Species Diversity of Macro-benthic Invertebrates in Mangrove and Seagrass Ecosystems of Eastern Bohol, Philippines

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Marichu C. Libres
College of Fisheries and Marine Sciences, Bohol Island State University, Candijay Campus, Cogtong, Candijay, Bohol, Philippines
marichucny@yahoo.com

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Abstract - *Descriptive survey method through actual resource assessment was conducted to determine the species diversity of macro-benthic invertebrates in the mangrove forest and seagrass beds of Eastern Bohol, Philippines namely: Anda, Candijay, Mabini, and Ubay. The 4 representative sites were chosen through random sampling. In each municipality, the researcher selected a representative area wherein 3 transects were laid perpendicular to the shoreline. The assessment in each transect covered a strip of 4 m by 50 m. All macro-benthic invertebrates intercepted within 4-meter to the left and right of the transect line were identified, counted and listed in a slate board. The data gathered were subjected to Shannon-Weiner Index and Kruskal Wallis Test. In mangrove forests, results revealed that Anda got the highest species diversity index of 1.66 with 11 species. The lowest value which is 1.15 was recorded in Candijay having only five macro-benthic invertebrate species. In the 4 municipalities, a total of 12 species representing 3 phyla were identified. In seagrass beds, 19 taxa of macro-benthic invertebrates were recorded belonging to three phyla. Based on the findings, the researcher concluded that macro-benthic invertebrates in eastern part of Bohol is diverse both in mangrove forests and seagrass beds. Moreover, there is no significant difference in the species diversity among the four representative sites.*

Keywords - *benthos, invertebrates, macro-benthic invertebrates, species, species diversity.*

INTRODUCTION

Marine ecosystems support various organisms including macro-benthic organisms that play diverse ecological roles. Macro-benthos consists of the organisms that live at the bottom of a water column and are visible to the naked eye mainly composed of echinoderms, crustaceans, mollusks, polychaetes, and other groups [1][2]. These organisms play a very significant role in nutrient cycling and serve as food for humans, various fishes, and bird species [3] , and other marine organisms [4] [5] [6].

Macro-benthic organisms are present in mangrove forests [7] and seagrass beds [8]. Mangroves are salt-tolerant trees [7] while seagrasses are marine flowering plants [8]. These two habitats maintain their species diversity [9]-[12] and serve as feeding, spawning, and breeding ground [13], [14].

Like any other ecosystems in the world, these resources have been declining due to human activities such as deforestation, overexploitation, illegal fishing, improper waste management, pollution, and other related acts. All of these have caused serious threats to marine biodiversity. If this current trend of environmental degradation continues marine ecosystems will be irreversibly damaged leading to resource depletion [14].

To address the problem of coastal habitat degradation, attempts have been made to manage and develop the coastal areas, usually through community-based mgt which integrates all sectors and habitats in a holistic approach [15].

The need for conservation and management of coastal ecosystems and habitats require knowledge concerning the ecological requirements of species that make up the system; causes for the loss of any of the component organisms; and, the requirements for the survival of remaining species. Biodiversity assessment or the collection of systematic information concerning what taxa are present, is a prerequisite

for determining the factors previously mentioned [16].

In the province of Bohol, particularly in the eastern part, database on macro-benthic invertebrates is lacking and no studies have been directed to the ecological aspects of these macro-benthic invertebrates, despite the fact that most of them are commercially important. Moreover, macro-benthic assemblages are bio-indicators of the quality of the environment. They are commonly used in biodiversity assessment and monitoring in the coastal and marine environments. Indeed, responses of macrobenthic assemblages to environmental variations have been adopted as a tool for evaluating the success of conservation efforts and managing marine environments [17].

Thus, this study was conducted to determine the present status of macro-benthic invertebrates in mangrove forests and seagrass beds of eastern Bohol and analyze its ecological aspects such as species diversity and evenness. This study aims to secure baseline information as basis for the coastal resource management program and for future monitoring activities.

OBJECTIVES OF THE STUDY

The main thrust of the study was to assess the species diversity of macro-benthic invertebrates in coastal areas of Eastern Bohol namely: Anda, Candijay, Mabini, and Ubay. Specifically, it aimed to determine the species diversity profile of macro-benthic invertebrates in mangrove and seagrass ecosystems of eastern Bohol (Anda, Candijay, Mabini, and Ubay) and to test the significant difference in species diversity of macro-benthic invertebrates among the four representative sites.

