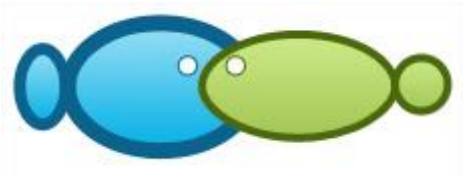

Structure of gastropod communities in the mangrove area of Kutang Beach, Lamongan, Indonesia

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Abstract. Gastropods are one of the communities that utilize the mangrove ecosystem as their habitat. This study aimed to identify gastropods as well as to analyze the community structure of gastropods and analyze their habitat characteristics, in the mangrove area of Kutang Beach, Lamongan Indonesia. Sampling was conducted during the lowest tide using the quadrant-transect method. The Gastropods were identified based on morphological characters. Community structure was analyzed descriptively and quantitatively, based on seven parameters, namely: density (D), relative abundance (KR%), relative frequency (FR%), importance value index (INP%), diversity index (H'), dominance index (C) and evenness index (E). The results revealed that on the Kutang Beach there were 30 species of gastropods belonging to several families. *Littoraria articulata* (Littorinidae family) had the highest density, D=1.83 ind m^{-2}, with a relative abundance of KR=19.88%, a relative frequency of FR=7.59% and an importance value index of INP=27.47%. The diversity index 1<H'<3 was moderate, the low dominance index C<0.5 indicated the absence of dominance between species and the evenness index 0.6<E<1 was high, indicating a relatively balanced distribution between species. Gastropods' habitat characteristics in the mangrove ecosystem were: a sandy mud substrate, a temperature of 29±0.00°C; a pH of 7.86±0.00 and a salinity of 3±0.58‰.
Key Words: intertidal zone, *Littoraria articulata*, snail, *Turbo petholatus*.

Introduction. Mangrove areas are coastal and estuary ecosystems that can be found in tropical and subtropical areas (Al-Asif et al 2020). Mangrove ecosystems have a contribution to balancing the biological cycle in the waters so that they can create healthy climatic conditions to support the survival of organisms in the vicinity (Sinaga et al 2019). Mangrove vegetation communities are generally dominated by several species of mangrove trees that can grow and develop in intertidal areas that periodically receive input of seawater and freshwater in the estuary area (Arifianti et al 2021). Mangrove vegetation provides various needs and provides enormous ecological services for the surrounding organisms. Mangroves play a role as a place to live for various types of organisms, improve water quality, maintain beach stability and supply food ingredients, so that they can support the life of Mollusca, several types of fish and crabs (Onyena & Sam 2020).The gastropod community is one of the aquatic organisms that utilize the mangrove area as a place to live. Salim et al (2019) proved that there is a strong relationship between mangrove density and gastropod density (the higher the mangrove density, the higher the gastropod density). Gastropods live as macrozoobenthos animals with a wide distribution both on the surface of the substrate and in the substrate (infauna) (Hendrickx et al 2007). Gastropods are one of the constituents of aquatic communities that can be found in various types of substrates because of their better adaptability compared to other classes (Hasan et al 2020). Mangrove areas in East Java are scattered in almost all districts or cities located in coastal areas. Lamongan Regency is one of the regencies in East Java which is located in the northern coastal area which has several beaches, namely Banjarwati Village Beach (Hitalessy et al 2015), Kemantren Beach (Joesidawati 2018; Rahayu et al 2019), North Beach Paciran (Arfiati et al 2019;

Rohmayani et al 2021) and Kutang Beach (Malihah & Romadhon 2020), which has mangrove area (Fatimah et al 2022a,b).

Several previous studies have reported the diversity of gastropods in this area. Hitalessy et al (2015) reported that in the coastal waters of Banjarwati Village, seven gastropod species were found with a moderate diversity index. Meanwhile, Joesidawati (2018) reported the results of the identification of gastropods on Kemantren Beach, with the highest density of 27 ind m^{-2} for the *Cerithiopsis emersoni* species. A similar study conducted by Rahayu et al (2019) in Kemantren Beach reported the identification of gastropods, with the highest percentage of 33% of total invertebrates found in this beach. Arfiati et al (2019) reported the results of their research in the seagrass ecosystem area in the Paciran region, with the highest relative abundance of the gastropod species *Cerithium granosum*. Another study conducted by Rohmayani et al (2021) in the intertidal zone of the North Coast of the Paciran Java Sea, obtained ten gastropod species, with a low diversity index.

