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Diversity of Decapods in Penor River Estuaries in Kuantan, Pahang

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Abstract
Decapods play an important role as in maintaining ecosystem to be in balance as well as one of protein sources to human. At juvenile stage, they inhabit estuaries to get nutrition and protection from predators. Aquatic diversity supports in playing roles to maintain ecological structure and food chain in the system. However, the study of diversity of decapods is still lacking in Pahang waters. Therefore, this study was carried out in order to study and identify the decapods found in one of the most active estuaries in Pahang. The sampling and samples identification was conducted to identify diversity and abundance of decapods in Penor River-estuary. Specimens were collected from three different sites from using traditional fish trap locally called 'temerang'. The samples were collected and identified into genus level based on their external morphological characteristics. The data recorded were analysed using Shannon-Wiener and Simpson's Diversity Indices. The highest diversity of decapods found at Penor River-estuary was Site 3 and Site 2, while the lowest diversity of decapods recorded at this river is Site 1. The most abundance decapods in Penor River-estuary were Brachycarpus, providing insight that this species availability in all three sites.
Keywords: *decapod diversity, river, species diversity.*

Abstrak
Dekapod memainkan peranan penting dalam penjagaan keseimbangan ekosistem dan merupakan salah satu sumber protein kepada manusia. Pada peringkat juvenil, dekapod mendiami muara untuk mendapatkan nutrisi dan perlindungan dari pemangsa. Kepelbagaian akuatik menyokong yang berperanan bagi mengekalkan struktur ekologi dan sistem rantaian makanan. Walau bagaimanapun, kajian mengenai kepelbagaian dekapod di perairan Pahang masih kurang diberikan perhatian. Oleh itu, kajian ini dilakukan untuk mengkaji dan mengenal pasti dekapod yang terdapat di salah satu muara paling aktif di Pahang. Pensampelan dan pengidentifikasian sampel dilakukan untuk mengenal pasti kepelbagaian dan kepadatan dekapod di muara Sungai Penor. Spesimen dikumpulkan dari tiga lokaliti yang berbeza dengan menggunakan perangkap ikan tradisional yang dikenali sebagai 'temerang'. Sampel dikumpulkan dan dikenal pasti hingga ke peringkat genus berdasarkan ciri morfologi luarannya. Data yang direkodkan dianalisis menggunakan Indeks Kepelbagaian Shannon-Wiener dan Simpson. Kepelbagaian tertinggi dekapod yang terdapat di muara Sungai Penor adalah Lokaliti 3 dan Lokaliti 2, sementara kepelbagaian terendah dekapod yang direkodkan di sungai ini ialah Lokaliti 1. Dekapod paling padat di muara Sungai Penor adalah *Brachycarpus*, yang memberikan gambaran bahawa ketersediaan spesies ini di ketiga-tiga lokaliti tersebut.
Kata Kunci: *Kepelbagaian dekapod, sungai, kepelbagaian spesies*

Introduction
Decapods are various species of crustaceans that belong to order decapods that have ten legs that joined to a segment of thorax. Decapods comprise of shrimps, crabs, lobsters and prawns that inhabit either marine or freshwater (Ambak, 2000). Prawns, lobsters and crabs command high prices in both market and restaurants to be served as premium delicacies. Data from Department of Fisheries (2016, 2018) shown increase total landing of crabs and shrimps from Malaysia. The percentage increased from 7% in 2016 to 9 % of total fisheries landing in 2018. In term of metric tonnes, the increment is from 114 thousand metric tonnes in 2016 to 131 thousand metric tonnes in 2018. This

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signifies its importance in providing source of protein to the nation and contributes to aquaculture sector. In addition, these invertebrates serve as food to improve health benefits. They are used traditionally as supplemental food in treating anaemia by improving blood indices (Saberi et al., 2016), improve antioxidant activities (Yusof et al., 2017), losing weight and prevention against cardiovascular disease (Wang et al., 2019). Brachyuran crabs and other decapods are major inhabitant in mangrove habitat in estuaries, playing multiple roles this ecosystem in different level of food chain (Peer et al., 2019). At lower level, their abundance affects the nitrogen fixation and soil aeration (Qashqari et al., 2020). Their burrowing activities act as bioturbators aid in physiochemical characteristics in soil and biogeochemical process within the mangrove areas (Agusto et al., 2020). At higher trophic level, they function as consumer and predator in that particular ecosystem (Abdullah & Lee, 2016; Glazner et al., 2020).