MATERIALS AND METHODS

Descriptive design was utilized in order to effectively respond to the study's aim in assessing the species diversity of macro-benthic invertebrates in coastal areas of Eastern Bohol using observational assessment and frequency counting. A 50-meter transect line (fiber glass tape) was used to ascertain the species diversity profile of macro-benthic invertebrates. Transects served as the reference lines during the assessment.

Study Site

This study was conducted in Eastern Bohol, particularly in the intertidal zones, mangrove forests and seagrass beds of the four (4) coastal municipalities namely: Anda, Candijay, Mabini, and Ubay (Fig. 1).

Instruments

In this study, researcher's instruments were employed in the actual assessment of the macro-invertebrate species. Diving goggles, snorkels, water slates, transects, and identification guide were utilized by the researcher in conducting the resource assessment. A global positioning system (GPS) was used to determine the coordinates or the exact location of the representative sites. Water parameters were determined by employing refractometer and thermometer. Data gathered during the assessment was recorded in the record sheets.

Procedures

In order to avoid bias in the conduct of the study, the researcher chose at random through drawing of lots 4 out of 8 coastal municipalities in eastern Bohol: Anda, Candijay, Mabini and Ubay to serve as sampling areas. In each municipality, the researcher selected a representative area wherein three transects were laid perpendicular to the shoreline labeled as Transect 1 (T_1), Transect 2 (T_2), and Transect 3 (T_3). The transects (fiber glass tape) served as the reference lines.

Assessment of Macro-benthic Invertebrates

For each representative site, the following information was recorded: site name and coordinates, transect number, species name, and species count.

The assessment in each transect covered a strip of four meters by fifty meters (4 m x 50 m). It was then laid by placing the weighted end of
the line on the bottom, at a point selected randomly within the general confines of the site. The specified recorder was positioned on a straight line, while the tape was being released from the reel carefully so as to avoid passing across grooves. This then minimizes the disturbance of the macro-benthic invertebrates prior to recording. To ensure accurate assessment, the recorder carried a slate board in standard format while walking along the transect line in the mangrove forest and seagrass beds. All macro-benthic invertebrates intercepted within 4-meter to the left and right of the transect line were identified, counted and listed to determine the species diversity and composition of macro-benthic invertebrates in the study sites. The

data from the slate board was transferred to the data sheet. For any species that were not identified in the field, a representative specimen was collected for later identification.

Sampling of Water Parameters

Water parameters such as temperature and salinity were taken in each representative area in the sampling site with a depth of 2 meters at the centermost portion of the middle transect.

Thermometer was immersed into the bottom of the water for at least five minutes before the reading of temperature.

Water salinity was taken using refractometer. Water droplets for refractometer reading were taken from the bottom of the sea. Water samples were collected and submitted to Holy Name University Waters Laboratory for chemical testing of nitrogen as ammonia and pH.

