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Diversity of Brachyura in the Estuary of Tambak Cemandi River Kalanganyar Village Sidoarjo East Java

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Abstract
Brachyura diversity in Indonesia is the highest diversity found in the Western Pacific and Central Pacific regions. Crab diversity is also influenced by the type of crab habitat for example in estuary. One of the estuary areas in East Java is in Cemandi Pond, Kalanganyar Village, Sidoarjo, which still has limited data on crab diversity. The purpose of this study was to describe the diversity of crabs and analyze the crab diversity index. The sampling technique used purposive sampling method. The number of points in this study using three stations. At each station can install transects along 500 m consisting of three imaginary plots containing traps in which there is bait in the form of decomposed tilapia fish. Identification was conducted based on morphological characteristics. The results of this study obtained 687 crabs consisting of seven species from five families namely Ocypodidae, Grapsidae, Sesarmidae, Portunidae, and Epiathidae. Based on the Shannon-Wiener diversity index formula (H') shows that the crab diversity index in this area is classified as moderate with an H' value of 1.77. Currently, it is necessary to conduct research related to this because there are many community activities that threaten the existence of crabs, such as the overhaul and development of the area. The conclusion of the research on crab diversity in the estuary area of Tambak Cemandi River, Kalanganyar Village, Sidoarjo has been carried out by obtaining 7 crab species with a moderate diversity index.

Keywords: biodiversity; estuarine ecosystem; shannon-wiener index; substrate; taxonomic identification
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INTRODUCTION

Diversity encompasses all living organisms, including all types of fauna, such as marine organisms from the crustacean class, specifically the ten-legged crustaceans known as crabs. Crabs belong to the phylum Arthropoda, class Malacostraca, order Decapoda, and suborder Brachyura. Brachyura, commonly referred to as true crabs, are highly diverse at the infraorder level. At the infraorder level, crabs are divided into several main families, including Portunidae, Grapsidae, Ocypodidae, Xanthidae, Gecarcinidae, Majidae, and Pachygrapsidae. Crab diversity in Indonesia is the highest found in the Western and Central Pacific regions (Wardianto et al., 2015). Currently, it is estimated that there are around 700 to 800 species of Brachyura crabs that have been identified in Indonesian waters. Research by Murniati et al., (2022) found around 50 species of crabs from Java that have been stored at the Museum Zoologicum Bogoriense (MZB) to date. Despite extensive research, accurate information on the diversity of crabs (Brachyura) in Indonesia remains unknown. This number is likely to increase further with the discovery of new species through ongoing taxonomic research and exploration.

The diversity of crabs, especially in the suborder Brachyura, is also closely related to the morphological variation of these crabs. The diverse morphology of crabs is used to adapt to various habitats, thereby promoting speciation and diversity (Lepa et al., 2022). One example of morphology found in crabs of the suborder Brachyura is found in the family Portunidae, which has pairs of walking legs and a fifth pair of legs that are flat and broad at the last segment and mostly live in the sea, mangrove waters, and brackish waters (Adnan et al., 2022). Morphological diversity is also closely related to the type of crab habitat. Diverse habitats can support diversity in crabs. Crabs in the suborder Brachyura can be found in sandy habitats, river mouths, freshwater, and coastal areas.

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Research on crab diversity (*Brachyura*) in the Opak River estuary, Special Region of Yogyakarta, has identified five species belonging to three families, namely Ocypodidae, Portunidae, and Sesarmidae (Eprilurahman, 2015). Another study also indicated the presence of the families Portunidae and Grapsidae in the river estuary area. This study explained that the presence of the Grapsidae family in the river estuary area could serve as a bioindicator of environmental conditions (Ridwan, 2016). A similar study was conducted in the river estuary waters of Labuhan Batu District, where crabs of the Portunidae family, specifically the species Scylla serrata, were found (Pratiwi and Dimenta, 2021). Research by Ambarwati et al. (2024) in the waters of Lamongan, East Java, showed that six crab species from four families were found, namely Portunidae, Eriphidae, Menippidae, and Vanuridae. From the four studies, it was found that the families Ocypodidae, Grapsidae, Sesarmidae, and Portunidae are the crab families most commonly found in river estuaries. Based on observations in the Tambak Cemandi river estuary, the area is covered with mangroves and there is a significant amount of sand and rocks along the riverbank, as described in the research findings of Yudhistira et al. (2022).

