Fisheries Journal, 15 (4), 2036-2047 (2025)
http://doi.org/10.29303/jp.v15i4.1619

ECOLOGICAL RELATIONSHIP BETWEEN MANGROVES AND CRABS IN THE MANGROVE FOREST OF KETAPANG INDAH VILLAGE, NORTH SINGKIL SUBDISTRICT ACEH SINGKIL REGENCY

Hubungan Ekologis Antara Mangrove dan Kepiting Pada Hutan Mangrove di Desa Ketapang Indah Kecamatan Singkil Utara Kabupaten Aceh Singkil

Syam'un[1], Munandar [2*], Wintah[3], Uswatun Hasanah[4], Muktaridha[5]

[1]Master of Fisheries Science Program, Teuku Umar University, [2]Marine Science Program, Teuku Umar University, [3]Public Health Program, Teuku Umar University, [4]Fisheries Program, Teuku Umar University, [5]Aquaculture Program, Teuku Umar University

Alue Peunyareng Street, Meureubo District, West Aceh, Aceh Province, Indonesia

[*]Corresponding Author: munandar@utu.ac.id

(Received June 3th 2025; Accepted August 22th 2025)

ABSTRACT

Mangrove forests are one of the important ecosystems in coastal areas. The existence of mangrove crabs is greatly affected by the condition of the surrounding mangrove ecosystem. The objectives of the study were to (1) analyze the level of mangrove and crab diversity; (2) analyze mangrove and crab density; (3) analyze the distribution pattern of mangrove and crab communities; (4) analyze the ecological relationship between mangroves and crabs. Mangrove sampling research method with purposive sampling method. Mangrove crab sampling using random sampling method. The results of the study showed that mangrove diversity found 4 species namely; Avicennia marina, Rhizophora mucronata, Rhizophora apiculata, and Sonneratia alba, crab diversity there are 3 species namely; Scylla serrata, Scylla olivacea, and Scylla paramamosin. Mangrove density was relatively high and ranging from 4000-4466,67 ind/ha and crab density ranging from 3,00-3,67 ind/m^2. The distribution of mangroves and crabs as a whole has a uniform distribution. Environmental factors that have the most influence on crab density are temperature and substrate factors. The temperature at the study site ranged from 28,47-28,77°C and the substrate at the study site was clay or sandy clay.

Keywords: Distribution, Diversity, Density, Crab, Mangrove

ABSTRAK

Mangrove Hutan mangrove merupakan salah satu ekosistem penting di kawasan pesisir. Keberadaan kepiting bakau sangat dipengaruhi oleh kondisi ekosistem mangrove yang ada di sekitarnya. Penelitian ini bertujuan untuk (1) menganalis tingkat keanekaragaman mangrove dan kepiting; (2) menganalisis kerapatan mangrove dan kepatan kepiting; (3) menganalisis pola distribusi mangrove dan kepiting; (4) menganalisis hubungan ekologis mangrove dan kepiting. Metode penelitian pengambilan sampel mangrove dengan metode purposive sampling.

Pengambilan sampel kepiting bakau dengan menggunakan metode random sampling. Hasil penelitian menunjukkan bahwa keanekaragaman mangrove ditemukan 4 spesies yaitu; *Avicennia marina*, *Rhizophora mucronata*, *Rhizophora apiculata*, dan *Sonneratia alba*, keanekaragaman kepiting ada 3 spesies yaitu; *Scylla serrata*, *Scylla olivacea*, dan *Scylla paramamosin*. Kerapatan mangrove tergolong tinggi berkisar antara 4000-4466,67 ind/ha dan kepadatan kepiting berkisar antara 3,00-3,67 ind/m^2. Distribusi mangrove dan kepiting secara keseluruhan memiliki distribusi tersebar rata. Faktor lingkungan yang paling berpengaruh terhadap kepadan kepiting adalah faktor suhu dan substrat. Suhu dilokasi penelitian berkisar antara 28,47-28,77°C dan substrat pada lokasi penelitian adalah lempung atau lempung liat berpasir.

Kata Kunci: Distribusi, Keanekaragaman, Kepadatan, Kepiting, Mangrove

INTRODUCTION

Mangrove Mangroves are vegetation that can withstand high salinity and are typically found in estuaries, the transitional area between land and water. Mangrove forests serve both ecological and economic functions (Wintah *et al*., 2023). Their ecological function is as a food source for organisms such as crabs, fish, shrimp, gastropods, and bivalves (Wintah *et al*., 2021), while their economic function includes the provision of timber and fishery products (Kauffman *et al*., 2012). Mangrove ecosystems are coastal ecosystems located in the intertidal zone, where interactions occur between seawater, brackish waters, rivers, and land. This interaction contributes to the high diversity of flora and fauna in mangrove ecosystems (Martuti, 2013). Ecologically, mangroves serve as habitats, feeding grounds, spawning grounds, nursery grounds, protection, sources of germplasm, and sources of energy for life in estuaries and seas (Prasetiyo et al., 2006; Nagelkerken *et al*., 2008; Kusen *et al*., 2016).

