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Biodiversity of Mangrove Brachyuran Crabs of Family Ocypodidae and Sesarmidae in Koto XI Tarusan District, West Sumatera, Indonesia

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ABSTRACT

The Mangrove ecosystem is an ecosystem that is around the edge of the coast and many organisms live in this ecosystem, one of them is crabs. The crabs that are often found are deposit crabs from the Ocypodidae and Sesarmidae families that act as balancers in the mangrove ecosystem. This study aimed to analyze species, diversity, evenness, and dominance in the mangrove vegetation area of Koto XI Tarusan District, West Sumatera, Indonesia. The method used is the descriptive method. The biodiversity of brachyuran crabs' families, Ocypodidae and Sesarmidae, was analyzed with the Shannon-Wiener index (H'). Four indices were calculated for crabs Ocypodidae and Sesarmidae: species identification, Shannon-wiener (H') diversity, evenness, and dominance indices. The results showed that there were six species of deposited crabs from the Ocypodidae and Sesarmidae families, namely *Uca bellator, U. rosea, Perisesarma eumolpe, P. plicatum*, *Sarmatium germaimi*, and *Sesarma curoense*. The most abundant species (Di) came from the family Sesarmidae. However, for all stations, diversity (H') has a value that is in the medium category, and evenness (E) is in the high category at each station. The dominance (D) obtained a value categorized as low at each observation station. The condition of environmental parameters in the mangrove vegetation area is included in the category of a good environment. It is still within normal limits for the crabs of the Ocypodidae and Sesarmidae families to live. Two substrate types are found in each observation path: muddy and sandy mud.

1. Introduction

Mangroves are examples of coastal wetlands that provide a variety of ecological roles, from nutrient cycling to sustaining biodiversity. Ecosystems like mangroves offer a variety of functions to the coastal region, including carbon sequestration, flood control, protection, pollution management, breeding and nursery habitats, and shoreline ability (Maharajan *et al.* 2015; Lapolo *et al.* 2018; Ginantra *et al.* 2021; Freitas *et al.* 2021). Mangrove ecosystems consist of plant and animal life systems interacting with environmental conditions (Rahayu *et al.* 2017; Cappenberg *et al.* 2021).

The mangrove ecosystem is one of the ecosystems with many flora and fauna diversities. Healthy mangrove forests provide a critical habitat for many species, especially for crabs in intertidal and estuarine areas, and the key to healthy marine ecology. Mangroves are the most suitable feeding, breeding and nursery grounds for crabs and other crustaceans (Pratiwi and Widyastuti 2018; Paramita *et al.* 2020). Many species of macroinvertebrates found in mangrove ecosystem, one of the them is brachyuran crabs live in mangroves. Worldwide, more than 300 species of brachyuran crabs can be found in the mangrove ecosystem (Kumar and Amina 2021). Brachyuran have a rich diversity: a total of 5,000 to 10,000 species belonging to 700 genera have been identified worldwide, and due to their great abundance of biomass and community structure (Ng

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et al. 2008; Shukla *et al.* 2013; Kamalakkannan 2015).

Brachyuran crabs are the most crucial groups that adapt and live in ecosystem mangroves. Crustaceans, especially brachyuran crabs, are the most numerous and have the highest biomass (Setyadi *et al.* 2021). Many species of brachyuran crabs are found in the mangrove ecosystem, especially those of the family Ocypodidae and Sesarmidae (Le *et al.* 2018; Mohanty *et al.* 2019). Many species of Ocypodidae live in the mangrove ecosystems, such as fiddler crabs *Uca* spp. The male fiddler crab has a larger craw and is intended as a means of defense from enemies and attract female crab.