The current, research on crab diversity in the Tambak Cemandi Estuary Area in Kalanganyar Village, Sidoarjo is still limited. The lack of data on crab diversity in the Tambak Cemandi River Estuary Area in Kalanganyar Village, Sidoarjo, may hinder conservation efforts and understanding of the role of crabs in the river estuary ecosystem. Fisheries activities are the dominant activity and constitute the largest sub-sector of agriculture, accounting for over 40%. In the fisheries sector in Sidoarjo Regency, shrimp and milkfish are the main commodities, dominated by species such as keting, kakap, and belanak (Wulandari et al., 2018). This indicates that Sidoarjo has significant potential in coastal, estuarine, and beach areas. These areas serve as habitats supporting crab diversity.

Currently, research on this issue is necessary because many community activities threaten the existence of crabs in the area, such as redevelopment and construction. These community activities may threaten the existence of crabs, which have the potential to serve as bioindicators of environmental quality in the area. This research aims to describe the diversity of crabs, analyze the index of the relationship between crab substrates and the aquatic ecosystem of the River Estuary in Kalanganyar Village, Sedati, Sidoarjo, East Java. It is hoped that the results of this research can contribute to the management of coastal areas and ecosystems, SDG 14, namely Life Under Water (Marine Ecosystems).

MATERIALS AND METHODS

This research was conducted from August 2024 to January 2025. Data collection in the Kalanganyar Village River Estuary Area Sidoarjo East Java was carried out adjusting the tides of West Indonesia Time (WIB) using the "My Tides Times" application, The results of observation data were identified at the Biology Taxonomy Laboratory, Surabaya State University.

The research was conducted in the area of the Estuary of Kalanganyar Village, Sidarjo. The research site was divided into three stations. Station I which has an area close to the settlement, station II area near the pond, and station III in the area near the mangrove. Making a map of the research location using ArcGis application. The research location map can be seen in **Figure 1.**

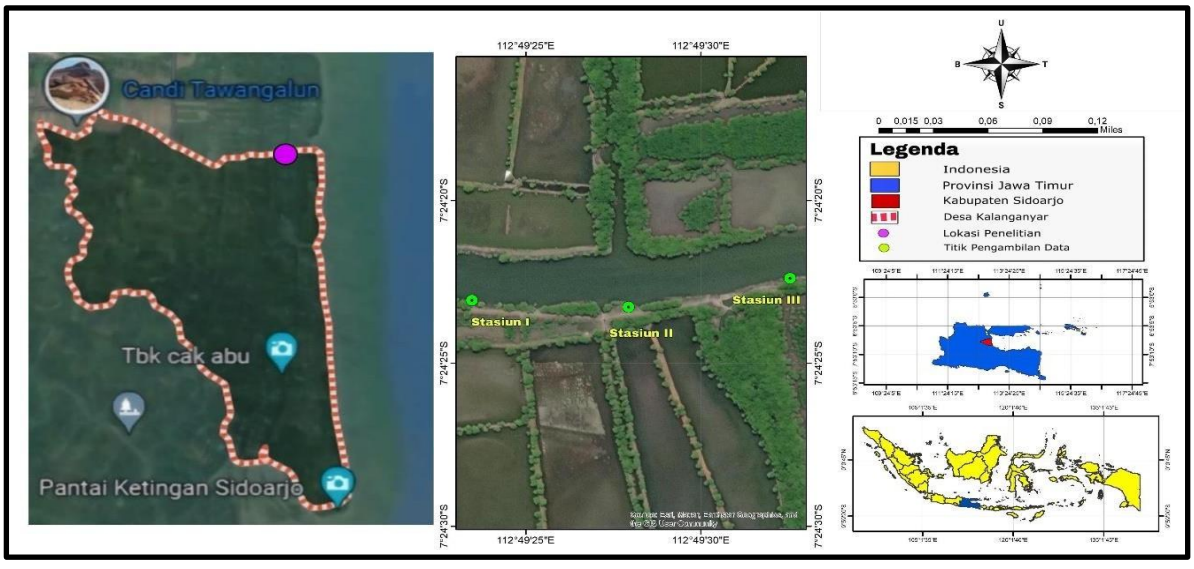


Figure 1. Research site map.

The tools and materials used in this study were traps, buckets, stationery, cool boxes, ice cubes, clear bottles, label paper, small shovels, and crabs found in each plot that has been made and identification keys based on Martin (2009), Murniati (2010), Lepa et al. (2022), and Yudhistira et al. (2022) to identify the samples that have been obtained.