The existence of mangrove crabs is greatly influenced by the condition of the surrounding mangrove ecosystem. In general, the crabs' natural food comes from tree litter, leaves, and mangrove fruits which are still widely available in the waters of Busung Village (Unthari *et al*., 2018). For crabs, mangrove forests play an important role in supporting their survival (Irwani and Suryono, 2012). Research on the ecological relationship between mangroves and crabs in the mangrove area of Aceh Singkil will provide an overview of the balance of the mangrove forest ecosystem in Aceh Singkil. A deep understanding of the interaction between mangrove vegetation and crabs will help identify the factors that contribute to the health of mangrove ecosystems.

Aceh Singkil Regency has an area of 2,185 km², located at 2°20'-2°27'30" N and 97°45'00" E. Data from the Forestry and Plantation Service of Aceh Singkil Regency in 2012 shows that the area of mangrove forest is 6,514 hectares. Mangrove forests in Indonesia in 2010 reached 3,112,989 ha or 22.6% of the total area of mangroves in the world, making Indonesia the country with the largest mangrove forests (Giri *et al*., 2011). Mangrove forests are also a habitat for mangrove crabs. Mangrove crabs are one of the potential fishery resources that utilize mangroves as their main habitat. These crabs are categorized as keystone species because their activities such as digging holes and looking for food can affect ecosystem processes (Widyastuti, 2016). According to La Sara (2010), the life cycle of mangrove crabs is closely related to the mangrove ecosystem. The potential for crabs in Indonesia is quite large due to their widespread distribution in Indonesian waters, particularly in areas with mangroves (Serosero, 2011). Ecologically, crabs play a role in nutrient conversion, mineral enrichment, and oxygen distribution in the soil (Redjeki *et al*., 2017). According to Hamidy (2010), crabs can also be used as indicators of water pollution because they are highly sensitive to changes in water quality.

By understanding the structure of mangrove and crab communities, it is hoped that the results of this study can be a basis for the management and preservation of mangrove ecosystems sustainably in Aceh Singkil Regency, especially in Ketapang Indah Village, North Singkil District. The sustainability of mangrove ecosystems is important for maintaining the balance of coastal ecosystems and maintaining the biological resources within them, including mangrove crab populations that have ecological and economic value. This study aims to analyze the level of diversity of mangrove and mangrove crab species, analyze mangrove density and crab density in mangrove forest ecosystems, identify distribution patterns of mangrove and crab communities, and analyze the ecological relationship between mangrove vegetation and crab populations in the Mangrove Forest area of Ketapang Indah Village, North Singkil District.

RESEARCH METHODS

This research was carried out in Mangrove Forest, Ketapang Indah Village, North Singkil District, Aceh Singkil District in January-February 2025. Data collection was carried out at three stations, namely station 1 (ST1) with coordinates 02°16'51.73" LU – 097°54'19.01" E, station 2 (ST2) at 02°16'52.96" LU – 097°54'12.92" E, and station 3 (ST3) at 02°16'56.01" LU – 097°54'23.04" E (Fig 1). This study used various tools such as a camera for documentation, writing instruments for data recording, and a handfractosalinometer, thermometer, pH meter, and DO meter for measuring environmental parameters. Soil sampling was carried out using a corer, while species identification was assisted by an identification book. Crabs were caught using a trap, measured using a ruler and calipers, and then weighed with a scale. Raffia rope was used to tie the caught crabs, and plastic was used as a sample container. All of these tools supported the collection of data related to the condition of the mangroves and crabs at the research site. At each station, sampling of mangroves is carried out using a positive sampling method on three different plots, namely plot 1 which is directly opposite the beach, plot 2 in the middle, and plot 3 in the inner part, with a distance between plots of around 50 meters between station more than 100 meter. Each plot for tree observation has a plot of 10 m x 10 m, a stake plot of 5 m x 5 m, and a seedling plot of 1 m x 1 m (Figure 2). Identifying mangrove types using mangrove guides and mangrove research. The sampling method for mangrove crabs was used using a random sampling method with a 45 cm^2 45 cm square mangrove trap placed randomly at three points in each mangrove plot of 10 m x 10 m. Crab catching is carried out for 12 hours from 18.00 to 06.00. The number and type of crabs collected are calculated, their morphology is observed, and their carapace length and body weight are measured.

