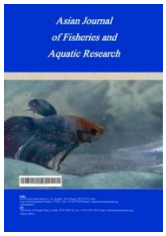

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Distribution of Decapods in the Selected Mangrove Sites in Sta. Maria, Davao Occidental, Philippines

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To identify the species of decapods and their edibility, determine the population density, abundance, dominance, and diversity indices of decapods found in the selected mangrove sites, and measure the physicochemical parameters of the area.
Place and Duration of Study: Barangay Tanglad, Mamacao, and Basiawan of the Municipality of Sta. Maria, Davao Occidental. April 25-29, 2022.
Methodology: A transect-plot method was used in sampling and the samples were handpicked or captured using tongs, scooped using the locally used net, dug from their burrows, and collected from wooden hides. The samples were put in a container with seawater and ice, then cleaned, photographed, and identified. The samples were presented to the fisherfolks and locals to identify local names and their edibility. The pH, temperature, and salinity of the seawater were recorded on site. The decapods' taxonomic classification was identified. The population density, abundance, dominance, and diversity indices were computed.
Results: There were 13 species of decapods found in the three sampling sites, namely: Triangular fiddler crab *(A. triangularis),* Nymph snapping shrimp *(A. euphrosyne),* Mud crab *(B. vinosus),* Forceps crab *(E. dentatus),* Brown land crab *(C. carnifex),* Hermit crab *(C. rugosus),* Indian prawn *(F. indicus),* Giant freshwater prawn *(M. rosenbergii)*, Alamihi crab *(M. thukuhar),* Mudflat crab *(P. pictum)*, Flat porcelain crab (*P. cinctipes*), Mangrove swimming crab *(T. crenata),* and Compressed

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fiddler crab *(T. coarctata).* A total of 633 individuals were gathered from the three sampling sites. 279 individuals were collected in Barangay Tanglad, 189 individuals in Barangay Mamacao, and 165 individuals in Barangay Basiawan. Triangular fiddler crab *(A. triangularis),* Hermit crab *(C. rugosus),* Indian prawn *(F. indicus),* Alamihi crab (*M. thukuhar*), Mudflat Crab (*P. pictum),* and Compressed fiddler crab (*T. coarctata*) were observed to be present among the three sites. In the three sampling sites, Mudflat crab *(P. pictum)* showed to have the highest population density of 199 ind./2,700 m2, highest index of the dominance of 0.291, and a relative abundance of 31.44%. Mudflat crab *(P. pictum),* Triangular fiddler crab *(A. triangularis),* and Compressed fiddler crab *(T. coarctata)* were the most dominant species in the area.

Conclusion: Barangay Tanglad was found to be the most diverse site, it also had the highest index of evenness. Barangay Mamacao and Basiawan had the highest similarity index. There was no significant difference in the number of decapod species between the sampling sites. The physicochemical parameters are within the optimum level which could be a favorable condition for the abundance of the decapods.

Keywords: Distribution; decapods; mangroves; Davao Occidental.

1. INTRODUCTION

Mangroves are woody trees or shrubs that grow in dense thickets or forests along tidal estuaries, in salt marshes, and on muddy coasts and that characteristically have prop roots and respiratory or knee roots. Mangroves are extremely important to the coastal ecosystems it inhabits as it serves as a buffer between marine and terrestrial communities and protects shorelines from damaging waves, winds, and floods. Mangroves are also the most suitable feeding, breeding, and nursing grounds for the decapods [1].

Decapoda is the most diverse order of the class Malacostraca in marine and freshwater ecosystems with more than 15,000 species of crustaceans that include shrimp, lobsters, crayfish, hermit crab, and crabs. Decapods are useful and appropriate models for many years of biological research and are also important to many economies as highly valued edible shellfish. A high abundance of food and shelter and low predation pressure forms an ideal habitat for a variety of animal species during part or all their life cycles [2]. Thus, healthy mangrove forests are key to a healthy marine ecology.

Little is known about the population biology and distribution of marine decapods in the province. Hence, this study was conducted to establish data on the distribution of decapods in the mangrove sites of Sta. Maria, Davao Occidental, and the results were shared to provide awareness to the local community on marine decapod species.