Meanwhile, female crab claws are small and function to eat and dig burrows or holes (Fadilah *et al.* 2023). Sesarmidae is one of the families of brachyuran crabs, whose crabs have the same size of claws either in length or; the way to distinguish between males and females is by looking at the color of the carapace and body size. Sesarmidae live in the trunks and roots of mangrove trees (Lapolo *et al.* 2018; Le *et al.* 2018; Katili and Utina 2019). These crabs belong to the Brachyura component and are found in the intertidal plains near tropical and subtropical forests. These two types of crabs can survive by eating nutrients derived from organic matter derived from mangrove litter, and these crabs also play a role in remineralizing detritus in mangrove ecosystems (Chakravarty *et al.* 2016; Bandekar 2021). West Sumatera Province consists of several concluded to have various marine potentials, one of them is Koto XI Tarusan district, Pesisir Selatan Regency. Koto XI Tarusan District is overgrown with mangroves that is still classified as good condition and beautiful with natural plant growth market; one of them is at "Gemuruh River." Five types of mangrove vegetation can be found in Gemuruh River and mangrove vegetation was dominated is *Rhizopora mucronata*. Mangrove zoning at Gemuruh River is still well maintained because the propagule still grows around the mother tree, and the mangrove zoning still describes compatibility with the environmental (Dafikri and Kamal 2021; Dafikri *et al.* 2022).

The mangrove ecosystem at Gemuruh River has a lot of potential diversity of diverse aquatic flora and fauna. In this place, many activities are carried out, such as fishing activities, catching mangrove crabs, and several development activities to support the convenience of tourism around the mangrove ecosystem in the Gemuruh River. But many people need to learn about the existence of these small crabs that come from the Ocypodidae and Sesarmidae families that live in the area.

Even the existence of these crabs found in this mangrove area has never been published regarding the diversity of these brachyuran crabs, so research is needed so that the presence of Ocypodidae and Sesarmidae crabs can be exposed and known to outsiders. The purpose of this scientific research is to become a reference and basis for the conservation of Ocypodidae and Sesarmidae crabs in the mangrove area and to analyze the presence of crabs from what families inhabit the mangrove ecosystem in the Gemuruh River area.

2. Materials and Methods

2.1. Location and Time of Research

The research was conducted in the mangrove area of Gemuruh River Koto XI Tarusan District, Pesisir Selatan Regency, West Sumatera Province, Indonesia (Figure 1), during July-August 2022.

2.2. Research Methods

The research method is descriptive quantitative with a survey approach and direct observation in the field. The descriptive method is a method to describe characteristics of the population and the descriptive method can be interpreted as a problem-solving procedure investigated by describing the situation subjects or objects in research can be people, institutions, communities, and others which are currently based on facts that appear or what they are (Setyadi *et al.* 2021). The method to collect crab samples using a purposive sampling technique. Purposive sampling is a sampling technique with certain considerations. The reason for using this purposive sampling technique is because it is suitable for use in quantitative research, or studies that do not generalize according (Sugiyono 2016).

2.3. Data Collection

The location of data collection of crab samples was divided into three categories, namely dense mangrove density, medium mangrove density, and sparse mangrove density. Each station was established at a distance inland from the river bank in the mangrove ecosystem intertidal. The species target collected is brachyuran crabs belonging to the family Ocypodidae and Sesarmidae at each data