Habitat degradation due to anthropogenic activities has adverse effects on biodiversity (Azrina et al., 2006), even miniscule modification in mangrove ecosystem can alter the diversity of macrofauna and may further lead to local extirpation. Particularly on decapods, their high selectivity behaviour of in finding microhabitat caused them to be more sensitive towards small-scale changes in their ecosystem, (Natin & Lee, 2018). Hence, the study of species diversity is important as it will provide insight about available species, distribution, abundance, and their function in the ecosystem (Farooq & Siddiqui, 2020). This information's are essential in developing future plan for conservation program or managing fisheries activities areas. Studies of diversity in aquatic organism in Malaysia has been done for various species (Al-Shami et al., 2011; Ashton et al., 2003; Suzawa et al., 1993; Zieritz et al., 2016). Particularly in Pahang, studies on decapod diversity is still insufficient and required spatial documentations for future references (Naim et al., 2020). This study focuses on decapod diversity in Penor River, which anthropogenic activities are still trifling.

Materials & Methods

Study Area

This study was carried out at Penor River-estuary, Pahang which located at latitude 3.6333° and longitude 103.3667° as in Figure 1. Three sampling sites were selected based on their habitat and environment.

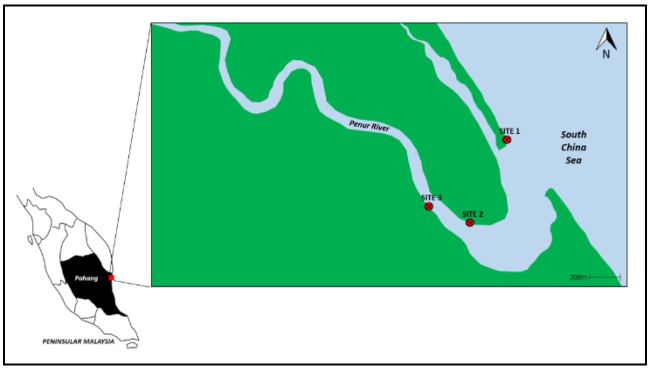

Figure 1: Sampling Sites at Penor River-estuary (Source: modified from Google Maps)

Site 1: located at outer river mouth with sandy bottom and intrusion of salt water happened almost all the time. Water depth ranged from 0.2 meter to 1 meter.
Site 2: located at middle river mouth with mangroves at riverbank. Intrusion of salt water happened only during high tide. Water depth ranged from 1.5 meter to 3 meter.
Site 3: located at inner river mouth with mangrove at riverbank. Intrusion of salt water happened during high tide. Water depth ranged from 2 meter to 4 meter.

Sampling Method

The sampling was done from May until August 2017. A traditional fish trap called "temerang" was used throughout the sampling sessions. A set of 10 units of "temerang" were deployed at each sampling site. The samples were collected on the monthly basis. The targeted samples were mainly Decapoda (crab sand shrimp). The collected samples were preserved directly in 90% ethanol at the field. Further sample analyses were carried out at laboratory.

Samples Identification

The decapod samples collected were sorted based on their morphological characteristics. The decapods were identified until genus level using Leica compound microscope. Several identification guidelines were used to identify the decapods. Mostly, the decapod samples were identified based on their external morphological characteristics.

Data Analyses

The diversity of decapods was analysed using Shannon-Wiener diversity index and Simpson's diversity index.

Results

Abundance of Decapods in Penor River-Estuary

Figure 2 to 4 showed the abundance of decapods based on sites. At Site 1, a total of 10 genera were found and recorded. The recorded genera are Thalamita, Callinectes, Penaeus, Brachycarpus, Macrobrachium, Myomenippe, Sanquerus, Charybdis, Palaemon, and Chiromantes. The genus Brachycarpus showed the highest number of decapods found throughout this study with 524 individuals, while Callinectes, Sanquerus, and Charybdis recorded in lowest number with one individual each genera. A total of nine genera were found at Site 2. The genera recorded are Thalamita, Myomenippe, Alpheus, Macrobrachium, Penaeus, Brachycarpus, Charybdis, Callinectes, and Portunus. The highest number of individuals found was the genus Brachycarpus with 217 individuals, while the lowest number of individuals found was Charybdis which only one individual found. At Site 3, a total of 16 genera were recorded. The recorded genera are Penaeus, Brachycarpus, Macrobrachium, Charybdis, Thalamita, Callinectes, Myomenippe, Alpheus, Palaemon, Lysmata, Dyspanopeus, Chiromantes, Metagrapsus, Eurypanopeus, Goniopsis, and Perisesama. The genus Brachycarpus showed the highest number of decapods found throughout this study with 96 individuals, while Perisesama recorded in lowest number with only one individual.