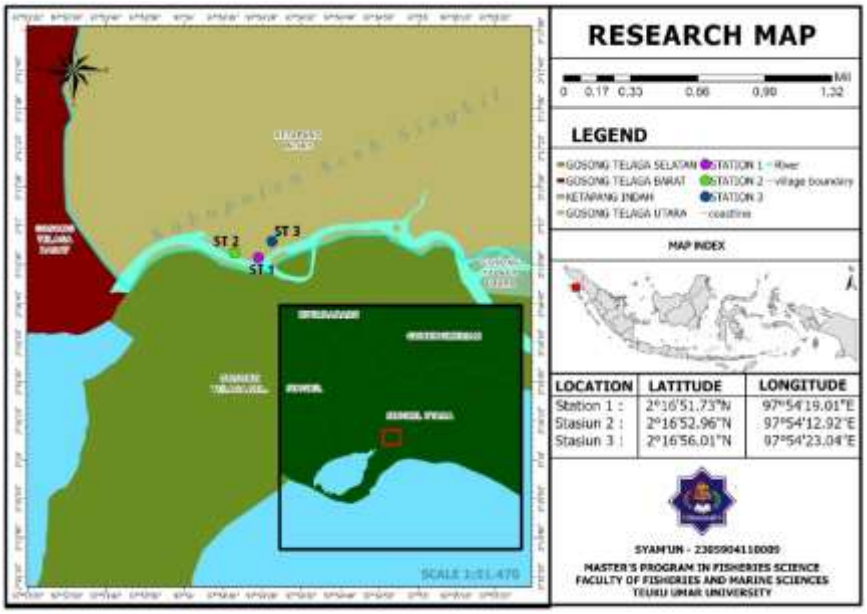

Figure 1. Station points at the research location

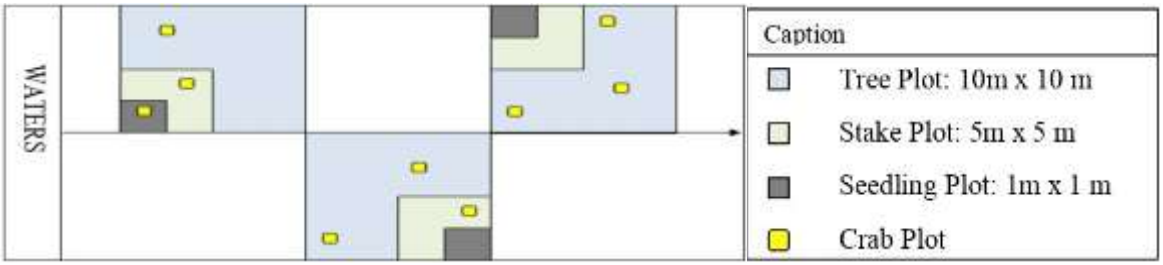

Figure 2. Mangrove vegetation measurement and crab sampling

Environmental assessment of environmental parameters is carried out directly in the field to determine water temperature, salinity, water pH, and fresh oxygen (DO) as supporting data for crab abundance. Meanwhile, soil chemical and physical parameters such as pH, texture, organic matter, total phosphorus, and total nitrogen are analyzed locally in the Shia Ku$ala Agricultural Faculty laboratory. Data analysis was carried out by calculating an index of species diversity using the Shannon-Wie$r index, species density based on the number of individuals per unit, and distribution of species using the Morisita index. Distribution patterns are categorized as random, clustered, or evenly distributed based on the value of the Morisita index. The ecological relationship between mangrove environmental factors and crab density was analyzed using Principal Component Analysis (PCA) with STATISTICA 10.0 software, while the relationship between carapace length and width and crab density was analyzed using SPSS Statistics 23 for crabs. Know the growth patterns of mangrove crabs.

RESULTS

Mangrove Diversity

Based on the results of mangrove identification, 4 species of tree levels were found, 4 species of saplings, and 3 species of saplings. The diversity index for mangroves in the categories of trees is 1.21, saplings are 1.13, and seedlings are 1.05, which in total includes the medium-sized kategori criteria of Odu$m (1993). Mangrove tree and sapling levels were found in 4 species, namely *A. marina, R. mucronata, R. apiculata, and S. alba* (Tables 1 and 2).