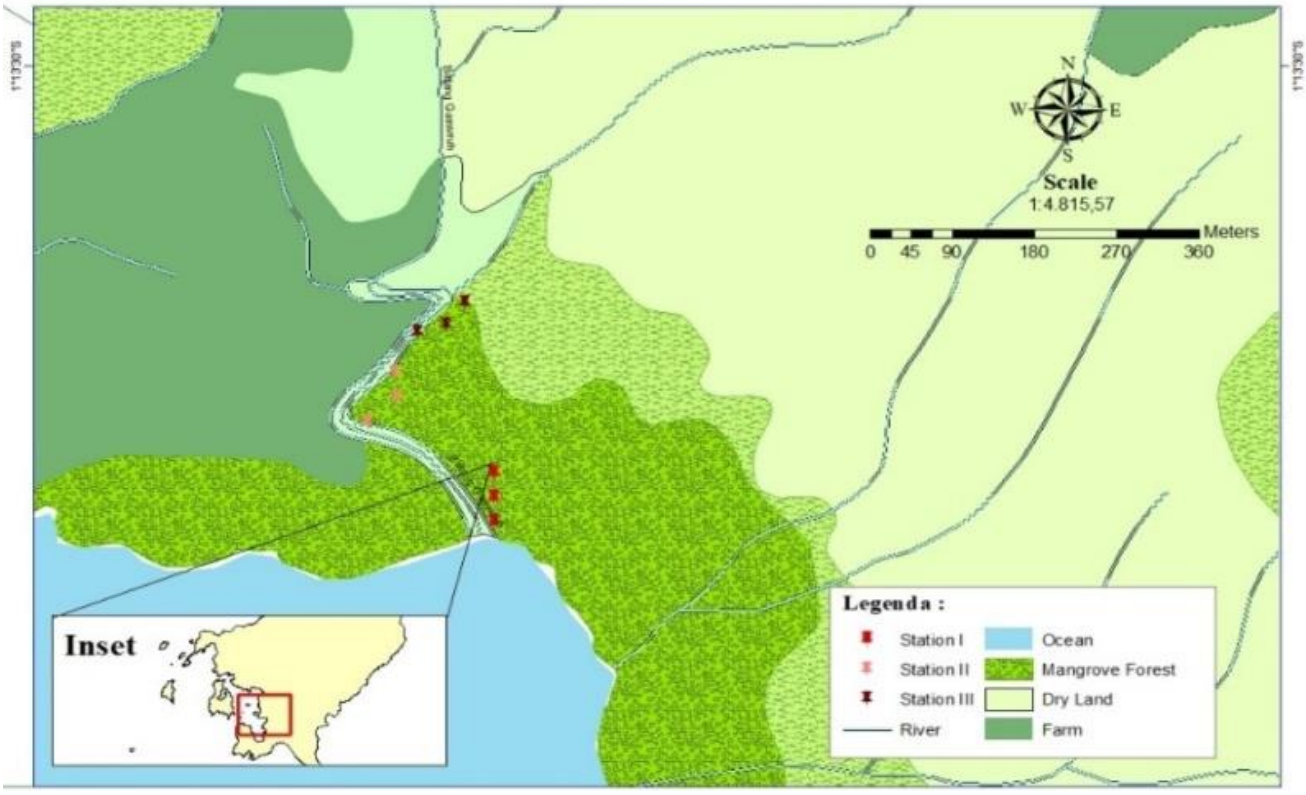

Figure 1. Research location diversity of Ocypodidae and Sesarmidae crabs in the mangrove area, Gemuruh River, Koto XI Tarusan District, Pesisir Selatan Regency, West Sumatera Province

sampling station, transect line, and plot. The transect line stretched at each station is 80 meters with a plot size of 5 × 5 meters for each station, with three plots for each station. The method was adopted from Ngo-Masou *et al.* (2018) and Setyadi *et al.* (2021) but with larger quadrats. Sampling was carried out for one month at low tide (lowest low tide) from 06.00 until 09.00 AM. The collection sample process involved four people.

The four people involved in this study played a role in assisting the entire crab sampling process, including digging burrows and removing all Ocypodidae and Sesarmidae crabs that had been seen in each plot on the transect for one hour until no more Ocipodidae and Sesarmidae crabs were found. Sampling of crabs in the substrate hole was carried out by digging the substrate as deep as 10-20 cm using a hand shovel. After the sample is taken, clean the crab first with clean water so that the sediment attached to the crab's body can be lifted. All samples have been cleaned, put in a labeled plastic bottle, and put in a cooler box with ice. All specimens preserved in 70-75% alcohol solution for 5 minutes to later identify the species.

2.4. Data Analysis

The biodiversity of brachyuran crabs' families, Ocypodidae and Sesarmidae, were analyzed with the Shannon-Wiener index (H'). The Shannon-Wiener index is commonly used to evaluate the diversity of mangrove species in Indonesia (Kasim *et al.* 2019; Sadono *et al.* 2020). Four indices were calculated for Ocypodidae and Sesarmidae crabs: identification of species, Shannon-Wiener (H') diversity, evenness and dominance indices.