However, until now there has been no publication on the diversity of gastropod species and information on their community structure in the mangrove area of Kutang Beach, Lamongan Regency, Indonesia. Therefore, this study aimed to identify gastropod species and analyze community structures, including density, relative abundance, relative frequency, importance index, diversity index, dominance index, gastropod evenness index and analyze the characteristics of the habitats that support gastropod life in the mangrove areas of Kutang Beach, Lamongan Regency. Data on gastropod species along with information on their community structure can be used as a reference in the rehabilitation and preservation of mangrove ecosystems in the area.

Material and Method

Description of the study sites. Sampling was carried out in the mangrove area of Kutang Beach, Lamongan Regency (Figure 1). Sampling was carried out on 14–16 and 27–29 October 2021, at the farthest low tide. Gastropod sampling was carried out at six different stations (Figure 1) using the quadrant transect method. The selection of station points was based on mangrove conditions, namely: dense mangroves, thin mangroves and no mangroves at all (open beaches). The condition of dense mangroves is characterized by thick mangrove vegetation and large trees, while thin mangroves are characterized by sparse mangrove cover or mangroves with smaller trees. The position of each station point was recorded using AlpineQuest 2.2.9.

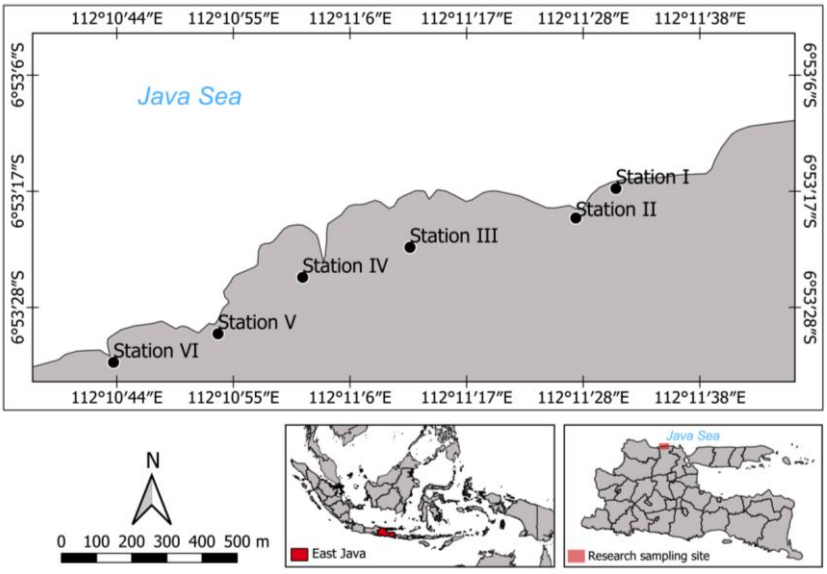

Figure 1. Sampling locations in the mangrove area of Kutang Beach: Stations I and VI (areas without mangroves), Stations II and V (thin mangroves) and Stations III and IV (thick mangroves).

Gastropods collection. Each station consisted of three sub-stations, with each sub-station made up of a plot measuring 5 x 5 m^2, each sub-plot measured 1 x 1 m^2 (Figure 2) (Katukdoan et al 2018). All of the gastropods were observed carefully. Gastropod sampling was carried out in plots of soil substrate, roots, stems and mangrove leaves. All types of gastropods in the plots were collected, then put in plastic bags and labeled. The samples were preserved in bottles that already contained 70% alcohol. The samples that have been preserved are then identified based on their morphological characters, by referring to Poutiers (1998), Dharma (2005) and to the database website of World Register of Marine Species (www.marinespecies.org).