Table 1. Tree level diversity

Tree	ni	pi (ni/N)	Ln pi	pi.Ln pi	H'
Avicennia marina	32.67	0.2792	-1.2758	-0.3562	
Rhizophora mucronata	35.7	0.3048	-1.1879	-0.3621	1,2146
Rhizophora apiculata	44	0.3760	-0.9779	-0.3677	
Sonneratia alba	4.67	0.0398	-3.2217	-0.1285	

Table 2. Diversity of stake levels

Stake	ni	pi (ni/N)	Ln pi	pi.Ln pi	H'
Avicennia marina	21.00	0.2242	-1.4952	-0.3352	
Rhizophora mucronata	30.3	0.3238	-1.1275	-0.3651	1,1343
Rhizophora apiculata	40.67	0.4342	-0.8343	-0.3622	
Sonneratia alba	1.67	0.0178	-4.0289	-0.0717	

Table 3. Seedling level diversity

Seedling	ni	pi (ni/N)	Ln pi	pi.Ln pi	H'
Avicennia marina	10.33	0.1975	-1.6223	-0.3203	
Rhizophora mucronata	20.3	0.3885	-0.9454	-0.3673	1,0527
Rhizophora apiculata	21.67	0.4140	-0.8819	-0.3651	

Crab Diversity

Meanwhile, the identified crab species consisted of Scylla average, *S. olivace*, and *S. paramamosain*, with a diversity index of 1.09 (Table 4).

Table 4. Crab Diversity

Species	pi	pi (ni/N)	Ln pi	pi.Ln pi	H'
Scylla serrata	3	0.2903	-1.2368	-0.3591	1,0914
Scylla olivacea	3.3	0.3226	-1.1314	-0.3650	
Scylla paramamosain	4	0.3871	-0.9491	-0.3674	

Mangrove Density and Crab Density

The highest total density of mangrove trees was found in Station 1, namely around 3,100 ind/ha, followed by Station 2 with 2,600 ind/ha, and Station 3 with 1,600 ind/ha. The highest sapling density was also at Station 1 at 3,800 ind/ha (Figure 3). The highest seed density in Station 2 was 2,400 ind/ha. Based on KLH standards (2004), this density is classified as high. Tree level density at research locations is high. This is in accordance with the Purpose of Managing the Living Environment No. 201 of 2004 that mangrove density is classified as high if the density is more than 1500 ind/ha. Furthermore, the highest density of crabs is found at stations 1 and 2 with a value of 3.67 ind/m², while at station 3 the lowest density is (3 ind/m²) (Figure 4).

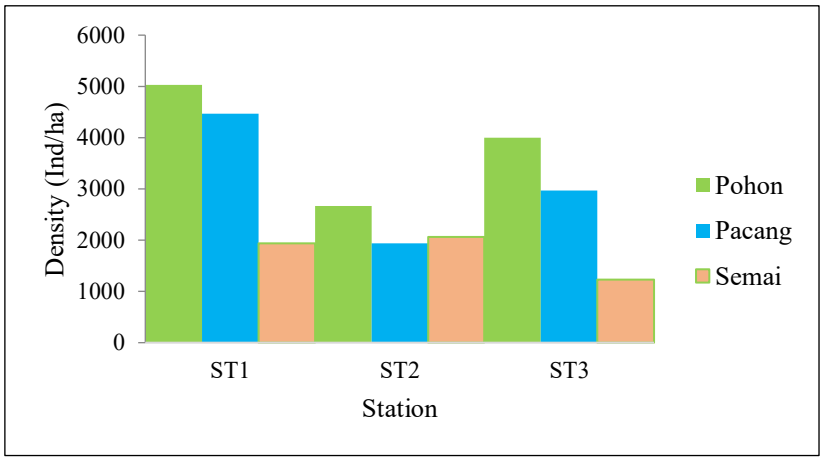

Figure 3. Mangrove density per stationstasiun

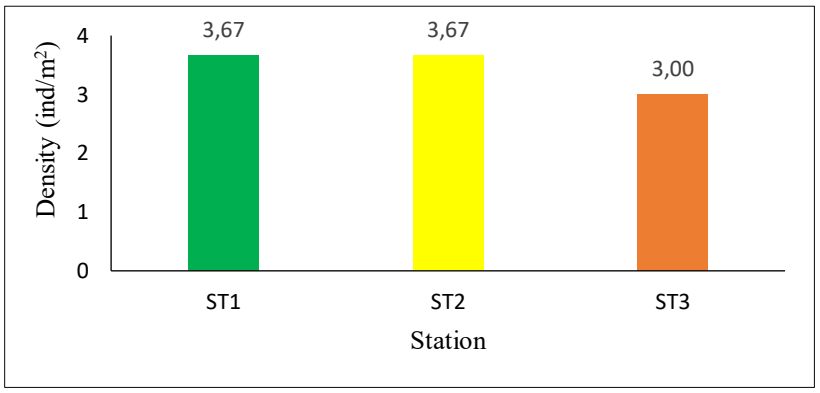

Figure 4. Crab density per station

Mangrove Distribution

The distribution pattern of mangrove species shows a morisita index value of less than 1 in all stations, showing a uniform distribution. The tree and sapling level distribution at the research location was found to have distributions of *A. marina, R. mucronata, R. apiculata*, and *S. alba* generally having moricide index values less than 1 (Tables 5 and 6).

