RESEARCH PAPER

Diversity of macrobenthic invertebrates in the mangrove ecosystem of Leyte, Philippines

Myra A. Abayon*[1], **Paolo Alburo**[2], **Mariel Diaz**[1], **Fettilyn Grace Cuartela**[1],

Angelo Rosales[2], **Samuel Amid Jr**[1], **Camille Fortaliza**[2], **Maria Isidra Maringal**[1],

Renz Nikko Orsal[1]

[1]*Leyte Normal University, Leyte, Philippines*

[2]*Department of Education, Leyte Normal University, Philippines*

Abstract

A study on benthic macroinvertebrates was conducted in the coastal areas of Barangay Old Kawayan in Tacloban City and Barangay Tangan in Carigara, Leyte, focusing on the species diversity within the sites' mangrove ecosystems. The study employed quadrat and transect sampling methods, with two stations established at each site. Within each station, three transects were laid perpendicular to the shoreline to gather data. In Old Kawayan, 15 species and a total of 2,107 macrobenthic invertebrates were found, with the girdled horn snail (*Cerithideosilla* spp) being the most abundant species at 1,434 individuals. In contrast, Tangan Carigara recorded seven distinct species with a total count of 111 individuals, dominated by the telescope shell (*Telescopium* spp), which had 35 individuals. The study sites recorded members belonging to the Phylum Arthropoda (four different species) and Phylum Mollusca (eleven different species), with the latter showing a significantly high relative abundance of 93.73%. The community of Tangan Carigara exhibited higher species richness and evenness, making it a more diverse and balanced ecosystem, while the community of Old Kawayan showed higher species dominance. The contrasting factors between the two study sites include water salinity, the presence of a sandy substrate, and the specific mangrove species present. Understanding the population numbers of individuals in the study sites is crucial for gaining valuable insights into the conservation and management of mangrove ecosystems.

***Corresponding Author:** Myra A. Abayon ✉ myra.abayon@lnu.edu.ph

Introduction

Benthic macroinvertebrates, also known as "bottom-dwelling" macroinvertebrates, are small aquatic animals that can be seen with the naked eye and are larger than 0.5 millimeters (United States Environmental Protection Agency, 2022). These invertebrates include mostly insects as well as planarians, decapod crustaceans, mollusks, leeches, and oligochaetes (Jacobsen *et al.*, 2008). Open intertidal areas have greater diversity, density, and species diversity than nearby mangrove forests (Rumisha *et al.*, 2015). According to Kathiresan and Bingham (2001), mangrove forests are among the most productive ecosystems in the world, enriching coastal waters, producing commercial forest products, safeguarding coastlines, and supporting coastal fisheries. The mangrove ecosystem is home to an incredible variety of creatures, some of which are unique to these forests, including seagrasses, fish populations, barnacles, mollusks, shrimp, crabs, lobsters, jellyfish, tunicates, and gastropods (Wolf, 2012).

Understanding the structure and function of mangrove ecosystems requires knowledge of the species distribution, abundance, and diversity of mangrove benthic macroinvertebrate fauna, as well as their relationships to environmental conditions (Kumar and Khan, 2013). Macroinvertebrate metrics are useful tools for evaluating the health of the aquatic ecosystem and the quality of the water (Tampo *et al.*, 2021). They are also essential for biomonitoring since macroinvertebrates live their entire lives in the ecosystem's bottom substrates, which include rocks, snags, sediment, and aquatic plants (Sengupta and Dalwani, 2008). Macroinvertebrates contribute to the structure and stability of ecosystem cycles such as productivity, natural organizations, nutrient and biogeochemical cycling, and stability (Bento *et al.*, 2023). Factors other than geographic location are more significant in describing the distribution of macroinvertebrates within minimally disturbed watersheds. Significant variables include drainage area, water temperature, alkalinity, hardness, chloride, ammonia, total nitrogen, and total phosphorus for each macroinvertebrate stream class (Bellucci and Becker, 2011).

Barangay 102 Old Kawayan in Tacloban City and Barangay Tangnan in Carigara are coastal areas in Leyte, rich in mangrove ecosystems. These intertidal regions are valuable natural resources, offering numerous benefits to the environment, the community, and the economy through sustainable livelihood and ecological research. The unique ecosystems and abundant biodiversity of these barangays attract researchers interested in marine and coastal ecosystems. The high biodiversity in these areas supports various plant and animal species, contributing to environmental health, resilience, and the sustainability of local fisheries and tourism. This study focuses on the macroinvertebrates of Barangay Old Kawayan and Barangay Tangnan. To address potential degradation from human activities or climate change, these barangays can actively engage in the conservation and restoration of mangroves, thereby enhancing the resilience of these vital habitats.