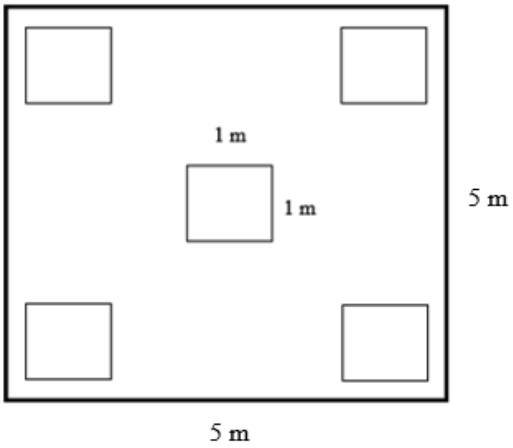

Figure 2. Examples of plots and sub-plots.

Parameter analysis. The community structure parameters analyzed included density, relative abundance, relative frequency, important value index, diversity index, dominance index and evenness index. Community structure parameters are calculated using the following formulae (Rohmayani et al 2021):

$$Di = \frac{Ni}{A}$$

Where:
Di - individual density of species i (individuals m^{-2});
Ni - number of individual species i;
A - total area of sampling.

$$KRi = \frac{Ki}{KN} \; x \; 100\%$$

Where:
KRi - relative abundance of species i (%);
Ki - species abundance i;
KN - the total abundances of all species.

$$FRi = \frac{Fi}{FN} \; x \; 100\%$$

Where:
FRi - relative frequency of species i (%);
Fi - species frequency i;
FN - total frequency of all species.

$$INPi = KRi + FRi$$

Where:
INPi - significance value index (%);
KRi - relative abundance of species i (%);
FRi - relative frequency of species i (%).

In addition, the values of the diversity index, dominance index, and evenness index are also calculated as follows (Krebs 2014):

$$H' = -\Sigma\, Pi \ln Pi$$

Where:
H' - Shannon-Wiener diversity index;
Pi - the ratio of the number of individuals of the species (ni) to the total number of individuals (N): (ni/N).

$$C = \Sigma\, (Pi)^2$$

Where:
C - Simpson dominance index;
Pi - the ratio of the number of individuals of the species (ni) to the total number of individuals (N):(ni/N).

$$E = \frac{H'}{H'max}$$

Where:
E - evenness index;
H' - diversity index;
H'max - maximum diversity = ln S;
S - number of species.

Environmental parameters, namely temperature, pH, and salinity were analyzed descriptive quantitatively.

Results. 830 individuals consisting of 30 species and 17 families of gastropods were identified, that were collected from six stations with a total plot area of 90 m^2. The gastropod species found were *Telescopium telescopium*, *Turbo petholatus*, *Trochus stellatus*, *Angaria delphinus*, *Tenguella granulata*, *Azumamorula mutica*, *Chicoreus capucinus*, *Littoraria articulata*, *Conus quercinus*, *Conus radiatus*, *Paratectonatica tigrina*, *Polinices peselephanti*, *Tanea lineata*, *Natica vitellus*, *Turritella terebra*, *Turritella duplicata*, *Clypeomorus tjilonganensis*, *Clypeomorus* sp., *Cerithium* sp 1, *Cerithium coralium*, *Cerithium traillii*, *Cerithium* sp 2, *Mauritia depressa*, *Palmadusta asellus*, *Ellobium aurisjudae*, *Cryptospira ventricosa*, *Oliva amethystina*, *Vexillum* sp, *Saginafusus pricei* and *Canarium urceus*. This species belongs to the family Potamididae, Turbinidae, Trochidae, Angariidae, Muricidae, Littorinidae, Conidae, Naticidae, Turritellidae, Cerithiidae, Cypraeidae, Ellobiidae, Marginellidae, Olividae, Costellariidae, Melongenidae and Strombidae (Table 1).

Community structure parameters. Community structure parameters include density (D), relative abundance (KR%), relative frequency (FR%) (Table 1), diversity (H'), dominance (C) and evenness (E) indexes (Table 2).