The sampling technique in this study used the Proposive sampling method (Wahyudi et al., 2014). The type and morphological identification of crabs in the River Estuary Area of Tambak Cemandi Village, Kalanganyar Sidoarjo, East Java is a method used in calculating the crab population by sampling and determining certain points that represent each in an area, the method is adapted from the method used previously in Michael (2020). The number of points in this study using 3 stations. At each station, a 500 m long transect can be installed consisting of 3 imaginary plots with traps containing bait. Crab samples that have been obtained are then fixed using ice cubes, and preserved using 75% alcohol (Sawitri et al., 2019).

Crab identification was carried out by cleaning the carapace first with running water and then with a fine brush to remove mud or sand attached to the carapace and crab claws. Crabs that have been frozen in a cool box are laid out on millimeter paper, then documented (**Figure 2**.) and identified the type of crab based on morphological forms including carapace (frontal, size, shape and abdominal). Color and pattern cannot be used as an identification key because the pigment color on the crab's body is influenced by habitat or substrate and the type of algae eaten (Tuaputty, 2023). Crabs were identified at the Taxonomy Laboratory of the Department of Biology, Surabaya State University. Observed crabs were identified and described using identification keys from Martin (2009), Murniati (2010), Lepa et al. (2022), and Yudhistira et al. (2022).

RESULTS

Observations of the diversity of Brachyura in the estuary area of Tambak Cemandi River, Kalanganyar Sidoarjo Village were carried out using the sampling method with the division of three stations. At each station, there are three plots using traps, bubu, and fishing gear, with a total of 9 plots. The results of the identification of crabs in the Estuary of Cemandi Pond River, Kalanganyar Sidoarjo found a total of 687 individuals, namely 7 species from 5 families shown in **Table 1**.

Table 1. Recapitulation of the number and diversity index of crabs found in the estuary of Tambak Cemandi River, Kalanganyar Village, Sidoarjo.

No.	Famili	Name of Species	Station			Total
			Station 1	Station 2	Station 3	
1	Ocypodidae	*Macrophthalmus setosus*	0	84	57	141
2		*Tubuca coarctata*	0	31	98	129
3		*Tubuca dussumieri*	0	43	71	114
4	Grapsidae	*Metopograpsus frontalis*	25	96	56	177
5	Sesarmidae	*Episesarma mederi*	17	26	19	62
6	Portunidae	*Scylla serrata*	0	35	13	48
7	Epialtidae	*Doclea aduncus*	0	7	9	16
	Total		42	322	323	687
	H′		**0.67**	**1.73**	**1.7**	**1.77**

The most species of crabs found in this study were *Macrophthalmus setosus* of the Ocypodidae family and *Metopograpsus frontalis* of the Grapsidae family. While the least species of crabs found in this study *was Doclea aduncus* of the Epialtidae family. In this study, the diversity of crabs was found at station two and station three which had conditions near ponds and mangroves with sand, mud and rock substrates. While the least found is at station one which has conditions near settlements with sand and rock substrates. The following is a description of crab species found in the estuary area of Cemandi Pond River, Kalanganyar Sidoarjo Village and can be seen in (**Figure 3**).

Macrophthalmus is a species with a long, slender frontal region and a 4 inch wide rectangular carapace. *M. setosus* is predominantly *sky blue* and *orange* in color (**Figure 3. A1**). The carapace has a rough surface with small bumps and waves, setae along the carapace margin, long, upward-pointing eye stalks, a pair of claws of equal size, serrated fingers, a pointed dactylus, and a thick propodus. There are four pairs of long, slender legs with setae. The ventral region has an abdomen with male genitalia (**Figure 3. A2**). This species is found on muddy, sandy substrates.

Other variations are found in *T. coarctata*, which has a smooth carapace, narrow frontal, carapace width of 2.3 cm, long eye stalks that protrude upward, and a curved carapace that is elongated and narrows at the bottom. In general, the color of *T. coarctata* is predominantly dark with a slight

yellow-blue pattern on part of the carapace. This color is clearly visible on the carapace and manus of the large claws of T. *coarctata* (**Figure 3. B1**). The claws of T. *coarctata* are small and resemble those of males. The small claws of females are much smaller than the large claws of males. The small claws are smooth and curved. The ventral region has an abdomen with female genitalia (**Figure 3. B2**). This species is found on muddy mangrove substrates.

