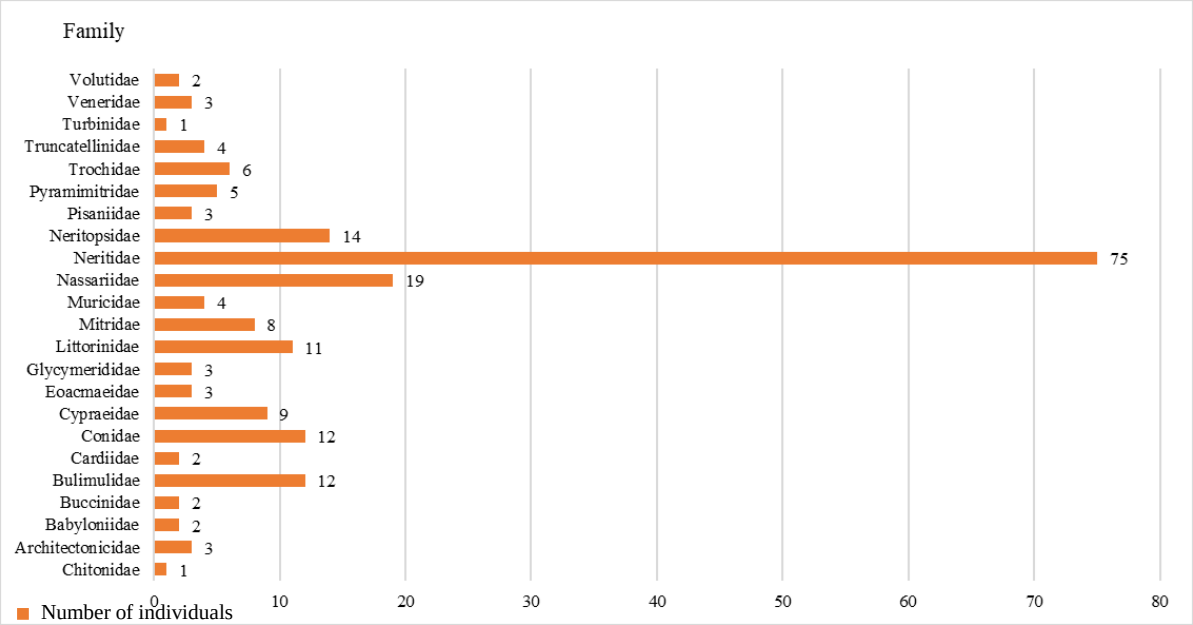


Figure 3 Number of Individuals of Each Mollusc Family on Peh Pulo Beach

3. Richness

The richness of mollusk species on the Peh Pulo coast can be seen from the number of individuals and the number of species found. The types found can be put into 23 families (Figure 3). The family with the highest number of species is the Neritidae family (75 species). The Neritidae family species found include *Nerita plicata* (47 individuals), *Nerita polita* (18 individuals), *Nerita costata* (8 individuals), and *Nerita tessellata* (2 individuals). Tan & Clements (2008) stated that *Nerita plicata* is often found in habitats of holes and crevices in rocks, large boulders, depressions, sand, large rocks, and cliffs facing open waves. Meanwhile, the families with the lowest number of species include the Chitonidae (*Acanthopleura gemmata*) and Turbinidae (*Trochus tectus*) families. Rachmawati et al., (2022) explained that *Acanthopleura gemmata* is predominantly found on substrates that are submerged in water compared to substrates that are dry during the day. In addition, the distribution pattern of *Acanthopleura gemmata* is more influenced by tides. Because samplingwas carried out during the day when seawater experienced maximum tides, the

density of species from the Chitonidae family was low. For the record, the composition of Mollusc species found in this research is of course only a small part of the Mollusc resources available at Peh Pulo Beach, one of the beaches in the south of Blitar Regency. Furthermore, more serious efforts are needed to reveal the marine biodiversity in the Blitar South Coast area.

4. Conclusion

The number of mollusc species identified at Peh Pulo Beach was 37 species from 23 families from the Polyplacophora, Gastropods, and Bivalvia classes. The diversity of mollusc species on Peh Pulo beach based on the Shannon-Wiener (H') diversity index value of 2.35 is included in the moderate criteria. The evenness of mollusc species on Peh Pulo beach is calculated based on Pielou's evenness index (E) of 0.65, meaning that the evenness between species found is relatively even or the same. The richness of mollusc species based on the Margalef Richness Index (DMg) of 4.67 illustrates that the Peh Pulo beach area is semi- disturbed so appropriate management and conservation strategies are needed for the maintenance and sustainability of molluscs.

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