Gastropods density. The gastropod density found at six stations in the mangrove area of Kutang Beach ranged between 0.01–1.83 ind m^{-2} (Table 1). *L. articulata* showed the highest density in the mangrove area of Kutang Beach, which was 1.83 ind m^{-2}, followed

by *T. petholatus* and *T. stellatus* with density values of 1.74 ind m^{-2} and 1.62 ind m^{-2}. The other gastropod species had a density value of fewer than 0.90 ind m^{-2} (Table 1). *L. articulata* was the dominating species, with the highest density of 1.83 ind m^{-2} at Station III, in dense mangroves (Figure 4A).

Table 1

The composition of the gastropods of the mangroves of Kutang Beach

Family	*Species*	*D (ind m^{-2})*	*KR(%)*	*FR(%)*
Potamididae	*Telescopium telescopium*	0.50	5.42	5.06
Turbinidae	*Turbo petholatus*	1.74	18.92	7.59
Trochidae	*Trochus stellatus*	1.62	17.59	7.59
Angariidae	*Angaria delphinus*	0.06	0.60	2.53
Muricidae	*Tenguella granulata*	0.56	6.02	7.59
	Azumamorula mutica	0.44	4.82	7.59
	Chicoreus capucinus	0.01	0.12	1.27
Littorinidae	*Littoraria articulata*	1.83	19.88	7.59
Conidae	*Conus quercinus*	0.01	0.12	1.27
	Conus radiatus	0.02	0.24	1.27
Naticidae	*Paratectonatica tigrina*	0.01	0.12	1.27
	Polinices peselephanti	0.01	0.12	1.27
	Tanea lineata	0.01	0.12	1.27
Turritellidae	*Natica vitellus*	0.01	0.12	1.27
	Turritella terebra	0.01	0.12	1.27
	Turritella duplicata	0.01	0.12	1.27
Cerithiidae	*Clypeomorus tjilonganensis*	0.22	2.41	5.06
	Clypeomorus sp.	0.03	0.36	2.53
	Cerithium sp 1	0.04	0.48	3.80
	Cerithium coralium	0.87	9.40	5.06
	Cerithium traillii	0.06	0.60	2.53
	Cerithium sp 2	0.87	9.40	5.06
Cypraeidae	*Mauritia depressa*	0.14	1.57	7.59
	Palmadusta asellus	0.01	0.12	1.27
Ellobiidae	*Ellobium aurisjudae*	0.01	0.12	1.27
Marginellidae	*Cryptospira ventricosa*	0.03	0.36	2.53
Olividae	*Oliva amethystina*	0.02	0.24	2.53
Costellariidae	*Vexillum* sp	0.01	0.12	1.27
Melongenidae	*Saginafusus pricei*	0.01	0.12	1.27
Strombidae	*Canarium urceus*	0.02	0.24	1.27

D-density (ind m^{-2}), KR-relative abundance (%), FR-relative frequency (%).

Figure 4. A. The population of *Littoraria articulata* in the mangrove area of Kutang Beach (Station III), B. Mangrove ecosystem of Kutang Beach (Station III).

Relative abundance and frequency of gastropods. *L. articulata* also showed the highest relative abundance value at 19.88%, followed by *T. petholatus* and *T. stellatus,* with 18.92 and 17.59%, respectively (Table 1). The highest relative frequency values

were found in *L. articulata*, *T. petholatus*, *T. stellatus*, *T. granulata*, *A. mutica* and *M. depressa* species of 7.59% each (Table 1). These six species were found at all research stations, while the other species were only found at stations one to four.

Presence of gastropods in mangrove locations. *T. telescopium*, *T. petholatus*, *T. granulata*, *A. mutica*, *C. capucinus* and *E. aurisjudae* were found in the middle and back of the mangrove forest, while *L. articulata*, *C. tjilonganensis*, *Cerithium* sp 1, *C.coralium* and *Cerithium* sp 2 were found in the foreground mangroves. Meanwhile, *S. pricei*, *P. asellus* and *N. vitellus* were found in particular in the intertidal zones, with a low frequency and density.