2.4.1. Biodiversity of Ocypodidae and Sesarmidae Crabs

The diversity index (H') of Brachyura crabs is determined by the equation of Shannon-Wiener (1984) in Odum (1994). The value of the diversity index (Shannon-Wiener) is showed on Table 1.

$$H' = -\sum_{i=1}^{S} [\,(pi)\ln(pi)\,]$$

Explanation:
H' = diversity index Shannon-Wiener
S = number of species
Pi = the proportion of the number individual of species 1 to the total number of individuals
Pi = ni/N
Ni = number of individuals species i
N = number of individuals of all species

2.4.2. Evenness Index (E) of Ocypodidae and Sesarmidae Crabs

Evenness can be said to be a balance, namely the individual composition of each type of species found in a community. The value of the diversity index (Shannon-Wiener) is presented on Table 2. Evenness is obtained from the diversity relationship (H') with the maximum value, the equation of evenness index Krebs (2014):

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

Explanation:
H' = diversity index
E = evenness index
Hmax = ln S (S = total species)

2.4.3. Dominance Index (D) of Ocypodidae and Sesarmidae Crabs

The value of the diversity index (Shannon-Wiener) is showed on Table 3. Dominance data of crabs was analysed using the Simpson dominance index according Odum (1993) in Nur and Kuntjoro (2020) using the formula:

$$D = \sum pi^2$$

Explanation:
D = simpson dominance
Pi = ni/N
Ni = number individual of species-i
N = number individual of all species

Table 1. The value of the diversity index (Shannon-Wiener)

Value	Category
If the value H' ≤ 1.5	Low species diversity, poor, very low productivity as an indication of heavy pressure and unstable ecosystem
If the value 1.5 < H' ≤ 3.5	Moderate diversity: sufficient productivity, moderately balanced ecosystem conditions, moderate ecological pressure
If the value H' > 3.5	High diversity: stable ecosystem stability, high productivity, resistant to ecological stress

Shannon-Wiener (1984) in Odum (1994)

3. Results

3.1. Species Richness

A total of species of Ocypodidae and Sesarmidae crabs were found in the study area presented in Table 4.

In the research, total 6 species of Ocypodidae and Sesarmidae were found at the mangrove ecosystem, Koto XI Tarusan District (Figure 2). The species brachyuran crabs with the highest total from all the station research was *Perisarma plicatum* (509), followed by *Perisesarma eumolpe* (466), *Sarmatium germaini* (346), *Uca bellator* (250), *Uca rosea* (250), and *Sesarma curoense* (168).

3.2. Biodiversity of Ocypodidae and Sesarmidae Crabs

Based on the number of individuals of Ocypodidae and Sesarmidae crabs from three

Table 2. The value of the evenness index

Value	Category
0 < E ≤ 0.5	Bad condition and low evenness
0.5 < E ≤ 0.75	Unstable condition and moderate evenness
0.75 < E ≤ 1.0	Stable condition and high evenness

(Krebs 2014)

Table 3. The value of the dominance index

Value	Category
If the value of 0 < D ≤ 0.5	low dominance
If the value of 0.5 < D ≤ 0.75	moderate dominance
If the value of 0.75 < D ≤ 1.0	high dominance

(Odum 1993)

Table 4. Species of brachyuran crabs families Ocypodidae and Sesarmidae in mangrove ecosystem, Koto XI Tarusan District

Value	Species	ST. I	ST. II	ST. III	Total
Ocypodidae	*Uca bellator*	69	155	26	250
	Uca rosea	101	47	102	250
Sesarmidae	*Perisesarma eumolpe*	122	160	184	466
	Sarmatium germaini	109	139	98	346
	Perisesarma plicatum	164	181	164	509
	Sesarma curoense	62	67	39	169
Total		627	749	613	