Tubuca dussumieri is a species with a smooth carapace, narrow frontal, carapace width of 2.5 cm, long eye stalks, and a curved carapace that is elongated and narrow at the bottom. In general, the color of *T. dussumieri* is predominantly dark with a slight medium blue hue on the meru. The large claws of *T. dussumieri are* white orange in color. These colors are clearly visible on the carapace and manus of the large claws of *T. dussumieri* (**Figure 3. C1**). The large claws have granules, serrated pollex, sharp tips, curved dactylus, and a cavity when closed. The small claws are smooth and curved. The ventral side has an abdomen with female genitalia (**Figure 3. C2**). This species is found on muddy substrates.

Metopograpsus is a species with a long, blunt frontal. There are small spines at the tip, the carapace is 3 cm wide, flat and broad. In general, *Metopograpsus frontalis* has a body color dominated by medium purple and has a dorsal pattern (**Figure 3. D1**). The carapace has a smooth surface with lines or spotted patterns, short, thick eye stalks that point sideways and are slightly raised, a pair of claws of equal size with a rough surface, and the carpus has rough bumps. There are four pairs of long, slender legs with setae. The ventral region has an abdomen with male genitalia (**Figure 3. D2**). This species was found on river mouth rock substrates.

Episesarma mederi is a species with a short, blunt frontal, and a carapace width of 3.3 cm. In general, the dorsal body color is dominated by dark and medium yellow on the vertebral carapace. Medium purple also dominates the dactylus (**Figure 3. E1**). The color of the dactylus of *Episesarma mederi* is dark and medium purple. The carapace is thick and square-shaped, with fine spines on the lateral sides. The carapace surface is rough, with granules on the posterior part, short, thick eye stalks directed sideways. A pair of claws of equal size, with the dactylus covered by microscopic spots, and the dactylus tip shaped like a hook. The ventral side has an abdomen with male genitalia (**Figure 3. E2**). This species is found on muddy rocky substrates.

Scylla serrata is a species with a prominent frontal crest and a carapace width of 5 cm. In general, *S. serrata* has a dorsal body color dominated by dark green and brown, while the ventral bone is white (**Figure 3. F1**). The carapace is wide and rounded with serrations on the margins. The carapace surface has a slightly rough texture, with small round eyes, a pair of claws of equal size and serrated tips. The upper propodus has a pair of sharp serrations and is slightly orange in color. There are serrations on the merus. There are three pairs of long walking legs with pointed tips. A pair of swimming legs are fan-shaped and have setae. The ventral side has an abdomen with male genitalia (**Figure 3. F2**). This species is found on sandy substrates.

Doclea aduncus has a long, downward-curving frontal, sharp hook-like tips, and a 4 cm wide, thick, oval carapace. The dorsal body is predominantly *medium purple* and *medium red* (**Figure 3. G1**). The dorsal surface is textured and has rough, spine-like bumps. There are three pairs of spine-like teeth on the lateral frontal. The eye stalks are slightly protruding. The two claws are of equal size, with a pointed dactylus, an oval-shaped propodus, and a long, slender merus. There are four pairs of long, slender legs without setae. The ventral region features an abdomen with male genitalia (**Figure 3. G2**). This species is found on sandy, muddy substrates.

Based on the identification of the diversity of crabs found in the Estuary of Cemandi Pond River, Kalanganyar Sidoarjo, the diversity index was 1.77. This shows that the diversity of crabs in the Estuary of Cemandi Pond River, Kalanganyar Sidoarjo is classified as moderate with complete data in **Table 1**. The following is a brief description of the characteristics of the substrate in each habitat in the area. Complete data can be seen in **Table 2.**

DISCUSSION

Crab diversity was analyzed based on **Table 1** The diversity of crabs in the Tambak Cemandi River Estuary Area in Kalanganyar Village, Sidoarjo, was found to consist of 687 individuals belonging to seven species from five families distributed across each substrate. Several crab species commonly found in the Tambak Cemandi River Estuary Area in Kalanganyar Village belong to the families Ocypodidae and Grapsidae.

This aligns with the research conducted by Eprilurahman (2015) and Pratiwi and Dimenta (2021), which indicated that in river estuary areas with muddy and sandy substrates, species from these two families are generally abundant.