This study aims to identify and analyze the diversity of macrobenthic invertebrate species in the mangrove ecosystems of Barangay Old Kawayan in Tacloban City and Barangay Tangnan in Carigara, Leyte. By conducting a comparative analysis of the study sites, we will identify the factors influencing the presence of different species. The primary focus will be on examining various ecological strategies, local habitat structures, scientific classifications, orders, and conservation efforts within the mangrove ecosystems at both locations. This research will serve as a preliminary assessment of macroinvertebrate species diversity in these local sites, highlighting the importance of understanding and preserving these valuable biological systems.

Materials and methods

This study primarily aimed to evaluate the diversity of macro-benthic invertebrate species in the coastal areas of Barangay Old Kawayan in Tacloban City and

Barangay Tangnan in Carigara, Leyte. The specific objectives were to compare the species diversity of macrobenthic invertebrates in the mangrove ecosystems of these two areas and to determine if there were significant differences in species diversity between the two sites: the inter-tidal zones and mangrove forests of Brgy. Old. Kawayan, Tacloban City and Brgy. Tangnan, Carigara, Leyte.

Instruments
In this study, the researchers utilized various instruments to assess the macro-invertebrate species. These instruments included rash guards, rubber boots, a small whiteboard, transects, and an identification guide. All data gathered during the assessment were meticulously recorded on prepared record sheets.

Research procedures
To ensure impartiality in the study, the researchers employed a purposive process in choosing the coastal areas in Leyte, namely: Brgy. Old Kawayan in Tacloban City and Brgy. Tangnan in Carigara, Leyte, as the sampling sites. Within each municipality or city, the researcher purposely identified two stations in the representative area, where three transects per station labeled Transect 1 (), Transect 2 (), and Transect 3 () were laid perpendicular to the shoreline. These transects, made of plastic straw rope, were used as reference lines for the study.

Assessment of macrobenthic invertebrates
For each representative site, the following data were recorded: site name, station number, transect number, common name of species, vernacular name of species, the number of individuals observed, and distinguishing features for each species. The assessment in each transects covered a strip of 1 meter by 15 meters (1m × 15m). The transect was placed at the weighted end of the line, at a randomly selected point within the site's scope. The designated recorder stood straight while the rope was carefully released to avoid crossing the mangrove trees, minimizing disturbance to the macro-benthic invertebrates during recording. The recorders carried record sheets to ensure accurate data collection while walking along the transect line in the mangrove forest. They also took photographs of sample organisms to document distinct behaviors and features. All macro-benthic invertebrates within 1 meter to the left of the transect line were identified, counted, and listed to determine the species diversity and composition at the study site. Data from the record sheets were subsequently transferred to the primary datasheet. A representative specimen was collected for later identification of any species not recognized in the field.

Results and discussion
A total of 2,218 macrobenthic invertebrates belonging to 15 species were recorded within the mangrove ecosystems of Old Kawayan in Tacloban and Tangnan in Carigara, Leyte (Table 1, Fig. 1). Eleven (11) species identified belong to Phylum Mollusca, and four belong to Phylum Arthropoda. Among all species documented, the girdled horn snail *(Cerithideosilla cingulate)* is the most abundant, with a 64.59% relative abundance recorded, followed by *Isognomon alatus* with relative abundance of 5.27%, and *Nerita balteata* with relative abundance of 5.18%. The girdled horn snail *(Cerithideosilla* spp), the most abundant species in the mangrove ecosystems surveyed, typically rests on the trunks of trees and other vegetation and migrates to the substrate to feed at low tide. This small mangrove snail can often be seen hanging on mangrove trees at low tide at very high densities. However, the *Cerithideosilla* spp was not observed in the Tangan site may be due to low salinity resulting from freshwater inflow from a nearby river, and a sandy substrate was observed in the mangrove area seaward serving as a habitat for gastropods and bivalves that may account for their scarcity.

Species composition and relative abundance
Phylum Mollusca recorded higher relative abundance (93.73%) than phylum Arthropoda (6.27%). Like many previous studies, the mollusks were the most abundant. Mollusks (gastropods and

bivalves) species are important associated species of mangrove forests. Gastropods are one of the most dominant groups in mangrove swamps compared to bivalves. Dewiyanti and Sofyatuddin (2012) highlighted that gastropods' high abundance and widespread distribution could be attributed to their mobility and characteristic behavior. Both sampling sites have productive mangrove vegetation and growth, implying that the distribution of mollusks is highly correlated with tree density and composition of vegetal species (Camargo *et al.*, 2013).