2. MATERIALS AND METHODS

2.1 Research Locale

The municipality of Sta. Maria is a 2nd class municipality in the province of Davao Occidental, Philippines. It is located on Mindanao Island, about 40 kilometers northwest of province capital municipality of Malita, and about 1-23 kilometers south-south-east of Philippine's main capital Manila. It has a total area of 175 km^2, having coordinates of 6°33'N 125°28'E According to the 2020 census, Sta. Maria has a population of 57, 526 people. The municipality of Sta. Maria is composed of 24 Barangays. The study was conducted in the three selected mangrove sites: Barangay Tanglad, Barangay Mamacao, and Barangay Basiawan. Barangay Tanglad is located at the coordinates of 6° 36' 41.2164"N 125° 26' 0.6324"E; Barangay Mamacao is at 6° 35' 41.0496"N 125° 26' 53.4696"E; and Barangay Basiawan is at 6° 31' 35.2308"N 125° 31' 10.4052"E.

2.2 Sampling Design and Technique

The transect plot method was used in the study. Three sampling sites were established in the study area, in each site, three transect lines with a length of 50 meters were laid out perpendicular to the shore, at 20 meters from each other. In every line, a 10x10 m plot for the sampling for decapods was set up with an interval of 10 meters for every plot (See Fig. 3). The collection of samples was done inside the plots. In ecology, plot sampling is a method of abundance estimation in ecology in which plots are selected and sampled from within a survey region. General plot sampling is a helpful strategy [3].

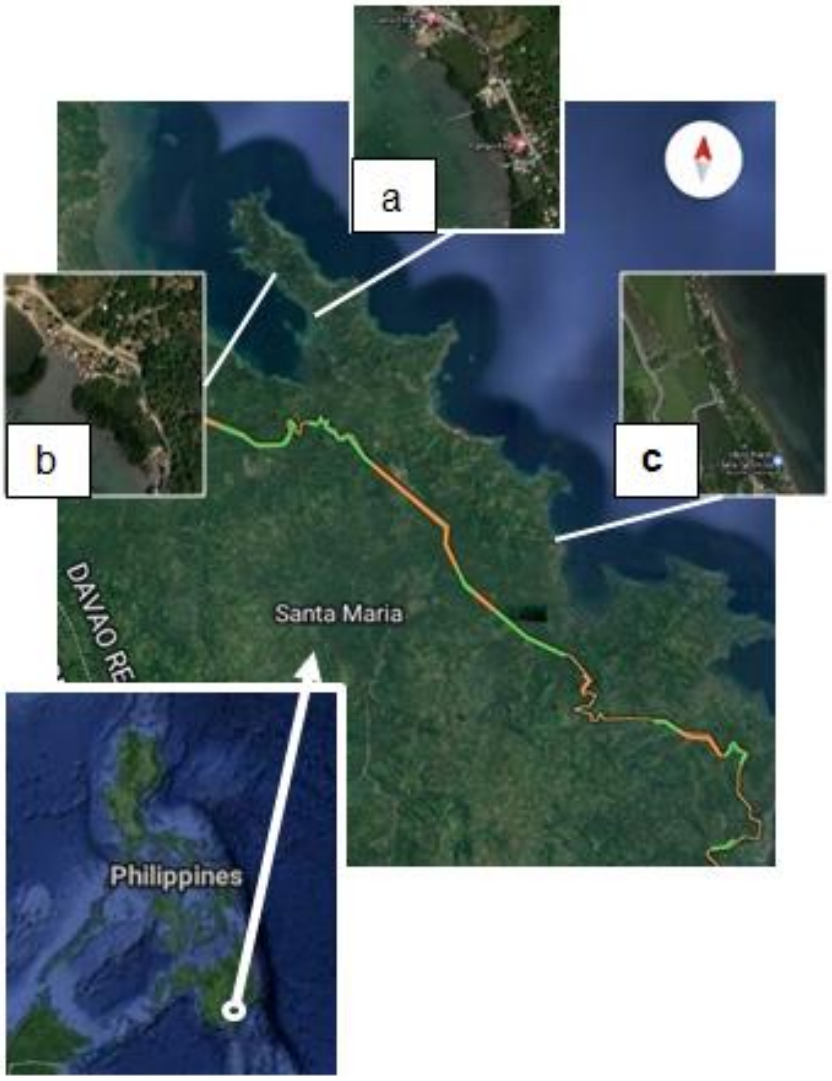

Fig. 1. Map showing the three study sites: (a) Barangay Tanglad, (b) Barangay Mamacao, (c) Barangay Basiawan via Google Maps

2.3 Data Gathering Procedure

The samples of decapod species in the selected mangrove areas were gathered in the daytime during low tide. Gears, such as the locally used dip net, tongs, and bolo were used to capture decapods. The decapods that were easy to collect were handpicked or aided by tongs. On the other hand, dip nets were used to scoop small decapods, especially in the narrow spaces of the root systems of mangroves. Bolo or garden shovel was used to dig into the burrows of the burrowing crabs and to check those under the rocks. The decapods living within the wood in decomposition (fallen logs) were collected by breaking the log and catching them. All the collected samples were stored in a container with a small amount of seawater and ice to preserve them for later identification.