Importance value index of gastropods. *L. articulata* showed the highest INP value, 27.47%, followed by *T. petholatus*, *T. stellatus* and *C. coralium*, with INP values of 26.51% 25.19% and 14.46%, respectively (Figure 3).

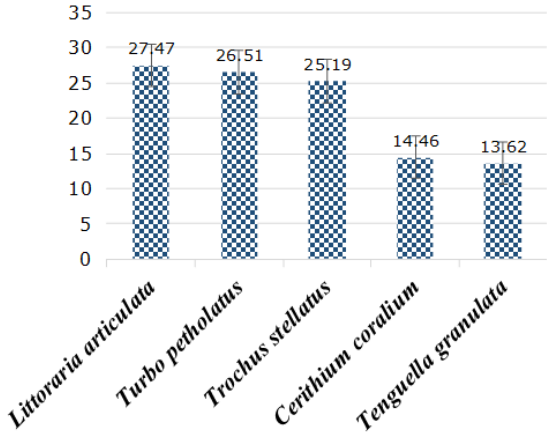

Figure 3. Importance value index of some mangrove gastropods in Kutang Beach.

Gastropod species at each station. The highest number of gastropod species was found in dense mangrove areas (Station III), with 20 species, followed by dense mangroves (Station IV) with 19 species and thin mangroves, namely Station II, with 14 species and Station V, with ten species. Only nine and seven gastropod species were found at the areas without mangroves, the Stations I and VI, respectively (Table 3).

Gastropod diversity index. The gastropod diversity index values ranged from 1.49 to 2.37 (Table 2). The highest diversity index, 2.37, was obtained in the dense mangrove area (Station III) (Figure 4B), which showed the best ecosystem condition compared to other stations, and the lowest, 1.49, was obtained in the area without mangroves (Station VI).

Gastropod dominance and evenness indexes. The gastropod dominance index values ranged from 0.12–0.26 (Table 2). Meanwhile, the highest evenness index was obtained in the thin mangrove area (Station V) (E=0.77) (Table 2). The lowest evenness index was obtained in the dense mangrove area (Station III) (E=0.54) (Table 2).

Table 2

Index of diversity (H'), dominance (C), and evenness (E) of each station

Index	*Station*					
	I	*II*	*III*	*IV*	*V*	*VI*
Diversity (H')	1.68	2.26	2.37	2.34	2.04	1.49
Dominance (C)	0.22	0.12	0.12	0.12	0.15	0.26
Evenness (E)	0.60	0.68	0.54	0.55	0.77	0.63

Table 3

Presence of gastropod species at each station

Family	*Species*	*Station*					
		I	*II*	*III*	*IV*	*V*	*VI*
Potamididae	*Telescopium telescopium*	0*	1*	1	1	1	0
Turbinidae	*Turbo petholatus*	1	1	1	1	1	1
Trochidae	*Trochus stellatus*	1	1	1	1	1	1
Angariidae	*Angaria delphinus*	0	0	1	1	0	0
Muricidae	*Tenguella granulata*	1	1	1	1	1	1
	Azumamorula mutica	1	1	1	1	1	1
	Chicoreus capucinus	0	1	0	0	0	0
Littorinidae	*Littoraria articulata*	1	1	1	1	1	1
Conidae	*Conus quercinus*	0	1	0	0	0	0
	Conus radiatus	0	1	0	0	0	0
Naticidae	*Paratectonatica tigrina*	1	0	0	0	0	0
	Polinices peselephanti	0	0	0	0	0	1
	Tanea lineata	1	0	0	0	0	0
	Natica vitellus	1	0	0	0	0	0
Turritellidae	*Turritella terebra*	0	0	1	0	0	0
	Turritella duplicata	0	0	0	1	0	0
Cerithiidae	*Clypeomorus tjilonganensis*	0	1	1	1	1	0
	Clypeomorus sp.	0	0	1	1	0	0
	Cerithium sp 1	0	1	1	1	0	0
	Cerithium coralium	0	1	1	1	1	0
	Cerithium traillii	0	0	1	1	0	0
	Cerithium sp 2	0	1	1	1	1	0
Cypraeidae	*Mauritia depressa*	1	1	1	1	1	1
	Palmadusta asellus	0	0	1	0	0	0
Ellobiidae	*Ellobium aurisjudae*	0	0	0	1	0	0
Marginellidae	*Cryptospira ventricosa*	0	0	1	1	0	0
Olividae	*Oliva amethystina*	0	0	1	1	0	0
Costellariidae	*Vexillum* sp	0	0	0	1	0	0
Melongenidae	*Saginafusus pricei*	0	0	1	0	0	0
Strombidae	*Canarium urceus*	0	0	1	0	0	0
Number of species		9	14	20	19	10	7