Cerithideosilla spp

Isognomon spp

Calliostoma spp

Littoraria intemedia

Telescopium spp

Anadara spp

Ellobium spp

Batillaria spp

Meretrix spp

Chicoreus spp

Nerita spp

Teredo spp

Pseudosesarma spp

Tubuca spp

Scylla spp

Penaeus spp

Fig. 1. Visual guide to common microbenthic invertebrates in the mangrove ecosystems of Leyte

The Gastropods and bivalves obtained during the sampling generally live on the substrate or attached to the roots. Shanmugam and Vairamani (2008) reported that gastropods exhibit well-suited adaptations to thrive in diverse macrohabitats within the mangrove ecosystems, benefiting from the favorable conditions that enhance their productivity. Given their predatory nature, gastropods play a crucial role in maintaining and functioning mangroves by

effectively "cleaning" the root systems of encrusting fauna.

In a similar study in mangrove forests in Tabuk and Cabgan Islets in Palompon Leyte, molluscs (mostly gastropods) are also the most common species inventoried (Picardal *et al.*, 2011). Also, gastropods dominated the survey data from mangrove areas and abandoned Lao and San Juan fishponds in Ormoc City (Olor-Pogado and Evangelio, 2020). Flat tree oyster (Isognomon alatus) is abundant and found in large groups, mainly in areas of high salinity and at intertidal and sub-tidal surfaces of mangrove roots touching the benthic surfaces.

Table 1. Species diversity of macro-benthic invertebrates in mangrove ecosystems of Barangays Old Kawayan, Tacloban and Tangnan, Carigara

Common name	Scientific name	Tacloban	Carigara	Total	Abundance (%)
Phylum Mollusca					
Girdled horn snail	*Cerithideosilla* spp	1434	0	1434	64.59
Flat tree oyster	*Isognomon* spp	117	0	117	5.27
Sea snail	*Nerita* spp	84	31	115	5.18
Blood clam	*Anadara* spp	59	25	84	3.78
Telescope shell	*Telescopium* spp	39	35	74	3.33z
Top shell	*Calliostoma* spp	67	0	67	3.02
Saltmarsh snail	*Ellobium* spp	65	0	67	3.02
Horn snail	*Batillaria* spp	48	8	56	2.52
Saltwater clam	*Meretrix* spp	45	0	45	2.03
Mangrove murex snail	*Chicoreus* spp	18	0	18	0.81
Teredo worm	*Teredo* spp	4	0	4	0.18
Phylum Arthropoda					
Red mangrove crab	*Pseudosesarma* spp	70	10	80	3.60
Mangrove fiddler crab	*Tubuca* spp	31	0	31	1.40
King mangrove crab	*Scylla* spp	14	1	15	0.68
White leg shrimp	*Penaeus* spp	12	1	13	0.59

Table 2. Species diversity, dominance, and evenness of macro-benthic invertebrates in mangrove ecosystems of Barangays Old Kawayan, Tacloban and Tangnan, Carigara using PAST4

Site	Taxa	Individuals	Shannon diversity (H')	Species dominance (D)	Species evenness (E)
Old Kawayan, Tacloban	15	2107	1.404	0.4732	0.2714
Tangnan, Carigara	7	111	1.574	0.2347	0.6895

Species diversity, dominance, and evenness

Species diversity, dominance, and evenness (Table 2) of macro-benthic invertebrates in mangrove ecosystems were determined using the PAST4 software. The macrobenthic community in Tangnan, Carigara, is more diverse (H'=1.574) and has higher species evenness (0.6895) than Old Kawayan. It can only be inferred that the Mangrove ecosystems in Tangnan Carigara are ideal habitat for this fauna. The complex root system protects the macro invertebrates from larger predators and serves as a food resource when algae, bacteria, and some nutrients accumulate. Fishes, mollusks, and crustaceans are dependent on the root system of the mangrove species found in Tangnan Carigara because of its stable temperatures ideal for a growing species. The mangrove genera Avicennia along with genus Rizophora were the dominant plant communities in the research area. However, the macrobenthic community in Old Kawayan reported higher species dominance manifested by a high number of individuals observed compared to the Tangnan site. These organisms found in the mangrove system of Old Kawayan have great population sizes as well as in productivity as compared to other competitors.

Conclusion

The study in the coastal barangays of Tacloban City and Carigara, Leyte, assessed macro-benthic invertebrate species in mangrove ecosystems, revealing 2,218 individuals across 15 species. Mollusks, particularly gastropods and bivalves,

dominated, accounting for 93.73% of the total, with *Cerithideosilla cingulata* making up 64.59%. Notably, this species was absent from the Tangnan site, likely due to low salinity and sandy substrate.

Tangnan exhibited higher species diversity and evenness (H'=1.574, evenness=0.6895) compared to Old Kawayan, where species dominance was greater. These findings suggest varying ecological conditions between the sites. The study underscores the ecological importance of mangroves, highlighting their biodiversity, role in ecosystem functioning, and value to local communities.