2.4 Identification of Samples

The collected samples were cleaned carefully and photographed on a white background. The photographed samples were used for taxonomic classification and description using the field guide for the edible crustacea of the Philippines [4], marine decapod crustacea of Southern Australia: A guide to identification [5], key to families of brachyura [5], keys to superfamilies and families of Caridea [5], simple key to common shallow-water caridean families [5], dichotomous key for the mangrove crab Genus *Scylla* [6] and verified on the WoRMS internet

database. Furthermore, the invisible samples were subjected for validation by expert. And the local names were determined through an interview with the locals.

2.5 Edibility of Samples

The samples' edibility was identified. The locals and fisherfolks were presented with the actual decapods samples and they were interviewed to help identify and create list of edible and non-edible decapods.

2.6 Data Analysis

Relative abundance

The relative abundance of each species was based on the formula (Odum, 1971):

$$\text{RA of species (\%)} = \frac{\text{total number of species}}{\text{total count of all species}} \times 100$$

Density of decapods

All individuals of decapods found in each site were counted per species and density was calculated following the formula (Odum, 1971):

$$D = \frac{\text{Number of individuals of the same species}}{\text{Area } (m^2)}$$

Index of dominance

The Index of Dominance of the species of decapods in the study area was determined using the formula (Odum, 1971):

$$C = \sum \left(\frac{ni}{N}\right)^2$$

Where:

C = index of Dominance
ni = number of individuals per species
N = total number of individuals of all species

Species diversity indices

To determine the diversity index of the decapods, the Shannon Weiner Index of Diversity and Evenness formula was used (Spellberg et. al. 2003).

Shannon Weiner diversity index

$$H' = 3.322 \left[\log N - \sum \frac{ni\ (\log ni)}{N}\right]$$

Where:

H' = Shannon-Weiner Index of Diversity
n_1 = number of individuals per species
N = total number of individuals of all species

Shannon's equitability or evenness

$$E = \frac{H'}{\log N}$$

Wherein:

E = equitability or evenness
H' = Diversity index
N = total number of species

Index of similarity

The index of similarity was based on the formula of Jaccard (1912). Where, Jaccard coefficient;

$$SJ = \frac{a}{a + b + c} \times 100$$

Where:

SJ = Jaccard similarity coefficient,
a = number of species common to (shared by) sites,
b = number of species unique to the first site, and
c = number of species unique to the second site

2.7 Statistical Analysis

Analysis of Variance (ANOVA) was used to determine if there is a significant difference in the species of decapods in mangroves in every site. However, Kruskal-Wallis was used to compare the number of decapods between sites.

Kruskal-Wallis

Formula:

$$H = \frac{12}{n(n+1)} \left[\sum_{t=1}^{k} \frac{Rj^2}{nJ}\right] - 3(n+1)$$

Where:

K = the number of samples
nj = the number of observations in the jth sample

n = the number of observations in all samples compiled
Rj = sum of ranks in the jth sample

Physico-chemical Parameters

During low tide, the temperature, pH, and salinity of the water in mangrove areas were recorded on-site using Multi-functional water quality test instrument. In addition, the depth of the water was recorded using a steel tape measure. These were recorded to determine the conditions of the environment in each site where decapods thrive.

3. RESULTS AND DISCUSSION

3.1 Decapod Species Composition

The assessment of decapod species in the mangrove forest of Barangay Tanglad, Barangay Mamacao, and Barangay Basiawan of Sta. Maria, Davao Occidental was conducted on April 25 to 29, 2022.