*1-found, 0-not found.

Environmental parameters. The mangrove area of Kutang Beach is one of the coastal areas in Lamongan Regency, which still has mangrove forests in good condition. The structure of the gastropod community in the area was influenced by several factors, such as temperature, pH, salinity and substrate type (Table 4).

Table 4

Environmental parameters in the mangrove area of Kutang Beach

Parameters	*Station*						*Quality standard**
	I	*II*	*III*	*IV*	*V*	*VI*	
Temp. (°C)	31±0.29	30±0.58	29±0.00	29±0.76	31±0.29	32±0.50	Coral 28-30[a] Mangrove 28-32[a] Seagrass 28-30[a]
pH	8.36±0.01	8.23±0.01	7.86±0.00	7.90±0.00	8.26±0.01	8.45±0.01	7-8.5[b]
Salinity (‰)	5±0.06	4±0.12	3±0.10	3±0.58	4±0.49	5±0.10	Coral 33-34[b] Mangrove s/d 34[c] Seagrass 33-34[c]

Parameters	Station						Quality standard*
	I	II	III	IV	V	VI	
Substrate type	Rocky	Sandy mud	Sandy mud	Sandy mud	Sandy mud	Rocky	

* Decree of the Minister of the Environment No 51, 2004 about Seawater Quality Standard; a-Permissible temperature changes are up to 2°C, according to the quality standard; b-Permissible pH changes are up to 0.2 units; c-Permissible changes seasonal mean salinity are up to 5‰.

Discussion. 30 species and 17 families were successfully inventoried from six stations in the mangrove area of Kutang Beach, Lamongan Regency. *L. articulata* showed the highest values of density, relative abundance, relative frequency and INP: 1.83 ind m^{-2}, 19.88, 7.59 and 27.47%, respectively. Differences in gastropod density indicate the influence of habitat and vegetation preferences on the composition of gastropod species (Islami 2015). In addition, the density value of fauna in its habitat is also influenced by the competition between species (Isnaningsih & Patria 2018). Meanwhile, according to Ladias et al (2020), the relative abundance of gastropods is influenced by various factors, one of which is the habitat degradation, as a result of the transformation of mangrove areas into aquaculture areas. This affects the population of gastropod species in the area. Meanwhile, a high INP value indicates that the gastropod species plays a large role in their community (Utami & Putra 2020). The density and frequency of gastropod species found at the study sites can be used as a marker, indicating whether the species is from the native, facultative or visitor group (Isnaningsih 2015). According to Budiman (1997) native mangrove gastropod groups were found from the front, middle to back of the mangrove forest. The species *C. capucinus* was found in the front of the mangrove, meanwhile, *T. telescopium* was found in the middle and at the back of the mangrove forest was found a gastropod species from the family Ellobiidae. Facultative gastropod groups are found in the front of the mangrove forest, one of which is from the Littorinidae family. Gastropod groups of visitors are usually found at a low frequency and density and their distribution is limited to the border area between mangrove areas and coastal ecosystems; gastropods belonging to this group include species from the Nassariidae, Turridae and Neritidae families.