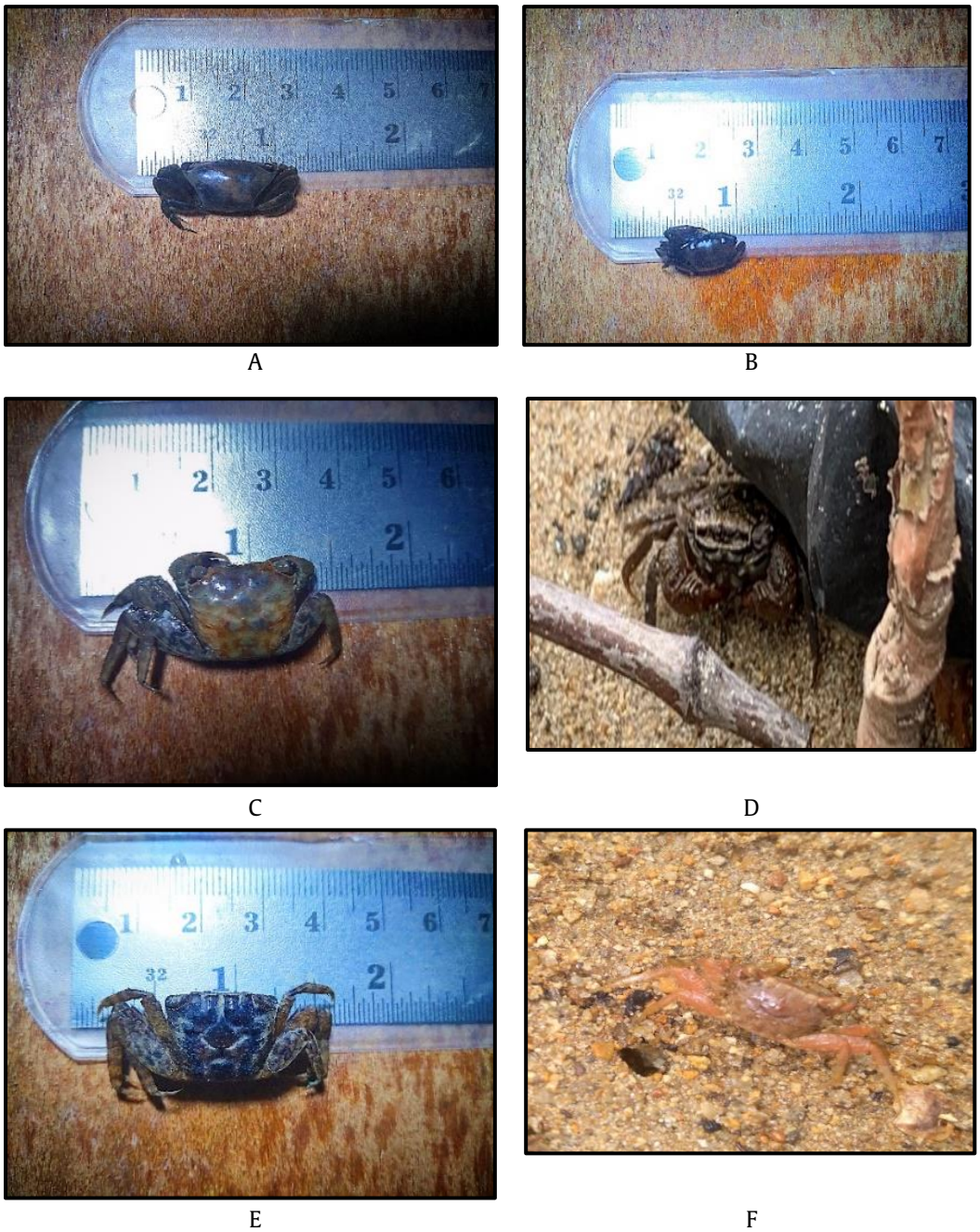

Figure 2. Species of Ocypodidae and Sesarmidae crabs at the mangrove area, Koto XI Tarusan. (A) *Uca bellator*, (B) *U. rosea*, (C) *Perisesarma eumolpe*, (D) *Sarmatium germaini*, (E) *P. plicatum*, (F) *Sesarma curoense*

locations in the mangrove ecosystem area of Koto XI Tarusan District, it shows that the diversity index value of Ocypodidae and Sesarmidae crabs is not much different (Figure 3). The highest diversity (H') was at station I (1.74), followed by station II (1.70) and station III (1.70).

3.3. Evenness of Ocypodidae and Sesarmidae Crabs

Based on the number of individuals of Ocypodidae and Sesarmidae crabs from three locations in the mangrove ecosystem area of Koto XI Tarusan District, it shows that the evenness index value (E)

of Ocypodidae and Sesarmidae crabs is not much different (Figure 4). The value of the evenness index (E) in each research station line ranged from 0.90 to 0.97.

3.4. Dominance Index (D) of Ocypodidae and Sesarmidae Crabs

Based on the number of individuals of Ocypodidae and Sesarmidae crabs from three locations in the mangrove ecosystem area of Koto XI Tarusan District, the results of the analysis of the dominance (D) of each species in each research station, it ranged from 0.18 to 0.22 (Figure 5).