Tabel 5. Distribution of mangrove$ at tree level in each station

Tree	ST1	ST2	ST3	*Iδ* Total	Distribution
A. marina	0.15	0.07	0.15	0.12	Spread evenly
R. mucronata	0.17	0.16	0.12	0.15	Spread evenly
R. apiculata	0.23	0.23	0.26	0.24	Spread evenly
S. alba	0	0	0.02	0.008	Spread evenly

Table 6. Distribution of mangrove sation at the sapling level in each station

Tree	ST1	ST2	ST3	*Iδ* Total	Distribution
A. marina	0.06	0.19	0.04	0.10	Spread evenly
R. mucronata	0.24	0.70	0.08	0.34	Spread evenly
R. apiculata	0.16	0.47	0.25	0.29	Spread evenly
S. alba	0	0.00	0.00	0.00	Spread evenly

At the distribution level of mangrove seedlings at the research location, it was found that the distribution of *A. marina*, *R. mucronata*, and *R. apiculata*, generally had a moricide index value of less than 1 (Table 6).

Table 6. Distribution of mangrove seedlings at each station

Tree	ST1	ST2	ST3	$I\delta$ Total	Distribution
A. marina	0.002	0.006	0.006	0.005	Spread evenly
R. mucronata	0.042	0.126	0.013	0.060	Spread evenly
R. apiculata	0.0461	0.137	0.041	0.074	Spread evenly

Crab Distribution

The value of the Morisita index for crabs also shows a uniform pattern. The distribution pattern describes the distribution of crabs which are grouped into an even distribution ($I\delta$ <1), random distribution ($I\delta$ = 1) and grouped ($I\delta$ >1). The distribution of crabs at the study location was found to have a distribution of *S. average, S. olivace*, and *S. Paramamosain* generally having a moricide index value of less than 1, which indicates an average distribution pattern (Table 7).

Table 7. Distribution of crab species at each station

Species	ST1	ST2	ST3	$I\delta$ Total	Distribution
Scylla serrata	0.41	0.00	-0.33	0.03	Spread evenly
Scylla olivacea	0.00	0.41	0.00	0.14	Spread evenly
Scylla Paramamosain	0.41	0.41	0.67	0.49	Spread evenly

Relationship between Carapace Length and Width and Crab Body Weight

Based on the Letter of the Regulation on Maritime Affairs and Fisheries No. 18/ME$N-KP/1/2015 concerning the catching of crabs (*Scylla spp.*), mangrove crabs that can be caught must weigh more than 200 grams. At research locations, the weight of male mangrove crabs ranges between 110-310 grams, and female between 100-270 grams. From the results of observations, only 28.57% of the male crabs met the criteria for catching were only 28.57%, while 71.43% were not worth catching. As for female crabs, only 17.65% were suitable for catching and 82.35% were not suitable. In terms of carapace width, male crabs with a width of ≤ 100 mm reached 85.71% and those > 100 mm were only 14.29%, while female crabs with a carapace width of ≤ 100 mm were 82.35% and those > 100 mm were 17.65%. These data show that most of the crab population at the research location has not met the size and weight criteria permitted for capture in accordance with the applicable regulations.