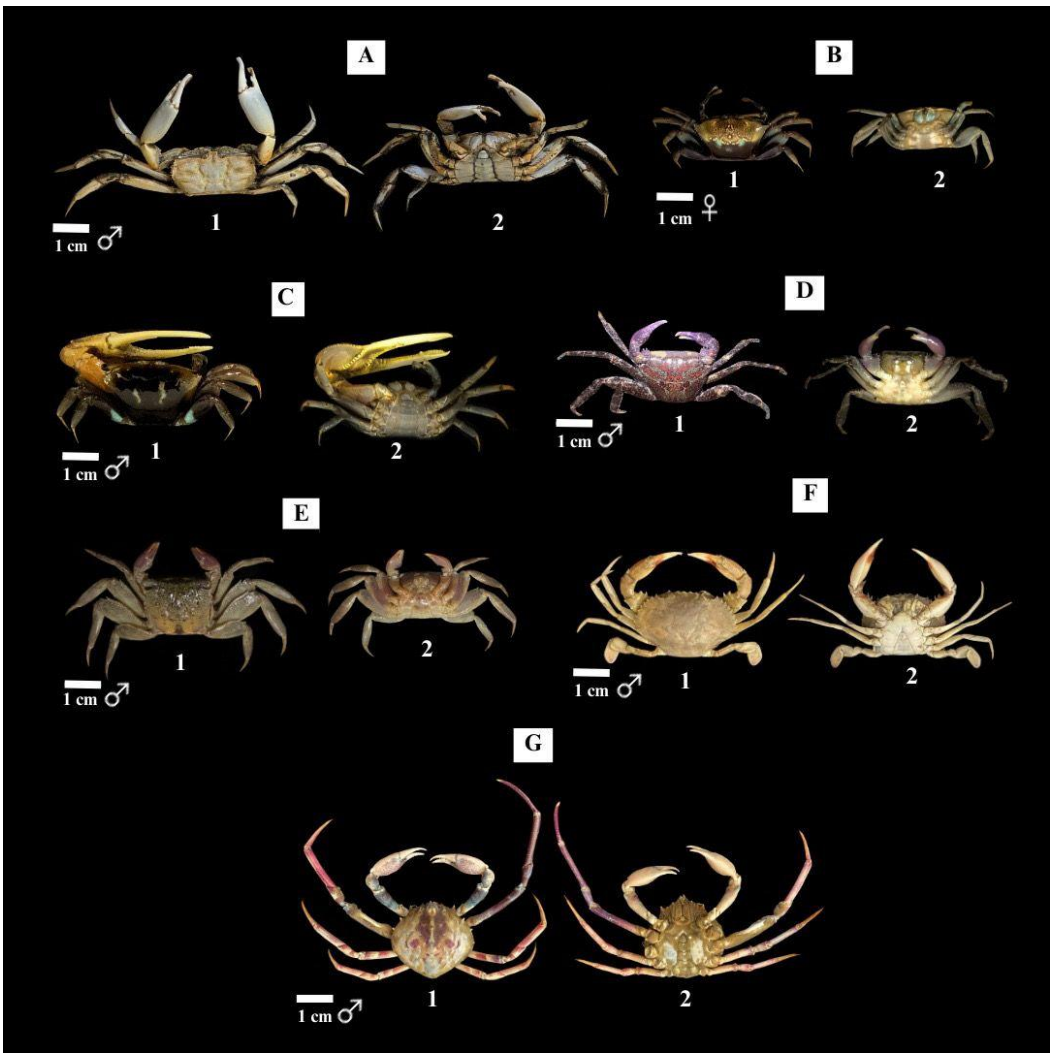


Figure 3. A1: *Macrophthalmus setosus* Dorsal, A2: *Macrophthalmus setosus* Ventral, B1: *Tubuca coarctata* Dorsal, B2: *Tubuca coarctata* Ventral, C1: *Tubuca dussumieri* Dorsal, C2: *Tubuca dussumieri* Ventral, D1: *Metopograpsus frontalis* Dorsal, D2: *Metopograpsus frontalis* Ventral, E1: *Episesarma mederi* Dorsal, E2: *Episesarma mederi* Ventral, F1: *Scylla serrata* Dorsal, F2: *Scylla serrata* Ventral, G1: *Doclea aduncus* Dorsal, G2: *Doclea aduncus* Ventral

Table 2. Substrate Characteristics in the Estuary of Tambak Cemandi River, Kalanganyar Village, Sidoarjo