4. Discussion

4.1. Species Richness

Based on Table 4 around the mangrove ecosystem in the Koto XI Tarusan District, it can be seen that the most dominant crabs are from the Sesarmidae

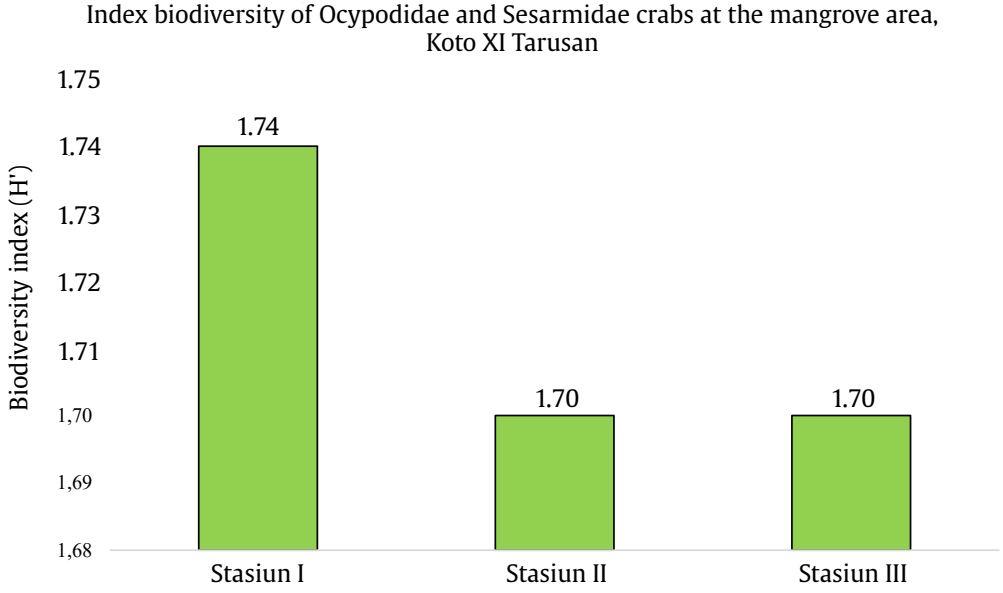

Figure 3. Biodiversity of Ocypodidae and Sesarmidae crabs at the mangrove area, Koto XI Tarusan

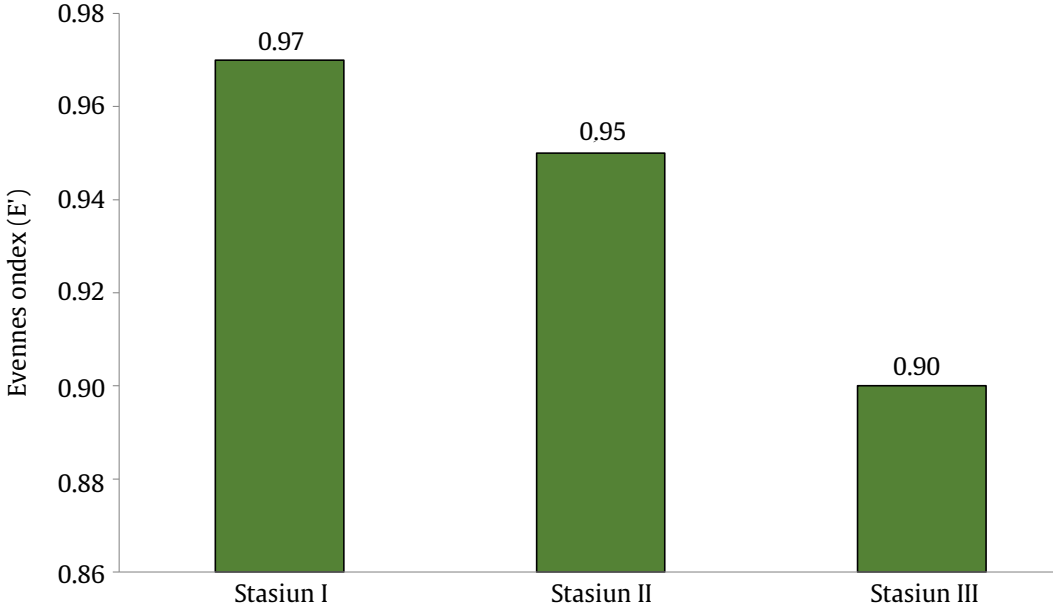

Figure 4. Evenness index (E') of Ocypodidae and Sesarmidae crabs at the mangrove area, Koto XI Tarusan