The study revealed that there were 13 species of decapods recorded and identified in Barangay Tanglad, these species include: Nymph snapping shrimp *(Alpheus euphrosyne)*, Triangular fiddler crab *(Austruca triangularis)*, Mud crab *(Baptozius vinosus)*, Brown land crab *(Cardisoma carnifex)*, Hermit crab *(Coenobita rugosus)*, Forceps crab *(Epixanthus dentatus)*, Indian prawn *(Fenneropenaeus indicus)*, Giant freshwater prawn *(Macrobrachium rosenbergii)*, Alamihi crab *(Metopograpsus thukuhar)*, Mudflat crab *(Parasesarma pictum)*, Flat porcelain crab *(Petrolisthes cinctipes)*, Mangrove swimming crab *(Thalamita crenata)*, and Compressed fiddler crab *(Tubuca coarctata).*

In Barangay Mamacao, eight species were recorded, namely: Triangular fiddler crab *(Austruca triangularis)*, Hermit crab *(Coenobita rugosus)*, Forceps crab *(Epixanthus dentatus)*, Indian prawn *(Fenneropenaeus indicus)*, Giant freshwater prawn *(Macrobrachium rosenbergii)*, Alamihi crab *(Metopograpsus thukuhar)*, Mudflat crab *(Parasesarma pictum)*, and Compressed fiddler crab *(Tubuca coarctata).*

In Barangay Basiawan, seven species were found and identified, these are: Triangular fiddler crab *(Austruca triangularis)*, Brown land crab *(Cardisoma carnifex)*, Hermit crab *(Coenobita rugosus)*, Indian prawn *(Fenneropenaeus indicus),* Alamihi crab *(Metopograpsus thukuhar)*, Mudflat crab *(Parasesarma pictum)*, and Compressed fiddler crab *(Tubuca coarctata).*

The taxonomic classification of decapods found in the three sampling sites including their common and local names (See Table 1). The IUCN red list is included in the table to know the current conservation status of each species collected from the study area. Of all 13 species, 12 were not yet assessed and Giant freshwater prawn *(M. rosenbergii)* was evaluated as least concern.

3.2 Edibility of Decapods

Identification of edible and non-edible species of decapods in three sampling sites was assessed through an interview with the locals and fisherfolks. The result of the interview revealed that 11 species of decapod species were edible, these are: Nymph snapping shrimp *(A. euphrosyne),* Triangular fiddler crab *(A. triangularis),* Mud crab *(B. vinosus),* Brown land crab *(C. carnifex),* Hermit crab *(C. rugosus),* Forceps crab *(E. dentatus),* Indian prawn *(F. indicus),* Giant freshwater prawn *(M. rosenbergii),* Mudflat crab *(P. pictum),* Mangrove swimming crab *(T. crenata)*, and Compressed fiddler crab *(T. coarctata).* Most of the locals do not consume Triangular fiddler crab *(A. triangularis)*, Hermit crab *(C. rugosus)* and Compressed fiddler crab *(T. coarctata),* but there were fisherfolks who preferred eating these three species. Furthermore, only the Flat porcelain crab *(P. cinctipes)* and Alamihi crab *(M. thukuhar)* were inedible.

3.3 Distribution of Decapods

Of the identified 13 species of decapods in Sta. Maria, Davao Occidental, all the 13 species were recorded in Barangay Tanglad, eight species in Barangay Mamacao, and seven in Barangay Basiawan. The species of Triangular fiddler crab *(A. triangularis)*, Hermit crab *(C. rugosus)*, Alamihi crab *(M. thukuhar)*, Mudflat crab *(P. pictum)*, and Compressed fiddler crab *(T. coarctata)* were found to be present among all three sites. The distribution of other decapods were presented in Table 2.

Table 1. Taxonomic classification of decapods in the study sites

FAMILY	SCIENTIFIC NAME	ENGLISH NAME	LOCAL NAME	IUCN Red List
Alpheidae	*Alpheus euphrosyne*	Nymph snapping shrimp	Takla	NE
Ocypodidae	*Austruca triangularis*	Triangular fiddler crab	Kumpihig/ Kapay-Langit	NE
Oziidae	*Baptozius vinosus*	Mud crab	Suga-Suga	NE
Gecarcinidae	*Cardisoma carnifex*	Brown land crab	Kagang	NE
Coenobitidae	*Coenobita rugosus*	Hermit crab	Umang	NE
Oziidae	*Epixanthus dentatus*	Forceps crab	Suga-Suga	NE
Penaeidae	*Fenneropenaeus indicus*	Indian prawn	Pasayan	NE
Palaemonidae	*Macrobrachium rosenbergii*	Giant freshwater prawn	Ulang	LC
Grapsidae	*Metopograpsus thukuhar*	Alamihi crab	Karas-Karas	NE
Sesarmidae	*Parasesarma pictum*	Mudflat crab	Asan	NE
Porcellanidae	*Petrolisthes cinctipes*	Flat porcelain crab	Kasway	NE
Portunidae	*Thalamita crenata*	Mangrove swimming crab	Kasag	NE
Ocypodidae	*Tubuca coarctata*	Compressed fiddler crab	Kumpihig/ Kapay-Langit	NE