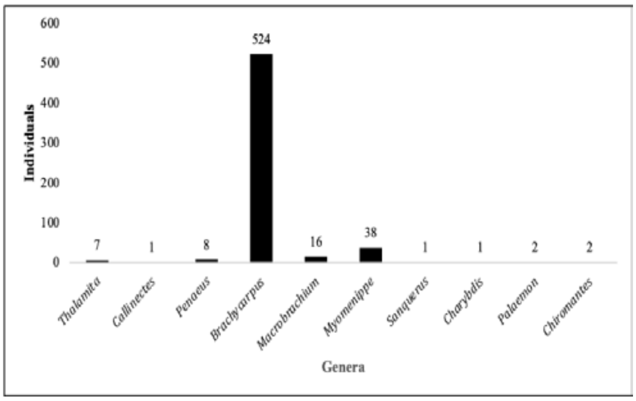

Figure 2: Abundance of Decapods in Site 1

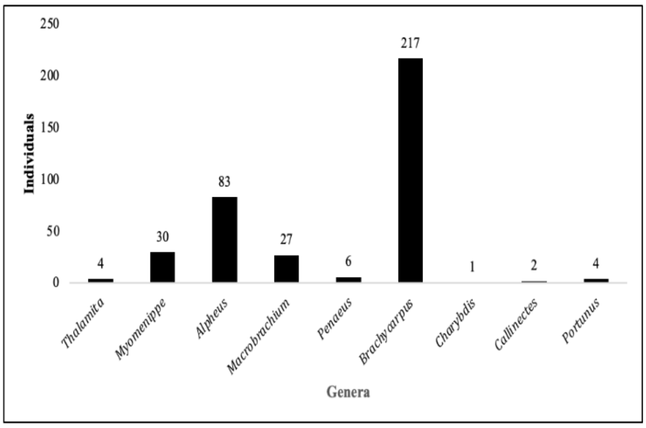

Figure 3: Abundance of Decapods in Site 2

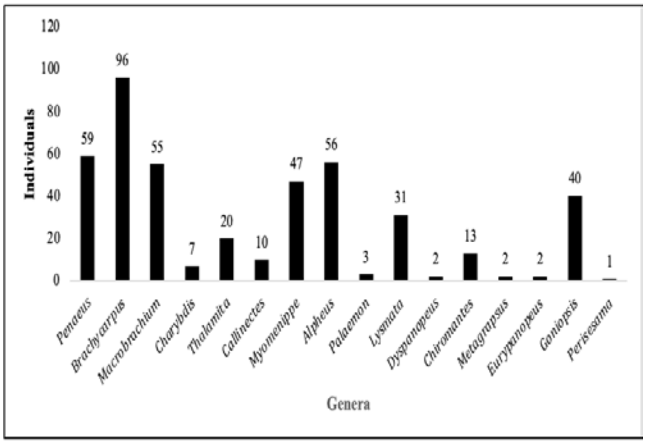

Figure 4: Abundance of Decapods in Site 3

Overall, 18 genera were found in Penor River-estuary throughout this study as showed in Figure 5. Among the genera found, *Brachycarpus* found to be dominated the Penor River-estuary with a total number of 837 individuals, while the genera *Perisesama* and *Sanquerus* found in lowest number with only one individual in each genus, respectively.

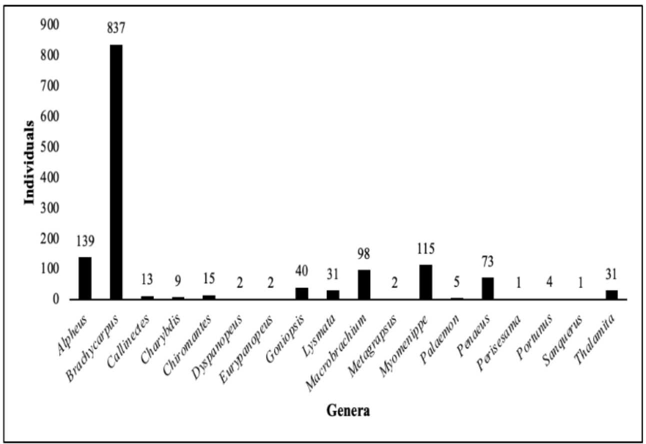

Figure 5: Overall Abundance of Decapods in Penor River-estuary

Table 1 showed the spatial distribution of decapods in Penor River-estuary. Among 18 genera found in Penor River-estuary, seven genera were observed to be present in all the three sites. Those genera are Brachycarpus, Callinectes, Charybdis, Macrobrachium, Myomenippe, Penaeus, and Thalamita. However, there were also some genera observed to be found in only selected sites of the study area. The genus that found only in Site 1 was Sanquerus, whereas the genus that only found in Site 2 was Portunus. The genera that were found only in Site 3 were Dyspanopeus, Eurypanopeus, Goniopsis, Lysmata, Metagrapsus, and Perisesama.