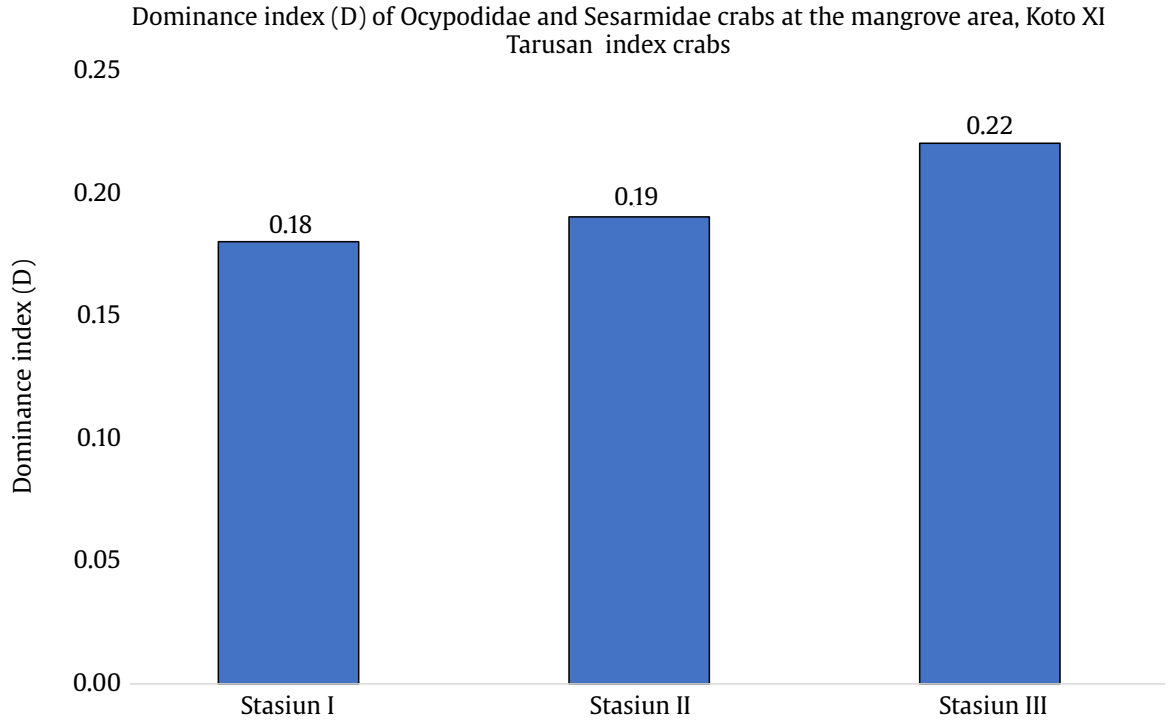

Figure 5. Dominance index (D) of Ocypodidae and Sesarmidae crabs at the mangrove area, Koto XI Tarusan

family. However, although the number of Ocypodidae familiy is relatively small, both species from these two families have an important role in the mangrove ecosystem and these four species are also the most common species of small crabs found in the mangrove ecosystem. From Kung Krabaen Bay, Chanthaburi Province, Thailand found 17 species crabs belonging 7 families, including Ocypodidae; Grapsidae; Varunidae; and Sesarmidae (Kunsook and Dumrongrojwatthana 2017). The Ocypodidae and Sesarmidae crabs that live almost exclusively on mangrove trees, which is restricted to *Rhizopora* sp. (Shih *et al.* 2016; Dahdouh-guebas and Shahdadi 2017).