*IUCN Red List Legend: **LC** – Least Concern **NE** – Not Evaluated*

Table 2. Distribution of decapods in the study sites

SPECIES	BARANGAY		
	TANGLAD	MAMACAO	BASIAWAN
A. euphrosyne	✓	×	×
A. triangularis	✓	✓	✓
B. vinosus	✓	×	×
C. carnifex	✓	×	✓
C. rugosus	✓	✓	✓
E. dentatus	✓	✓	×
F. indicus	✓	✓	✓
M. rosenbergii	✓	✓	×
M. thukuhar	✓	✓	✓
P. pictum	✓	✓	✓
P. cinctipes	✓	×	×
T. crenata	✓	×	×
T. coarctata	✓	✓	✓

Legend: ✓ - denotes presence; × - denotes absence

3.4 Population Density of Decapods

The population density of the species of decapods in the sampling area is presented in Table 3. Population density is a measure of the number of organisms that make up a population in a defined area (Arrington, 2018). A total of 633 individuals were found in the sampling area. Mudflat crab *(P. pictum)* had the highest density of 199 ind./2,700 m^2, followed by Triangular fiddler crab *(A. triangularis)* and Compressed fiddler crab *(T. coarctata)* which both have 91 ind./2,700 m^2, and the Nymph snapping shrimp obtained the lowest density, 1 ind./2,700 m^2.

3.5 Relative Abundance of Decapods

The relative abundance of decapod species found in the study area is shown in Fig. 2. Relative species abundance is a component of biodiversity and is a measure of how common or rare a species is relative to other species in a defined location or community (Hubbel, 2001). Mudflat crab *(P. pictum)* had the highest relative abundance with 31.438%, followed by both Triangular fiddler crab *(A. triangularis)* and compressed fiddler crab *(T. coarctata)* with 14.376%, and Alamihi crab *(M. thukuhar)* with 12.322%. Nymph snapping shrimp *(A. euphrosyne)* had the lowest relative abundance with 0.158%.

3.6 Species Diversity

The data gathered in the study area were computed and analyzed in terms of species diversity using the Shannon-Weiner index and evenness index. The number of various species in each area, as well as their relative abundance, is referred to as species diversity. It could be a habitat, a biome, or the entire biosphere in question [7].

The species diversity of marine decapods found in the study area is presented in Fig. 4. Barangay Tanglad had a higher Shannon-Weiner index value of 2.978 followed by Barangay Mamacao with 2.525, and Barangay Basiawan with 2.466. To interpret the index of diversity, the higher the value of H, the higher the diversity of species in a particular community; the lower the value of H, the lower the value of diversity [8]. Therefore, Barangay Tanglad had the highest diversity among the three sites for it had the highest Shannon-Weiner index of 2.978.

Barangay Tanglad had the highest value of evenness with 1.217, followed by Barangay Mamacao with 1.109, and Barangay Basiawan with 1.112. The Shannon Equitability Index is a way to measure the evenness of species in an area. The term evenness simply refers to how similar the abundance of different species is in the community [8]. An area in which all the species have similar abundances will have a greater species evenness [9].

3.7 Index of Dominance

The index of the dominance of decapods gathered in the three sites was computed. If it has a higher value, it indicates that a particular species occurrence is more dominating in number in the population of decapods. Mudflat crab *(P. pictum)* had the highest index of dominance among other species with a combined value of 0.218 from all sites.