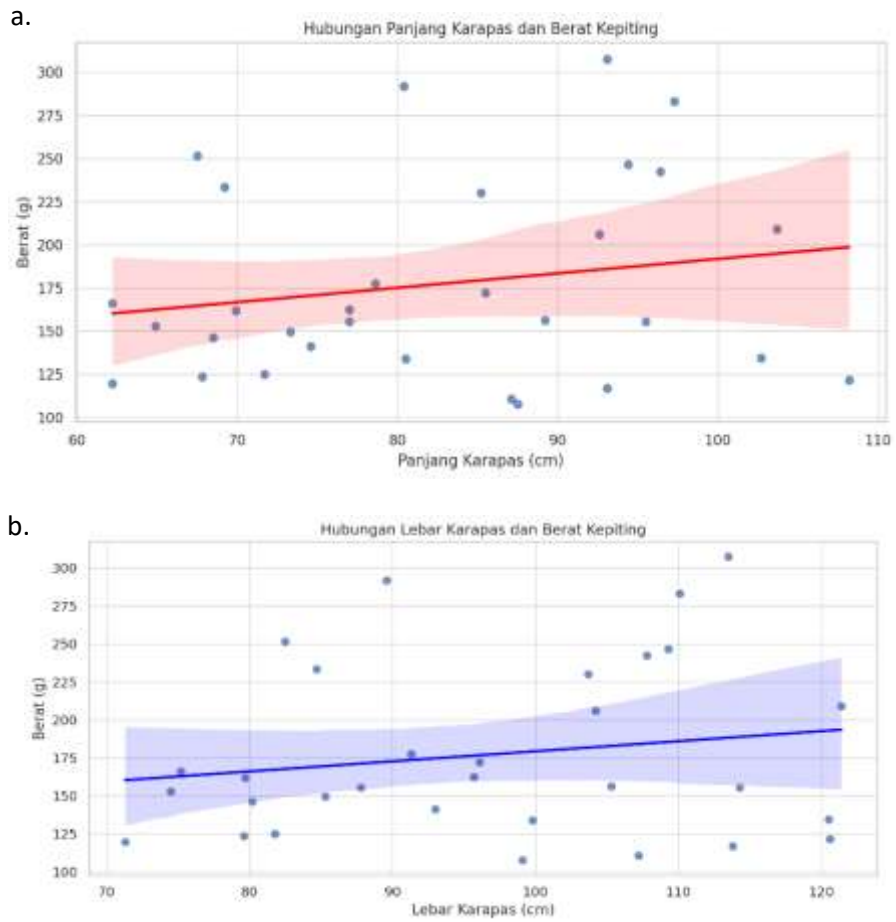

Figure 5. Scatter plot graphs of (a) carapace length vs. crab weight and (b) carapace width vs. crab weight

The relationship between length and width and crab weight can be seen in Figure 5. Based on the results of the regression analysis between carapace length and width and crab weight, the values showed values of 0.19 and 0.17. These values are included in the very low category. Both relationships based on data analysis showed a p value> 0.05, indicating there is no significant relationship between carapace length and width and crab weight (Table 8).

Table 8. Linear regression analysis between carapace length and width and crab weight

Indicator	*Multiple R*	*R Square*	*Significance F*
Length vs. Weight	0,191	0,036	0,302
Length vs. Weight	0,173	0,030	0,350

Environmental Factors

The most important environmental factors include temperature, pH, salinity, and substrate type. Temperatures range between 28.2°C at Station 3 to 29.6°C at Station 1. The pH is relatively stable between 7.04–7.28. Salinity is in the range of 25–27 ppt. The substrate is dominated by clay in all three stations. The results of the PCA analysis show that the environmental factors that have the most influence on the density of crabs are water and substrates which are dominated by clay or sandy clay. Water has the most important role in research locations because water is already a standard temperature quality for mangrove waters and is suitable for the life of mangrove biota. The temperature at the research location ranges

between 28.47-28.77°C, while the standard for mangrove waters is 28-32°C (PP RI No.22 of 2021 concerning environmental standards for mangrove waters).

DISCUSSION

The diversity of mangroves is classified as moderate, with an index value between 1.04–1.27, indicating that the ecosystem at the research location still supports a diversity of species (Odu$m, 1993). This condition is consistent with the findings of Gantini *et al*. (2020) and Sipayu$ng (2023), who also report moderate diversity in mangrove conservation areas. Meanwhile, crab diversity is moderate with an index between 0.95–1.04, and is still higher compared to locations experiencing environmental degradation such as mangrove areas in Demak (Adha, 2015).

The high density of mangrove trees, especially in Station 1 which reaches 3,100 ind/ha, reflects good vegetation conditions and provides a suitable habitat for the life of mangrove fauna as well as the importance of crabs. This vegetation structure plays an important role in supporting the activity and abundance of crabs (Rahman *et al*., 2019). The high density of crabs at Stations 1 and 2 (0.0067 ind/m^2) was also associated with the vegetation density and temperature which were in the optimal range for crab biological activity (Putringitias, 2019; Sawitri *et al*., 2019).

The distribution of mangrove and crab communities tends to be uniform, indicated by the Morisita index value <1 at all stations, indicating that environmental conditions between locations are relatively homogeneous. The absence of specific dominance between location points reflects a stable habitat and does not experience significant disturbance. This finding supports the statement of Sesosero *et al*. (2020) that a uniform distribution pattern reflects an ecosystem that is not in a condition of significant stress or disturbance.

Principal Component Analysis (PCA) analysis shows that water and substrate type are environmental factors that have the most influence on crab density. Water bodies in the range of 28–30°C are still within the optimal range for catabolism and biological activity of crabs (Widiyastuti, 2016), while the mineral substrates that dominate research locations are the type of natural habitat preferred by crabs. (Natania, 2017). These two factors show a positive correlation with crab density, as depicted in the PCA graphic visualization.