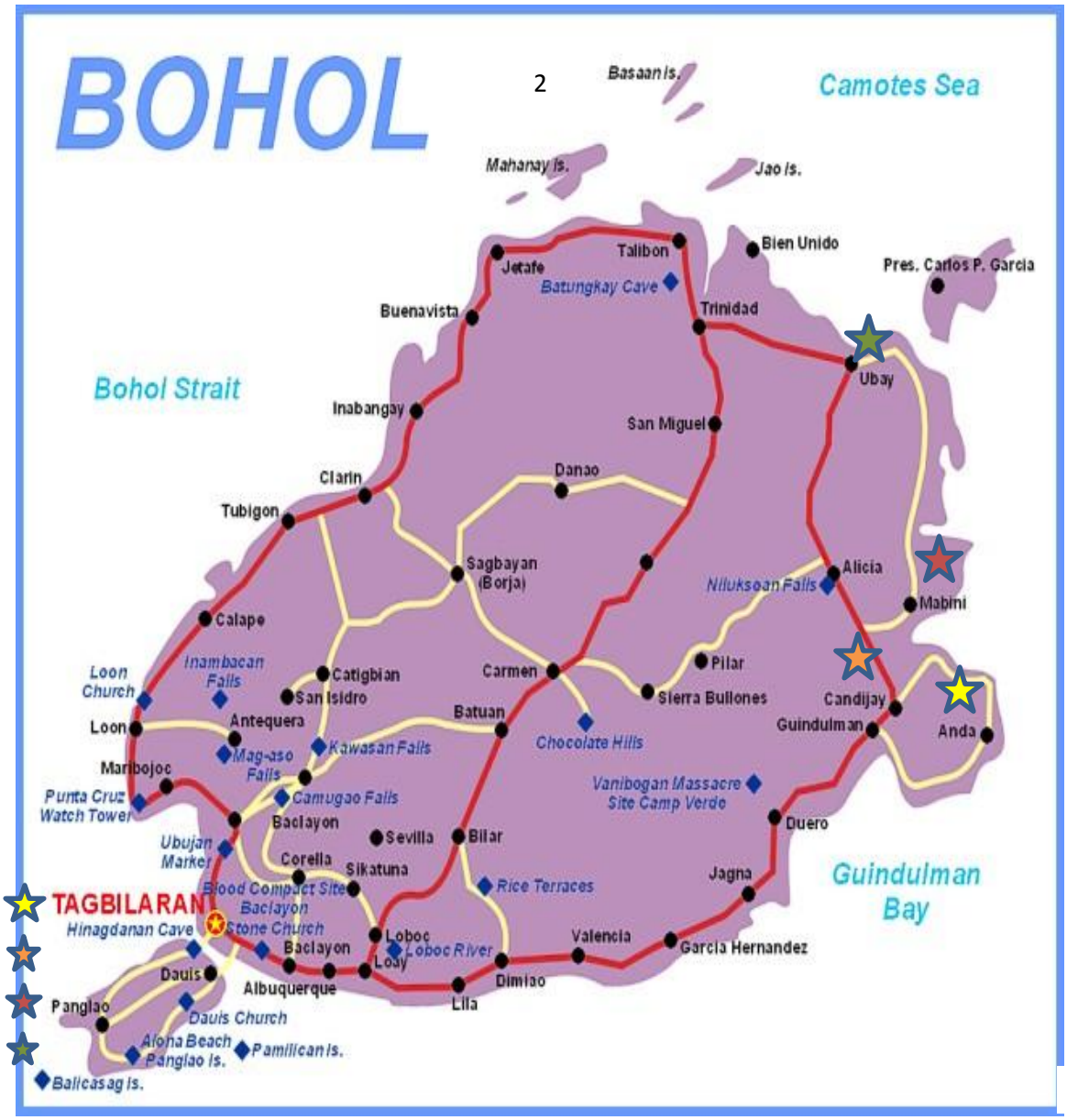

Fig. 1. The Study Site

Data generated from the observational assessment were consolidated, tabulated, analyzed and interpreted using appropriate statistical protocol.

RESULTS AND DISCUSSION

Tables 1 and 2 present the species diversity profile of macro-benthic invertebrates in mangrove forests and seagrass beds of eastern Bohol namely: Anda, Candijay, Mabini, and Ubay. In mangrove ecosystem, Anda got the highest species diversity index of 1.66 with 11 species. The lowest value which is 1.15 4 recorded in Candijay, having only five species of macro-benthic invertebrates. In the four coastal municipalities, a total of 12 species representing three phyla were identified. The status of mangrove macro-benthic invertebrates in the representative sites of eastern Bohol is diverse with a diversity index of 1.76. The result of this study supports the result of the study conducted by Zhou [18] which revealed that mangrove habitat has a positive influence on the macro-benthos.

In seagrass beds, 19 taxa of macro-benthic invertebrates were recorded belonging to three phyla. The result shows that eastern Bohol has diverse macro-benthic invertebrates in seagrass beds with a species diversity index of 1.51. The seagrass beds were dominated by long-spined urchin *(Diadema setosum)*. Diversity of species can be influenced by dominance because diversity not only involves the number of species in a community, but also how numbers of individuals are apportioned [19]. Hence, the presence of *D. setosum* contributed to the less diversity of macro-benthic invertebrates in Candijay. But on the overall, macro-benthic invertebrates in eastern Bohol is diverse.