Table 3. Population density (ind./m2) of decapods in the study sites

SPECIES	POP. DENSITY
Alpheus euphrosyne	1 ind./2,700 m^2
Austruca triangularis	91 ind./2,700 m^2
Baptozius vinosus	19 ind./2,700 m^2
Cardisoma carnifex	36 ind./2,700 m^2
Coenobita rugosus	3 ind./27,00 m^2
Epixanthus dentatus	75 ind./2,700 m^2
Fenneropenaeus indicus	21 ind./2,700 m^2
Macrobrachium rosenbergii	3 ind./2,700 m^2
Metopograpsus thukuhar	78 ind./2,700 m^2
Parasesarma pictum	199 ind./2,700 m^2
Petrolisthes cinctipes	10 ind./2,700 m^2
Thalamita crenata	6 ind./2,700 m^2
Tubuca coarctata	91 ind./2,700 m^2

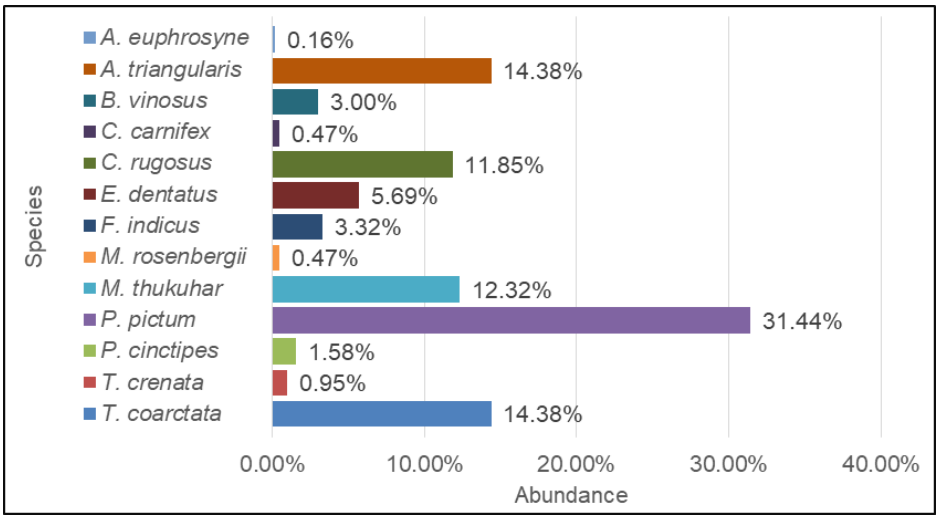

Fig. 2. The relative abundance of decapods in the study sites

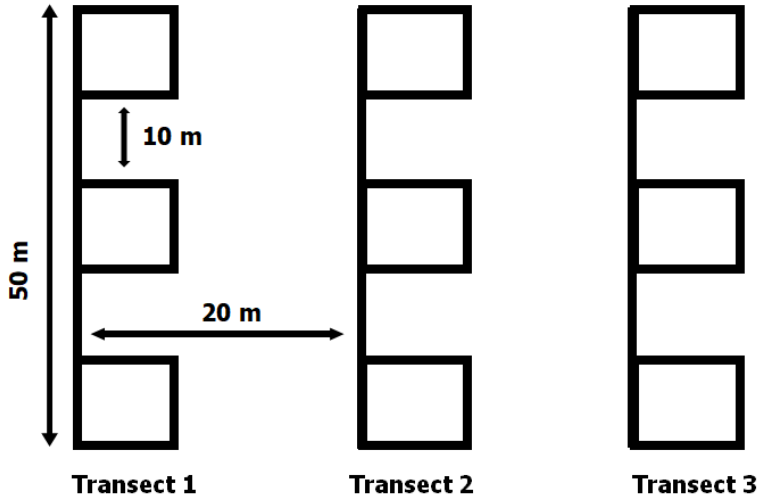

Fig. 3. Lay-out of the sampling design of the study

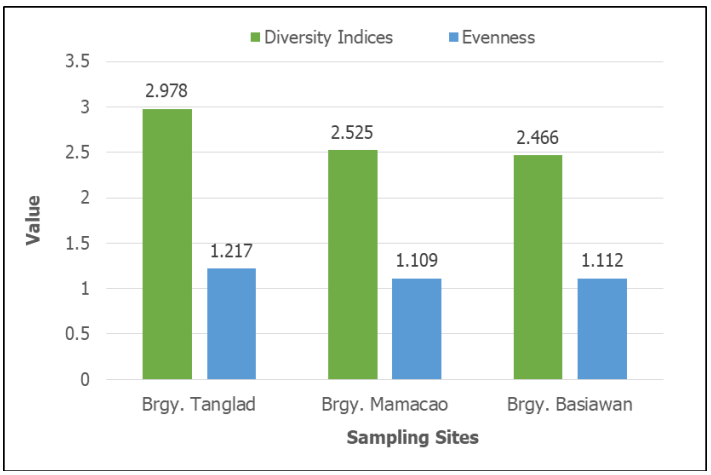

Fig. 4. Species diversity of decapods in the study sites

Table 4. Physico-chemical parameters in the study sites

PARAMETERS	BARANGAY TANGLAD	BARANGAY MAMACAO	BARANGAY BASIAWAN	MEAN
Temp. (^{0}C)	27.43	27.24	28.95	**27.87**
Salinity (ppt)	29.23	28.58	29.1	**28.97**
Ph	7.37	7.5	7.7	**7.52**
Depth (m)	0.05	0.18	0.28	**0.17**

3.8 Similarity Index

A similarity test of the three sites on the presence of mangrove decapods was computed to determine how similar the sites were in terms of species present.

Barangay Mamacao versus Barangay Basiawan had the highest value of 66.667% due to the presence of six common species, namely: Triangular fiddler crab *(A. triangularis)*, Hermit crab *(C. rugosus)*, Indian prawn *(F. indicus)*, Alamihi crab *(M. thukuhar)*, Mudflat crab *(P. pictum)*, and Compressed fiddler crab *(T. coarctata).*

Barangay Tanglad versus Barangay Mamacao had a similarity index value of 64.286% due to the presence of eight common species, namely: Triangular fiddler crab *(A. triangularis)*, Hermit crab *(C. rugosus)*, Forceps crab *(E. dentatus)*, Indian prawn *(F. indicus)*, Giant freshwater prawn *(M. rosenbergii)*, Alamihi crab *(M. thukuhar)*, Mudflat crab *(P. pictum)*, and Compressed fiddler crab *(T. coarctata).*

Barangay Tanglad versus Barangay Basiawan got the lowest value of 53.846% due to the presence of seven common species, namely: Triangular fiddler crab *(A. triangularis),* Brown land crab *(C. carnifex),* Hermit crab *(C. rugosus),* Indian prawn *(F. indicus)*, Alamihi crab *(M. thukuhar)*, Mudflat crab *(P. pictum)*, and Compressed fiddler crab *(T. coarctata).*