The gastropod group of the *Littoraria* genus has a close relationship with the mangrove vegetation, as a food source (Riyandi et al 2017). According to Reid et al (2010), the ability of gastropods of the *Littoraria* genus to associate with mangrove vegetation exists since a long time ago, which is evidenced by the phylogenetic ancestor's habitat reconstruction for these species that have long inhabited the mangrove area. Sanpanich et al (2004) reported that nine out of ten species of the genus *Littoraria* were found abundantly in mangrove areas near the seashore. In addition, Kusuma et al (2020) reported the results of their research in the mangrove area of Kaliwlingi and Sawojajar Villages, Brebes Regency, Central Java: as many as nine species of gastropods were identified, one of which was *L. articulata*. These gastropod species are most commonly found in mangrove areas, due to a tidal activity which is appropriate for the survival of gastropods. This is in line with Tapilatu & Pelasula (2012), stating that the gastropods of the Littorinidae family are the fauna with the highest density, associated with the capability to attach to the mangrove vegetation.

Research related to gastropod communities in mangrove areas was also carried out by Baderan et al (2019) & Dewiyanti et al (2021), who reported as many as 21 and 41 species of gastropods, respectively, one of which was the genus *Littoraria* found in soil substrate, roots, stems and mangrove leaves. Gastropods of the *Littoraria* genus include species that have a good adaptability to the mangrove areas and brackish water environments (Yolanda et al 2015). In addition, the presence of organic matter in the mangrove area also contributes significantly to meeting the needs and energy sources for the survival of these gastropod species.

The diversity index reflects the balance of the population in a community (Sirait et al 2018). The highest diversity index was found in dense mangrove areas (Station III), 2.37, followed by dense mangroves (Station IV), 2.34. According to Utami & Putra (2020), the Shannon-Wiener diversity index values in the range $1 \leq H' \leq 3$ indicate a

moderate diversity. The lowest diversity index was found in areas without mangroves (Station VI), 1.49. However, the diversity index of the six stations was in the range of 1–3.

The moderate diversity index value indicates that the environmental conditions in the mangrove area of Kutang Beach are relatively good so that they can maintain the stability of the ecosystem face to disturbances. Lekipiou & Nanlohy (2018) stated that gastropod communities always take advantage of good habitat conditions for sheltering, foraging and breeding, with the availability of a diversified vegetation. According to Sobari et al (2020), the diversity index in an ecosystem is also influenced by the presence or absence of a dominant species. If the diversity index is high, there is no dominant species found in the ecosystem. On the other hand, if the diversity index value is low, it is assumed that there the inter-species competition, predation and unstable conditions have a grater impact on species survival.

Gastropod dominance index in the mangrove area of Kutang Beach obtained the highest results in the area without mangroves, stations VI and I, with 0.26 and 0.22, respectively, while at Station II, where the mangroves were thin and at the stations with dense mangroves (III and IV) the calculated value for the dominance index was 0.12 and at Station V, with thin mangrove areas, the dominance index was 0.15. Based on the dominance index criteria, according to Ghufrona et al (2015), the dominance index ranges from $0 \leq C \leq 1$. The value of C will approach one if in an ecosystem it is only controlled by one species, which means that in the ecosystem there has been a grouping or concentration of gastropod species. The dominance index at six stations is known to be in a low category because in the observed community there are no species that dominate other species. This indicates that the gastropod community in the mangrove area of Kutang Beach is in a balanced state and it has an almost uniform number of individuals, which is supported by the relatively good condition of the mangrove ecosystem.

Gastropod evenness index had the highest value in the thin mangrove area, at stations V and II, with 0.77 and 0.68, respectively. The evenness index value of the six stations ranged from 0.54 to 0.77. The evenness index reflects the proportion of individuals of each species in a community (Fadilah et al 2015). According to Manusawai et al (2020), the evenness index value of species ranges from 0 to 1. If the value of E is in the range of 0.6–1 or close to 1, it means that in the ecosystem all species have an even or balanced population and density. The evenness index values at all six stations indicate that the distribution of each species is relatively balanced. This is evidenced by the absence of dominant gastropod species at the research stations. The community control is relatively spread across all gastropod species. The balance of an ecosystem will increase if the species' populations contained in a community are evenly distributed (Mandolang et al 2021).