Table 3 reveals the physico-chemical parameters of the study sites. The values of nitrogen as ammonia were similar in the four sites with <0.004 mg/L both in mangrove and seagrass beds. In general, ammonia levels in the

study sites are within the optimum value because other parameters are also close to the optimum values. In the present study, the recorded pH values in mangrove forests of Anda, Candijay, Mabini and Ubay were 8.0, 8.05, 7.35, 7.82, and 7.31 respectively. In addition, the calculated pH values in seagrass beds were 8.0, 8.07, 7.92, 7.57 and 8.15, respectively.

Table 1. Species Diversity of Macro-benthic Invertebrates in Mangrove Forests of Eastern Bohol

	Mangrove Forests				
	Macro-benthic Invertebrates	Species Count			
English Name	Scientific Name	Anda	Ubay	Mabini	Candijay
1. Arc Shell	*Scaphara sp.*	2	0	0	0
2. Channeled Turban	*Turbo cannaliculatus*	91	62	74	7
3. Cockle	*Cerastoderma glaucum*	1	0	0	0
4. Crenated Crab	*Thalamita crenata*	1	0	1	6
5. Fiddler Crab	*Uca sp.*	0	0	36	0
6. Lagoon Brittle Star	*Ophiocoma scolopendrina*	37	0	0	0
7. Marine Pulmonate	*Onchidium sp.*	7	0	22	0
8. Sea Cucumber	*Holothuria pulla*	3	0	0	0
9. Snail	*Cerithidea cingulata*	55	44	41	108
10. Telescope Shell	*Telescopium telescopium*	1	2	19	35
11. Top Shell	*Trochus maculates*	8	2	0	0
12. Zebra Periwinkle	*Littorina zicsac*	52	39	3	27
Total		**258**	**149**	**196**	**183**
Shannon Diversity Indices (H')		**1.66**	**1.19**	**1.57**	**1.15**
Species Evenness (E)		**0.69**	**0.74**	**0.81**	**0.71**
Species Richness (S)		**11**	**5**	**7**	**5**

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Table 2. Species Diversity of Macro-benthic Invertebrates in Seagrass Beds of Eastern Bohol

Seagrass Beds					
Macro-benthic Invertebrates		Species Count			
English Name	Scientific Name	Anda	Ubay	Mabini	Candijay
1. Arc Shell	*Scapharca sp.*	0	0	0	11
2. Bloody Cockle	*Anadara granusa*	0	1	10	0
3. Blue Linckia	*Linckia laevigata*	2	0	0	0
4. Blue-swimming crab	*Portunus pelagicus*	0	1	0	0
5. Chalky Sea Cucumber	*Bohadschia marmorata*	0	1	0	0
6. Cone Shell	*Conus figulinus*	0	1	0	0
7. Crenated Crab	*Thalamita crenata*	21	6	1	0
8. Dog Conch Shell	*Strombus strombus*	58	32	12	5
9. Horn Shell	*Cerithidium nodulosum*	0	1	0	0
10. Horned Sea Star	*Protoreaster nodosus*	3	3	2	0
11. Imperial Volute	*Cymbiola imperialis*	0	3	0	1
12. Long-Spined Urchin	*Diadema setosum*	19	56	32	270
13. Scorpion Shell	*Lambis lambis*	2	1	0	0
14. Sea Cucumber	*Holothuria sp.*	0	0	0	2
15. Sea Urchin	*Tripneustes gratilla*	2	0	0	1
16. Snail	*Cerithidea cingulata*	0	0	8	0
17. Tiger Cowrie	*Cypraea tigris*	0	1	0	2
18. Top shell	*Trochus maculates*	47	4	2	1
19. Zebra Periwinkle	*Littorina zicsac*	17	9	0	0
Total		**171**	**120**	**67**	**293**
Shannon Diversity Indices (H')		**1.68**	**1.63**	**1.47**	**0.39**
Species Evenness (E)		**0.76**	**0.62**	**0.76**	**0.19**
Species Richness (S)		**9**	**14**	**7**	**8**