In the mangrove ecosystem at area Gemuruh River, Koto XI Tarusan District four species from families Ocypodidae and Sesarmidae can be found in muddy substrates, but mostly found around the roots of mangrove plants at each station and each sampling. Crabs have an important role in the balance of the food chain and the nitrogen cycle or are also known as detritus animals, meaning that they break down waste, dead plants or animals. These small crabs feed on the litter that falls on from the mangrove vegetation. The production of fallen litter is an important part of the transfer of organic matter in the mangrove ecosystem, from vegetation to the soil (substrate) (Shahdadi and Schubart 2018) .

4.2. Biodiversity of Ocypodidae and Sesarmidae Crabs

The diversity index of Brachyuran crabs of Ocypodidae and Sesarmidae families at each research location is categorized as moderate. Diversity with moderate category indicates that sufficient productivity, moderately balanced ecosystem conditions, moderate ecological pressure. In general, moderate diversity and varying index values in crabs are caused by several factors, including ecosystem imbalances due to environmental pressures. Live and distribution of Ocypodidae and Sesarmidae crabs depends on their environmental conditions (Wulandari *et al.* 2023).

The diversity classified as moderate also indicates that only certain species can survive or other species dominate in the ecosystem (Krisnawati *et al.* 2018; Candri *et al.* 2019; Li *et al.* 2019). Moderate complexity of diversity, due to interactions in the form of finding a place to live, individual distribution, and reasonable community stability. The abundance of species in a community will affect the diversity of ecosystems

in the area. The variety of a species will decrease if the number of species and there are variations in the number of individuals of a larger species (Sawitri *et al.* 2019; Duya *et al.* 2021). Diversity (H') in the mangrove ecosystem, especially for the life of saving crabs or burrowing crabs, can be influenced by various factors such as the growth of mangrove vegetation, tides, sound pollution, and vibrations caused by human and natural activities (Sinamo *et al.* 2020; Hasan and Padjadjaran 2021).

4.3. Evenness of Ocypodidae and Sesarmidae Crabs

The evenness index (E) is used to see how the composition is and how comfortable it is to distribute the number of individuals of each species in a community. In the evenness index (E) the more evenness the distribution of individuals between species, the balance in an ecosystem will increase. The evenness value (E) in the mangrove vegetation area, Koto XI Tarusan district and other areas have varied values and are almost not much different in their evenness values for each observation path. The evenness that has been analyzed shows that the diversity index value of the diversity of deposit crabs originating from the families Ocypodidae and Sesarmidae which are in the mangrove vegetation area has a biodiversity index value ranging from 0.90 to 0.97 belonging to the high evenness category with stable conditions because at each station the evenness index value is almost close to 1. $5 < E \leq 0.75$ and high evenness ($0.75 < E \leq 1.0$).

The high evenness value of the crab deposits from the Ocypodidae and Sesarmidae families in the mangrove vegetation area of the rumbling river indicates that the distribution of individuals in each species of crab deposit is almost similar or no species dominates at all and the habitat conditions are stable. The even distribution of biota at a high evenness index is based on several factors such as abundant food sources in ecosystems resulting in interactions between species and other animals that eat the same food sources (Rahayu *et al.* 2018). In the mangrove forest located in Pasir Village, Mempawah Hilir District, Mempawah Regency, the crab evenness value also has a high evenness index value, which ranges from 0.68-0.90. In each Mangrove Park route in this location the spread of biota is influenced by environmental conditions (Sari *et al.* 2018).

4.4. Dominance Index of Ocypodidae and Sesarmidae Crabs

The dominance value of Ocypodidae and Sesarmidae crabs in this mangrove vegetation can be categorized as low at each research station. It's meaning that there are no deposit crab species from both the Ocypodidae and Sesarmidae families which dominate and the pattern mastery of each species in a community is relatively spread in each species. In addition, the absence of a dominant crab species in each research line indicates that the distribution of the number of Ocypodidae and Sesarmidae crabs is close to the same number and indicates that the waters in the mangrove vegetation are quite suitable for the life of deposit crabs from the Ocypodidae and Sesarmidae families. Low dominance is affected due to water salinity, soil, and light intensity (Saputra and Anwari 2021). Conversely, dominance (D) can be said to be high if there are certain species that dominate a community and only focus on one species that is very dominant (Mohanty *et al.* 2019; Bandekar 2021).

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