No.	Name of Species	Habitat Type	Characteristics
1	*Macrophthalmus setosus*	Near ponds and mangroves	a. Substrate with high organic content from leaf debris and litter. b. The presence of estuarine flow contributes to the substrate characteristics. c. The substrate has a combination of fine and coarse particles d. The texture of the substrate helps prevent anaerobic conditions e. Supports the soil aeration process by digging holes for cover (Avianto, 2013).
2	*Tubuca coarctata*	Near ponds and mangroves	
3	*Tubuca dussumieri*	Near ponds and mangroves	
4	*Metopograpsus frontalis*	Near residential areas, fish ponds, and mangroves	a. The substrate consists of a mixture of sand and rocks of various sizes fed by water from the estuary (Taqwa, 2014). b. Larger rocks provide a place for species to explore and feed. c. Gaps between rocks of different sizes provide shelter from predators.
5	*Episesarma mederi*	Near residential areas, fish ponds, and mangroves	
6	*Scylla serrata*	Near ponds and mangroves	a. The substrate consists of a mixture of fine sand and silt at the bottom of the estuary. b. Many crabs of the family Portunidae were found (Putriningtias, 2019). c. Substrate as a place to find food and shelter.

No.	Name of Species	Habitat Type	Characteristics
7	*Doclea aduncus*	Near ponds and mangroves	d. his substrate has limited aeration. so the diversity of crabs found is limited. a. The substrate consists of fine, small particles to large rocks. b. The substrate is in the intertidal zone of the estuarine area (Snedaker *et al*., 1985). c. The crabs found are limited because the area is difficult to traverse by human activities.

The most abundant species found were Macrophthalmus setosus, Tubuca coarctata, Tubuca dussumieri, and Metopograpsus frontalis. Some of these species were most abundant because the Tambak Cemandi Estuary in Kalanganyar Village, Sidoarjo, has a fairly varied and complex substrate that supports the crabs' needs. Research by Ridwan (2016) states that crabs belonging to the families Ocypodidae and Grapsidae are most commonly found in river estuaries with varied and complex substrates. The least commonly found species is Doclea aduncus. This species from the family Epialtidae is least commonly found because it is most commonly found in the intertidal zone (Sulistiyawati and Wantara, 2024). The crab species not yet found in this area is *Varuna litterata* from the Grapsidae family. Based on previous research, according to Martin (2009), this species is commonly found in areas near the sea, such as estuaries. However, this species has not yet been found in this study.

In this study, the number of crab species found in the Tambak Cemandi River Estuary showed good diversity. When compared to the study conducted by Eprilurahman (2015) in the Opak River, Special Region of Yogyakarta, only 5 crab species were recorded with a smaller total number of individuals, which was indicated to be caused by environmental factors such as pollution and habitat changes. The diversity of crabs in the area was lower, indicating that the river estuary area in Sidoarjo has a better ecosystem.

Research by Redjeki, (2017) in the Segara Anakan Mangrove Forest in Cilacap also showed that there is a fairly good diversity of crab species. In this study, 12 species from three families were identified. The diversity of crabs was also influenced by human activities and settlements. This finding is not significantly different from the results in the Tambak Cemandi River Estuary area, where crab species diversity was also influenced by environmental factors caused by human activities, such as fishing, pollution, and land-use changes.

The diversity of crab found was given a diversity index of 1.77 (**Table 1**). This index indicates a moderate level of diversity according to the Shannon-Wiener formula (H'), which means that the crab community in the area is relatively stable. Amin et al., (2021) states that in the Shannon-Wiener diversity index (H'), if H' > 3, species diversity is considered high, and if 1 < H' < 3, diversity is considered moderate. The diversity index can be used as a parameter for community stability (Pambudi, 2019).

The crab diversity index value in the Tambak Cemandi River Estuary Area in Kalanganyar Village, Sidoarjo, is categorized as moderate because the area has sufficient productivity and a fairly balanced ecosystem, such as the presence of mangrove vegetation around the river estuary, which plays an important role in providing habitat and food sources for crabs. According to Amin et al., (2021), biodiversity in an ecosystem can decline due to ecological pressures resulting from human activities in the area.

The diversity index was also analyzed at each observation station. Station one showed a diversity index of 0.67, which was lower than the other stations (**Table 1**). This was due to the less varied substrate conditions and human disturbance around the station. Meanwhile, station two had a diversity index of 1.73, indicating higher diversity. The presence of more varied substrates at this station contributed to an increase in the number of crab species found (Khosyi and Andriani, 2023). Station three has a diversity index of 1.70, indicating fairly good conditions, although not as high as station two. This shows that although there is variation in diversity at each station, overall, this area still has good potential to support crab communities (Pratiwi, 2013).