According Wijaya *et al*. (2010), mangrove crabs are categorized as adults if they have a carapace width of more than 100 mm. Based on these criteria, only 14.29% of male crabs and 17.65% of female crabs in the research location were classified as worthy of being caught. The results of the correlation analysis between carapace width and body weight show that the calculated R value is smaller than table R, which indicates that there is no significant relationship between the two parameters. In other words, the growth of the crab body is not isometric, where the increase in body weight is not comparable to the growth of the body weight of the carapace (Sanu, 2013). This imbalance is thought to be due to the increase in body weight, especially in the claws, occurring more quickly compared to the growth of the width of the carapace. This is in line with the typical morphology of Scylla sp., which has large claws so that individuals with similar carapace width can have much different weights (Wijaya *et al*., 2010). This finding is supported by Muna's study (2009) which revealed that the growth pattern of mangrove crabs in various Indonesian waters tends to show positive allometry, namely a condition in which the increase in the crab's body weight is faster than the growth in the size of its carapace as it ages.

CONCLUSION

The results of the study indicate that the mangrove ecosystem in Ketapang Indah Village has a moderate level of diversity, both in mangrove vegetation and the mangrove crab species

that live there. Four mangrove species were found, namely *A. marina, R. mucronata, R. apiculata, and S. alba,* and three crab species, namely *S. serrata, S. olivacea,* and *S. paramamosain*. The mangrove vegetation density is relatively high (up to 3,100 ind/ha) and the crab density reached 3.67 ind/m². The distribution pattern of both shows an even distribution across all observation stations. Analysis of ecological relationships through PCA showed that temperature and substrate type were the environmental factors that most influenced crab density. However, the regression results between carapace length and width with crab body weight showed a very weak and insignificant relationship ($p>0.05$), indicating that crab growth is not isometric. Most of the crab population has not met the regulatory catch size, thus indicating the importance of sustainable management to maintain the sustainability of the ecosystem and mangrove crab population in this region.

ACKNOWLEDGEMENT

The authors express their deepest gratitude to the community of Ketapang Indah Village, North Singkil District, Aceh Singkil Regency, for their support and cooperation during the implementation of this research. Thanks are also extended to the village officials and related parties who granted access permits to the site, as well as to the Laboratory of the Faculty of Fisheries and Marine Sciences, Teuku Umar University, and the Laboratory of the Faculty of Agriculture, Syiah Kuala University, for facilitating the analysis of environmental samples. Their support and assistance were invaluable in ensuring the smooth running of this research.

REFERENCES

Adha, M. (2015). Keanekaragaman jenis kepiting bakau (Famili Portunidae) di kawasan mangrove Kabupaten Demak. [Skripsi, Universitas Diponegoro].

Gantini, R., Indrawan, M., & Rahman, H. (2020). Keanekaragaman jenis mangrove di kawasan konservasi mangrove Langsa, Aceh. *Jurnal Sylva Lestari, 8*(1), 59–67. https://doi.org/10.23960/jsl1860-67

Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., Masek, J., & Duke, N. (2011). Status and distribution of mangrove forests of the world using earth observation satellite data. *Global Ecology and Biogeography, 20*(1), 154–159.

Hamidy, R. (2010). Struktur dan keragaman komunitas kepiting di kawasan hutan mangrove Stasiun Kelautan Universitas Riau, Desa Purnama Dumai. *Journal of Environmental Science, 2*(4), 81–91.

Irwani, & Suryono, C. A. (2012). Pertumbuhan kepiting bakau *Scylla serrata* di kawasan mangrove. *Buletin Oseanografi Marina, 1*(1), 15–19.

Kauffman, J. B., & Donato, D. C. (2012). Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests (Working Paper 86). CIFOR.

Kementerian Kelautan dan Perikanan Republik Indonesia. (2015). Surat edaran Menteri Kelautan dan Perikanan Nomor 18/MEN-KP/1/2015 tentang pedoman pengelolaan sumber daya alam hayati dan ekosistem laut. KKP.

Kementerian Lingkungan Hidup Republik Indonesia. (2004). Keputusan Menteri Lingkungan Hidup Nomor 201 Tahun 2004 tentang pedoman penilaian dampak lingkungan hidup. Kementerian Lingkungan Hidup.

Kusen, J. D., Lumingas, L. J. L., & Rondo, M. (2016). Ekologi laut tropis. FPIK UNSRAT.

La Sara. (2010). Study on the size structure and population parameters of mud crab *Scylla serrata* in Lawele Bay, Southeast Sulawesi, Indonesia. *Journal of Coastal Development, 13*(2), 133–147.

Martuti, N. K. T. (2013). Keanekaragaman mangrove di wilayah Tapak, Tugurejo, Semarang. *Jurnal MIPA, 36*(2), 123–130.

Muna, N. F. (2010). Keragaan reproduksi kepiting bakau (*Scylla* sp.) di perairan Indonesia [Skripsi, Institut Pertanian Bogor].