Table 3. Physico-chemical Parameters of the Study Site

Ecosystem	Physico-chemical Parameters	Tolerable Range	Optimum Level	Study Sites			
				Anda	Candijay	Mabini	Ubay
Mangrove	Nitrogen as ammonia (mg/L)	<1.0 – 1	<1	<0.004	<0.004	<0.004	<0.004
	pH	7- 9	8.0	8.05	7.35	7.82	7.31
	Salinity (ppt)	34 – 38	35	35	32	36	33
	Temperature (^{o}C)	25 – 30	28	27	29	27	29
	Substrate			Muddy Sand	Muddy	Muddy	Muddy Sand
Seagrass	Nitrogen as ammonia (mg/L)	1.0 – 1	1.0	0.004	0.004	0.004	0.004
	pH	7 – 9	8.0	8.07	7.92	7.57	8.15
	Salinity (ppt)	34 – 38	35	36	38	39	36
	Temperature (^{o}C)	25 – 30	28	28	30	27	29
	Substrate			Muddy sand			

It implies that the study sites both in mangrove forests and seagrass beds have normal pH measure and favorable for the survival of macro-benthic invertebrates.

Based on the result of this study, the amount of salt dissolved in seawater especially in seagrass beds were relatively high in Anda, Candijay, Mabini, and Ubay with 36 ppt, 38 ppt, 39 ppt, 36 ppt, respectively. High salinity levels were attributed to higher evaporation rate during summer time in which the study was conducted.

Moreover, the presence of streams and rivers close to the sea also affects seawater salinity. In the present study, it can be gleaned from table 4 that the salinity values in mangrove forest of Candijay is 32 ppt and 33 ppt in Ubay. These values were relatively low because of the presence of the tributary rivers near the sites compared to Anda and Mabini which are far from rivers and streams.

The recorded values of water temperature in mangrove forest at different study sites like Anda and Mabini were the same at 27 °C while Candijay and Ubay got the same at 29 °C. The recorded water temperature in Anda, Candijay, Mabini, and Ubay is 28^oC, 30^oC, 27^oC, and 29^oC, respectively. Of all the temperature readings, only Anda is at its optimum level. This means that the temperature in Anda during the conduct of the study can be considered as the level of which the macro-benthic invertebrates can function best. Thus, Anda got the highest among the four study sites in terms of species diversity.

In terms of the substrate, Anda and Ubay had muddy sand while Mabini and Candijay were similar having muddy substrates. Hence, the physico-chemical parameters in eastern Bohol are good indication that marine waters in eastern Bohol are still suitable for the growth of macro-benthic invertebrates under the same condition. Species diversity and distribution of macro-benthos are influenced by the physico-chemical factors such as sediment type, temperature, salinity, and other factors [20] [21].

Table 4 presents the result of Kruskal-Wallis test. In mangroves, the computed value is 0.46. Since it is lesser than the tabular value, there is no evidence to reject Ho. In seagrass beds, the computed value 1.64 is lesser than the tabular value 7.815. The result indicates that there is no significant difference in species diversity of macro-benthic invertebrates in mangrove and seagrass beds of eastern Bohol. The result then entails that the four coastal municipalities have diverse macro-benthic invertebrates.

Table 4. Results of Kruskal-Wallis Test

Parameter	Computed Value (X^2)	Tabulated Value (X^2)	Decision
Species Diversity Index in Mangroves	0.46	7.815	Not Significant
Species Diversity Index in Seagrasses	1.64	7.815	Not Significant

CONCLUSION AND RECOMMENDATION

The results of this study therefore showed that physico-chemical parameters like nitrogen as ammonia, pH, salinity, temperature, and substrate of the mangrove and seagrass ecosystems have bearing in the abundance and diversity of macro-benthic invertebrates. Diverse macro-benthic invertebrate species can be attributed to the good water quality of the study sites. The information derived from this study can be used in formulating management measures for the sustainability of these resources. The researcher then recommends that regular monitoring of the physico-chemical parameters and status of the macro-benthic invertebrates be conducted. A parallel study shall also be conducted considering other physico-chemical parameters such as dissolved oxygen, phosphate, potassium, total dissolved solids, water current and species diversity of the marine flora, specifically, mangroves and seagrasses.

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