The research conducted by Pambudi (2019) shows that the diversity index value is low at 0.993 (**Table 1**). This is due to unbalanced habitat conditions and environmental parameters that are unsuitable for crabs. According to Wally et al. (2020), if a community is composed of diverse species, it can be said to have high species diversity. Conversely, if a community is composed of few species, it is said to have low species diversity. Crab diversity is closely related to the types of substrate present, as substrate influences habitat and food sources for crabs (Avianto, 2013).

The substrate in the habitat where the crabs were found in this study area consists of sandy, muddy, and rocky substrates. **Table 2** indicates that muddy mangrove substrates are rich in organic matter, which supports crab activities such as foraging and movement (Khosyi and Andriani, 2023).

Therefore, many crabs from the family Ocypodidae were found on these substrates. Not only from the family Ocypodidae, but also the families Grapsidae and Sesarmidae were found on the sandy-rocky substrate, which is a mixture of sand and rocks of various sizes. According to Muniarti *et al* (2010), the presence of crab species is highly dependent on environmental conditions, especially for burrowing crab species.

Table 2 also provides information that the muddy sand substrate consists of a mixture of fine sand and mud. Crabs from the Portunidae family were found in this substrate type. This family is commonly found on the seabed, so the crabs found have swimming legs (Evans and Dinesen, 2020). The family Epalitidae was found on sand, mud, and rock substrates, which are substrate types with a mixture of fine, small particles to large rocks. According to Sulistiyawati and Wantara (2024), this family is found in the intertidal zone, so the crabs found in this area with such substrates are limited, as the area is difficult to access due to human activity.

The water temperature in the Tambak Cemandi River Estuary Area in Kalanganyar Village, Sidoarjo, averages between 25.3–28.2°C, which is considered normal. This is in accordance with (KMNLH, 2009), which states that the optimal water temperature for crab survival ranges between 25–35°C. Salinity levels at each station in the Tambak Cemandi River Estuary Area in Kalanganyar Village, Sidoarjo, range from 1.9 to 4 ppt. These values are still within the normal range for crab survival. Low to moderate salinity indicates an estuarine habitat or an area with interaction between freshwater and seawater (Sawitri et al., 2019).

The acidity level (pH) at each station varies, with an average of 6.2 at station one, 6 at station two, and 6.5 at station three. This does not align with the regulation (KMNLH, 2009), which states that the optimal pH range for crab survival is between 7.0 and 9.0. Human activities such as improper waste disposal in the Tambak Cemandi River Estuary Area of Kalanganyar Village, Sidoarjo, could be one of the factors contributing to the decline in pH in the area. However, the pH of the muddy substrate at stations two and three falls within the optimal pH range for crab survival, which is between 6.0 and 6.5. This aligns with Lutiya (2024) research, which indicates that the pH of soil suitable for crab survival ranges between 6.5 and 8.5.

This study shows that the Tambak Cemandi River Estuary Area in Kalanganyar Village, Sidoarjo, has a substrate type suitable for crab life (Yudhistira et al., 2022), so this area has a moderate biodiversity index value. The findings of this study can serve as a basis for information regarding biodiversity, diversity indices, and crab substrates in the Tambak Cemandi River Estuary Area of Kalanganyar Village, Sidoarjo. This study can serve as a source of information for researchers conducting further research, and the results are expected to contribute to sustainable coastal management and support the achievement of Sustainable Development Goal (SDG) 14: Life Below Water (Marine Ecosystems). This aligns with Almaududi (2024), who aims to preserve species diversity and maintain ecosystem balance.

CONCLUSION

The diversity of Brachyura found in the Muara Sungai Tambak Cemandi area, Kalanganyar Village, Sidoarjo, consists of seven species, namely *Macrophthalmus setosus, Tubuca coarctata, Tubuca dussumieri, Metopograpsus frontalis, Episesarma mederi, Scylla serrata*, and *Doclea aduncus*. These species belong to five families with a total of 687 individuals. The area has a moderate crab diversity index value, with an H' value of 1.77. In addition, the diversity of crabs in this area is also influenced by the type of substrate in the area which serves as a source of life for the crabs. So the type of substrate has an important role in determining the diversity of crabs in the area.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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