Nagelkerken, I., Blaber, S. J. M., Bouillon, S., Green, P., Haywood, M., Kirton, L. G., & Somerfield, P. J. (2008). The habitat function of mangroves for terrestrial and marine fauna: A review. *Aquatic Botany, 89*, 155–185.

Natania, L. (2017*).* Preferensi habitat kepiting bakau (*Scylla* spp.) berdasarkan jenis substrat di ekosistem mangrove Desa Pising, Kalimantan Selatan [Skripsi, Universitas Lambung Mangkurat].

Odum, E. P. (1993). Dasar-dasar Ekologi. (T. Samingan, Trans.; Ed. ke-3). Gadjah Mada University Press.

Peraturan Pemerintah Republik Indonesia. (2021). Penyelenggaraan perlindungan dan pengelolaan lingkungan hidup tentang baku mutu air laut.

Prasetiyo, D. E., Zulfikar, F., Shinta, & Zulkarnain, I. (2016). Valuasi ekonomi mangrove di Pulau Jawa Kepulauan Seribu: Studi konservasi berbasis green economy. *Omni Akuatika, 12*(1), 48–54.

Putringitias, S. (2019). Hubungan antara parameter lingkungan dengan keberadaan kepiting bakau (*Scylla spp.*) di kawasan mangrove Taman Wisata Alam Angke Kapuk. *Jurnal Ilmu dan Teknologi Kelautan Tropis, 11*(2), 419–428.

Rahman, M. A., Hossain, M. Y., & Pramanik, M. N. U. (2019). Habitat association of mud crabs (*Scylla spp.*) with mangrove vegetation: Implications for conservation and management. *Regional Studies in Marine Science, 29*, 100666. https://doi.org/10.1016/j.rsma.2019.100666

Redjeki, S., Arif, M., Hartati, R., & Pinandita, L. K. (2017). Kepadatan dan persebaran kepiting (Brachyura) di ekosistem hutan mangrove Segara Anakan Cilacap. *Jurnal Kelautan Tropis, 20*(2), 131–139.

Sanur, I. P. (2013). Studi pertumbuhan kepiting bakau (Scylla serrata Forskal, 1775) di perairan Karangsong, Kabupaten Indramayu, Provinsi Jawa Barat. [Skripsi, Institut Pertanian Bogor].

Sawitri, R. A., Hariyadi, S., & Pribadi, T. (2019). Studi kepadatan dan struktur populasi kepiting bakau (*Scylla spp.*) di hutan mangrove Segara Anakan Cilacap. *Jurnal Kelautan Tropis, 22*(1), 1–8. https://doi.org/10.14710/jkt.v22i1.5487

Serosero, R. (2011). Karakteristik habitat kepiting bakau (*Scylla spp.*) di perairan pantai Desa Todowongi, Kecamatan Jailolo Selatan, Kabupaten Halmahera Barat. *Agrikan: Jurnal Agribisnis Perikanan, 4*(1), 69–75.

Sesosero, E., Hidayat, T., & Irawan, B. (2020). Pola distribusi dan keanekaragaman spesies mangrove di Teluk Kendari. *Jurnal Ilmu dan Teknologi Perikanan Tangkap, 5*(2), 45–54.

Sipayung, R. (2023). Struktur komunitas mangrove di kawasan konservasi mangrove Lubuk Kertang, Langkat, Sumatera Utara. [Skripsi, Universitas Sumatera Utara].

Unthari, D. T., Purwiyanto, A. I., & Agussalim, A. (2018). Hubungan kerapatan mangrove terhadap kelimpahan kepiting bakau (*Scylla sp.*) dengan penggunaan bubu lipat sebagai alat tangkap di Sungai Bungin, Kabupaten Banyuasin, Provinsi Sumatera Selatan. *Jurnal Maspari, 10*(1), 41–50.

Widiyastuti, W. (2016). Suhu optimum untuk aktivitas metabolik kepiting bakau (*Scylla* spp.). *Jurnal Biologi Tropis, 16*(1), 23–29.

Wijaya, I. M., Yulianda, F., Boer, M., & Juwana, S. (2010). Biologi populasi kepiting bakau (*Scylla serrata* F.) di habitat mangrove Taman Nasional Kutai, Kabupaten Kutai Timur. *Oseanologi dan Limnologi di Indonesia, 36*(3), 443–461.

Wintah, N., Nuryanto, A., Pribadi, R., Sastranegara, H. M., Lestari, W., & Yulianda, F. (2021). Distribution pattern of gastropods and physical chemical factors in the Kebumen mangrove forest, Indonesia. *Bioflux, 14*(4), 1855–1864.

Wintah, N., Kiswanto, H., & Sastranegara, H. M. (2023). Mangrove diversity and its relationships with environmental conditions in Kuala Bubon Village, West Aceh, Indonesia. *Biodiversitas, 24*(8), 4599–4605.