3.9 Statistical Analysis

In Kruskal-Wallis Test, the result showed that there is no significant difference between the numbers of species of decapods since the computed value, 1.000 is higher than the tabular value of 0.05. The null hypothesis that stated, there is no significant difference in the number of decapods species between the sampling sites is accepted.

3.10 Physico-chemical Parameters

The prevailing physicochemical parameters in the three sampling sites such as temperature, pH and salinity, and depth were measured (See Table 4). The obtained temperature of the water in the study area during the daytime and low tide sampling was 27.87^{0}C. In addition, the average salinity of the seawater in the study site was 28.97 ppt, the average pH of the water was 7.52, and the average depth of the water was 0.17 m.

4. CONCLUSIONS

The following conclusions were deduced from the study;

1. A total of 13 species of decapods were found in the selected mangrove sites namely: *Alpheus. euphrosyne, Austruca triangularis*, *Baptozius vinosus, Epixanthus dentatus, Cardisoma carnifex, Coenobita rugosus, Fenneropenaeus indicus, Macrobrachium rosenbergii, Metopograpsus thukuhar, Parasesarma pictum, Petrolisthes cinctipes, Thalamita crenata,* and *Tubuca coarctata.*
2. Barangay Tanglad, Sta. Maria, Davao Occidental was found to have the most diverse in terms of decapod species with 13 species identified;
3. Mudflat crab *(Parasesarma pictum), Compressed fiddler crab (Tubuca coarctata),* and Triangular fiddler crab *(A. triangularis)* were revealed to be the most dominant species found in the study area;
4. The Physico-chemical parameters of the three sampling sites are in tolerable range for the survival of decapods species; and,
5. There was no significant difference in the number of decapod species between the sampling sites.

5. RECOMMENDATIONS

The following recommendation was drawn based on the result of the study;

1. Further study shall be conducted about the decapods in the mangrove forests.
2. Study of species diversity of decapods shall be conducted at nighttime during high and low tide to know the occurrence of

different species in the mangrove areas; and,

3. Further study considering the interrelationship of mangrove species and other associated fauna within Davao Occidental will be conducted.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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