Conservation recommendations include protecting mangroves from deforestation, pollution, and coastal development, establishing marine protected areas, and promoting sustainable practices. Continued research and environmental education are essential for mangrove preservation and resilience.

Recommendation(s)

1. Mangrove ecosystems in the coastal barangays studied support a rich and diverse macro-benthic invertebrate community, with mollusks being dominant.

2. The findings highlight the need for conservation efforts and the implementation of regional management strategies.

3. Mangroves, being highly productive ecosystems, provide essential ecological services and should be prioritized for protection.

4. Marine protected areas should be established, and regulations implemented to prevent habitat destruction.

5. Restoration efforts are necessary in areas where mangroves have been degraded to restore their ecological benefits.

6. Sustainable fishing and eco-friendly tourism practices should be encouraged to support the livelihoods of local communities.

7. Continued research on macroinvertebrates' ecological functions and interactions is crucial for informed management decisions.

8. Public awareness and education programs are necessary to foster community support for mangrove conservation.

9. Implementing these measures will enhance the sustainability and resilience of mangrove ecosystems, benefiting both the environment and local communities in Tacloban City and Carigara, Leyte.

References

Basyuni M. 2022. Mangrove biodiversity, conservation, and roles for livelihoods in Indonesia. In: Mangroves in the Changing Coastal Ecosystem (pp. 397-445).
https://doi.org/10.1007/978-981-19-0519-3_16

Bellucci C, Becker M. 2011. Characteristics of macroinvertebrate and fish communities from 30 least disturbed small streams in Connecticut. Northeastern Naturalist **18**(4), 411-444.

Bento M, Paula J, Bandeira S, Correia AM. 2023. Catching the drift of marine invertebrate diversity through digital repositories—A case study of the mangroves and seagrasses of Maputo Bay, Mozambique. Diversity **15**(2), 242.
https://doi.org/10.3390/d15020242

Dewiyanti IK, Sofyatuddin. 2012. Diversity of gastropods and bivalves in mangrove ecosystem rehabilitation areas in Aceh Besar and Banda Aceh districts, Indonesia.

Jacobsen D, Cressa C, Mathooko JM, Dudgeon D. 2008. Macroinvertebrates: composition, life histories and production.

Kaharudin LA, Wahidin LO. 2020. The diversity of molluscs in mangrove ecosystem of Kendari Bay. Journal of Biological Science and Education **2**(2), 54-63.

Kathiresan K, Bingham BL. 2001. Biology of mangroves and mangrove ecosystems. Advances in Marine Biology **40**, 81-251.

Krisanti M, Maknuun LLI, Anzani YM, Yuwono AS, Widyastuti R, Wardiatno Y, Wulandari D. 2020. A comparative study on the macroinvertebrates community in three rivers of Jawa Island, Indonesia. AACL Bioflux **13**(2), 570-581.

Kumar PS, Khan AB. 2013. The distribution and diversity of benthic macroinvertebrate fauna in Pondicherry mangroves, India. Aquat Biosyst **9**, 15. https://doi.org/10.1186/2046-9063-9-15

Rumisha C, Shukuru H, Lyimo J, Maganira J, Nehemia A. 2015. Benthic macroinvertebrate assemblages in mangroves and open intertidal areas on the Dar es Salaam coast, Tanzania. African Journal of Aquatic Science **40**, 1-9. https://doi.org/10.2989/16085914.2015.1051504

Sengupta M, Dalwani R. 2008. Benthic invertebrates- A crucial tool in biomonitoring of lakes. Proceedings of Taal 2007: The 12th World Lake Conference, 95-98.

Tampo L, Kaboré I, Alhassan EH, Ouéda A, Bawa LM, Djaneye-Boundjou G. 2021. Benthic macroinvertebrates as ecological indicators: Their sensitivity to the water quality and human disturbances in a tropical river. Front Water **3**, 662765. https://doi.org/10.3389/frwa.2021.662765

United States Environmental Protection Agency. 2022. Indicators: Benthic macroinvertebrates. https://www.epa.gov/national-aquatic-resource-surveys/indicators-benthic-macroinvertebrates#:~:text=Benthic%20(meaning%20%E2%80%9Cbottom%2Ddwellin,g,snails%2C%20worms%2C%20and%20beetles.

Wolf BM. 2012. Ecosystem in mangroves. University of Wisconsin-Stevens Point, 1-25.

Worm B, Barbier EB, Beaumont N, Duffy E, Folke C, Halpern BS, Jackson JBC, Lotze HK, Micheli F, Palumbi SR. 2006. Impacts of biodiversity loss on ocean ecosystem services. Science **314**, 787-790.

Zvonareva S, Kantor Y, Li X, Britayev T. 2015. Long-term monitoring of Gastropoda (Mollusca) fauna in planted mangroves in central Vietnam. Zoological Studies **54**(39).