Table 1: Spatial Distribution of Decapods in Penor River-estuary

Genus	Site 1	Site 2	Site 3
Alpheus	x	/	/
Brachycarpus	/	/	/
Callinectes	/	/	/
Charybdis	/	/	/
Chiromantes	/	x	/
Dyspanopeus	x	x	/
Eurypanopeus	x	x	/
Goniopsis	x	x	/
Lysmata	x	x	/
Macrobrachium	/	/	/
Metagrapsus	x	x	/
Myomenippe	/	/	/
Palaemon	/	x	/
Penaeus	/	/	/
Perisesama	x	x	/
Portunus	x	/	x
Sanquerus	/	x	x
Thalamita	/	/	/

*Note: (/) Present; (x) Absent

Decapods Diversity in Penor River-estuary

Table 2 showed the overall decapods diversity in Penor River-estuary based on sites. According to Shannon-Wiener diversity index, the higher the index, the higher the diversity of species in an area. In this study, Site 3 showed the highest diversity index, while the lowest diversity index was observed at Site 1.

Table 2: Decapods Diversity in Penor River-estuary

Site	Shannon-Wiener Index (H)	Species Richness (S)	Species Evenness	Simpson's Index (D)	1-D	1/D
1	1.82	14	1.06	1.06	0.94	5.28
2	2.74	15	1.41	0.64	1.36	7.03
3	4.69	26	2.18	0.84	2.16	11.43

However, according to Simpson's diversity index, the higher the index represent the lower the diversity of the area. As Shannon-Wiener diversity index, Simpson's diversity index also showed the same trend of diversity based on sites, with higher index value at Site 1. But, the lowest diversity index was observed at Site 2, which means Site 2 showing the higher diversity compared to the other 2 sites. For the species richness, Site 3 recorded the highest number of species, while the lowest species richness was observed at Site 1. As for species evenness, also Site 3 showed the highest value of species evenness, while Site 1 with lowest species evenness value.

Discussion

Abundance and Distribution of Decapods in Penor River-estuary

Estuaries are interfaces between land and sea, are the site of a range of hydrological, oceanographic and anthropogenic processes (Wolanski & Elliott, 2016). These complex processes produce habitats with intense thermal and salinity gradients and variable nutrient and pollutant concentrations. River estuaries serve as nursery ground for juvenile aquatic species. The area which rich in nutrient and vegetation, provide source of nutrition and shelter for fish juveniles (Shcherbak et al., 2019).

A Penor River-estuary is active with traditional fisheries activities with little industrial activities. Understanding the species composition will enable good management practice for socio-economic and sustainable biodiversity. A total of eighteen genera of decapods were found from these estuaries. The most abundance decapods in Penor River-estuary were *Brachycarpus*. This genus was recorded to be found in highest number of individuals in all the three sites. However, there are not many studies in Malaysia that recorded about the presence of *Brachycarpus* in Malaysian water. Genus *Brachycarpus* was found from Cockle Bay which is located in North Queensland, Australia that recorded the presence of *Brachycarpus* (Kwak & Klumpp, 2004). The genus *Brachycarpus* is a shrimp species of the family Palaemonidae that mainly occur in marine environment. This shrimp commonly called as "two-clamped shrimp". Species abundance in outer river mouth and middle river mouth (10 and 9 genera) is less in comparison to inner river mouth (16 genera). This showed the preferences of juvenile decapod to inhabit inner river mouth. Inner river mouth is considered as less disturbed estuary with low anthropogenic impact. The previous findings propose the less disturbed estuary may be more susceptible to anthropogenic impacts (Dolbeth et al., 2016).

Decapods Diversity in Penor River-estuary

Based on the result analyzed by using Shannon-Wiener and Simpson's diversity indices, the diversity of decapods observed showed almost the same trend, with slight difference. The Shannon-Wiener diversity index showed highest diversity at Site 3, while Simpson's diversity index showed the highest diversity at Site 2. However, both Shannon-Wiener and Simpson's diversity indices showed lowest diversity at Site 1. All over the world, study of Brachyuran crab diversity become essential in understanding the ecological roles and function in mangrove ecosystem (De Lima & Martinelli-Lemos, 2019; Mohanty et al., 2019; Ngo-Massou et al., 2018). Previously, there is no study about Brachyuran biodiversity in Pahang. The lowest diversity recorded at Site 1 (outer river mouth) could be probably because of the fisheries activities on that area. This could affect the diversity of decapods if they unsustainably harvest the marine organisms. Besides that, this activity could also lead to low water quality, unstable temperature, fluctuation of salinity and low dissolved oxygen that may occur temporarily. High species diversity in inner river mouth estuaries due to accessibility of food resources and benthic habitat structure (Mohanty et al., 2019; Woodland et al., 2019).

Conclusion

This study provides initial insight about decapod juvenile diversity in Pahang estuary. This is conspicuously the case in the studied estuaries, as underlined by the presence of juveniles sampled during survey period. This information is a key component for nursery habitat value. It will help enhances the importance of considering habitat and ecosystem connectivity in management strategies and future reference.

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