The structure of the gastropod community in the mangrove area of Kutang Beach is also affected by temperature. The temperature at the six stations was in the range of 29±0.00–32±0.50°C. The temperature at the dense mangrove area (Station III) was of 29±0.00°C in the morning, while in the area without mangroves (Station VI) it was of 32±0.50°C during the day. The difference in the observation time causes different temperature measurement results. This is in accordance with Arfan (2018), who stated that the difference in water temperature is caused by the level of absorption of sunlight, which causes heat energy fluctuations.

Based on the Decree of the Minister of the Environment Number 51 of 2004 concerning the range of water quality standard temperatures for marine life, the results of the temperature measurements at six stations have met the requirements. This is evidenced by observed temperature range of 29±0.00–32±0.50°C, while the quality standard values range from 28 to 32°C. Temperature is an important control factor in an ecosystem, affecting the life of aquatic organisms that have a tolerance limit to temperature (Marson & Harmilia 2021).

The pH at the six stations was in the range of 7.86±0.00–8.45±0.01. The pH value is considered optimal for the survival of gastropods. Based on the temperature range of water quality standards for marine life, as stipulated in the Decree of the Minister of the Environment Number 51 of 2004, the optimal pH range for waters is 7–

8.5. Syahrial et al (2020) stated that a high pH in an ecosystem indicates that there is little organic matter content, so that only certain organisms can be found. Meanwhile, according to Apriadi & Ashari (2018), a low pH concentration is due to rainfall, dissolved ion content and low sediment pH.

Salinity at the six stations ranged from 3±0.10 to 5±0.10‰, still in the water quality standard criteria for marine life (Decree of the Minister of the Environment Number 51 of 2004) which states that the ideal salinity content for the life of the biota in the mangrove area is up to 34‰. High salinity values increase the gastropod density (Lestari et al 2021). According to Patty (2013) salinity is one of the environmental parameters that reflects the mangrove ecosystem's health. If the value is <32‰, there is a mix of seawater mass with river freshwater, as well as influences from the land, due to the srreams. In addition, salinity values are also influenced by high and low evaporation and rainfall (Bhattacharjee et al 2013). Thus, the results of salinity measurements at six stations indicate that the mangrove area of Kutang Beach is located in brackish waters.

According to Piranto et al (2019), the type of substrate greatly affects the composition and density of gastropod species as their habitat. This is in accordance with the statement of Dwijaya et al (2021): the gastropod community is very dependent on the organic matter contained in the substrate of the mangrove ecosystem. The type of substrate found in the mangrove area of Kutang Beach are sandy mud and rocky. The muddy substrate contains high organic matter so it is suitable for the habitat of the gastropod community (Bolam et al 2002). Based on the presence of gastropod species at the six stations, the highest number of species was found in the dense mangrove area (Station III), 20 species. This indicates that the gastropod community prefers habitat conditions with fine sandy and even muddy substrate types, due to a higher content of organic matter supply (Setiyowati 2018). Rocky substrates are unfavorable habitats for the gastropod survival because they make more difficult the process of food filtering. Therefore, only a few tolerant gastropod species were found in that type of habitat.

Conclusions. The gastropod community in the mangrove area of Kutang Beach, Lamongan Indonesia was composed of as many as 30 species belonging to 17 families. The species *L. articulata*, from the Littorinidae family, showed the highest density, relative abundance, relative frequency and importance value index, namely 1.83 ind m^{-2}, 19.88%, 7.59% and 27.47%, respectively. The moderate diversity index was moderate (H'=1–3) and the the low dominance index indicated the absence of interspecies dominance. The evenness index (E=0.6–1) was high (C<0.5), indicating a relatively balanced distribution between species. Thegastropods' habitat in mangrove ecosystems was characterized by a sandy mud substrate with a temperature of 29±0.00°C, a pH of 7.86±0.00 and a salinity of 3±0.58‰.

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