Malacological Survey of Shellfishes in the Coastal Areas Capiz, Philippines

Harold O. Buenvenida
Aleta Rose A. Onglatco
Jocelyn M. Dagudag
Research Department, Capiz State University-Pontevedra Campus

Abstract

The marine and aquatic ecosystems contain the largest volume of life globally, covering 70.8% of the Earth's. They harbor the largest existing species of the planet composed of 232,500,000 known species surface (Bijukumar, 2008). This study was conducted to determine the species diversity of shellfishes found in the different coastal areas of Capiz, Philippines using a survey method of research. Raw data gathered were analyzed using PAST software. The result of the study revealed that there are 27 species belonging to 17 families of shellfishes found across the seven municipalities of Capiz. Software analysis revealed that over-all, there is a high diversity of shellfishes in the sampling sites as indicated by the Shanon's H (prime) value =3.143. The data generated in this study can serve as a baseline for future research and for policymaking in the locality considering its ecology and benefits in the ecosystem.

Keywords: Shellfish, mollusk diversity, malacology, coastal resources

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Corresponding author: Harold O. Buenvenida
Address: Capiz State University - Pontevedra Campus, Pontevedra, Capiz, Philippines
E-mail: hobuenvenida@capsu.edu.ph

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Introduction

The Philippines is an archipelagic country in Southeast Asia which is one of the megadiverse areas in the world. Much of the diverse groups of an organism includes macro-invertebrates, mollusks, crustaceans, echinoderms; which play a significant ecological role by actively interacting with other species (Bijukumar 2008; Venkataraman & Wafar, 2005). Moreover, crustaceans and related species are one of the richest fishery resources of the country. The island is host to about 22,000 mollusk species (Cabrera, 1987 as cited by Ramos, Batomalaque & Anticamara, 2018) about 10% of the conservative global mollusk species richness (200,000 species) (Rosenberg 2014 as cited by Ramos et al., 2018).

The mollusks are recognized to dominate biodiversity in marine environments. It is one of the most noticeable and well-known invertebrates, which includes gastropods, bivalves, clams, oyster, octopods, squids, and snails. It is the second largest group in the animal kingdom next to the arthropods (Morton 1958 as cited by Ponnusamy, Munilkumar, Subhashree, Verma, Venkitesan & Pal, 2017). Phylum Mullosca ranges from living organisms comprising of less than 100,000 species, among which there are 20,000 species of bivalves, 80,000 species of gastropods, 1,000 species of scaphopods, and 700 species of cephalopods. Ultimately it was apparent to be an appropriate significant group for local invertebrate biodiversity (Gladstone 2002 as cited by Ponnusamy et al., 2017).

There are essential roles in the ecosystems that are being played by mollusks. They provide nutrition for other species (Van Der Wal 1996 as cited by Ramos et al., 2018) and habitats (Gutiérrez et al. 2003 as cited by Ramos et al., 2018), in some cases mollusks also contribute to improving ambient environmental conditions (Coen et al., 2007 as cited by Ramos, et al., 2018). Majority of the mollusks species contribute to the Philippine economy, they comprised 28% of the inland fisheries production which made the country one of the major suppliers in the global shell trade and exports (Wells, 1981 as cited by Ramos, et al., 2018). With the current drive for more drug discovery, pharmaceutical bio-active products that possess medicinal potentials are also being explored from turrid snails (Seronay et al. 2010 as cited by Ramos et al., 2018).

The Province of Capiz is at the center of the aquamarine industry of the country (Dayrit, 2002). It is also reputed as the Seafood Capital of the Philippines. It has one of the richest fishing grounds in the country, and so, fishing is the main livelihood of the people. Shellfish in the country have high ecological, economic, cultural, and recreational value. Ecologically, much of the species filter nearshore waters, contributing to water quality improvement. They also serve as sources of food for carnivores in nearshore habitats. Culturally, they have been a critical part of the subsistence and culture of indigenous coastal communities for centuries. Economically, near shore shellfish in the Philippines have a commercial value of almost $40 M/ year from local produce of crabs, oysters, clams and mussels and many others. Recreationally, the tousist activity of harvesting of shellfish and shell collecting is a very popular despite the policies enacted to control it.

With this highlighted importance, there is still limited data that are available about the shellfish diversity, ecology and identification around the Philippines coast. The maintenance and management of our rich biodiversity need accurate, scientific and continuous updating of data around the archipelago most especially in disturbed and developed areas.

Fisheries, maritime affairs, and aquaculture are the primary source of income for the people. Modern day economics and day-today living have changed dramatically, shifting its focus from short-term profit goals to long-term sustainable potentials. This means that livelihood does not just provide for daily needs, but also it evokes a sense of responsibility towards the environment, which is after all the source of it all.

It is on this premise that inspired researchers to conduct a study on the different shellfish found in the coastal areas, in different nearshore municipalities in the province of Capiz since a complete checklist of the entire marine fauna of the Panay island coast is not available yet. This study aims to determine the ecology, diversity and socio-economic importance of the shellfish species in the various municipalities and city namely: Roxas City, Panay, Pontevedra, Pres. Roxas, Pilar, Ivisan, and Sapian. This study also highlights mollusks as a "keystone species" because of the important ecological services they provide to maintain or improve water quality and clarity and cycle nutrients between the water column and bottom-dwelling species.

Generally, this study aims to assess and determine the diversity and distribution of shellfish in the different coastal areas of Capiz. Specifically, this study aims to answer the following questions: 1) What species of shellfish can be found in the nearshore ecosystems of Capiz?; 2) What is the level of diversity of the shellfishes found in the sampling areas?; and 3) What is the distribution of shellfishes in the different nearshore ecosystems?

Methodology

Surveyed sites were mapped using a geographical information system. Species was determined and identified based on shell morphology. The physicochemical characteristics of the water, including pH and temperature, were determined using a pH meter with a glass electrode and a temperature probe. The sampling protocol utilized was adapted from the Natural Geography In-Shore Areas (NaGISA) method for rapid and regular monitoring of beach and shoreline sites. Specimens were gathered from the sampling sites within July- October of 2017, and February to April 2018.

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Sampling Sites

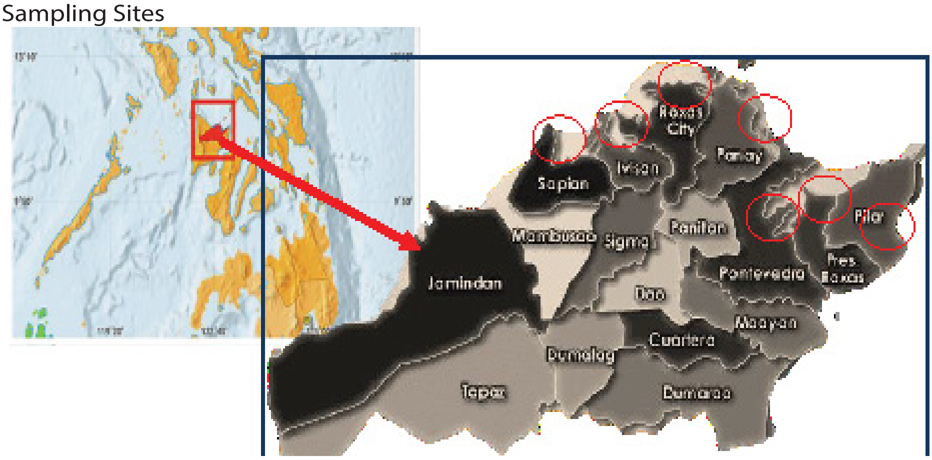

Figure 1.0 Research sampling sites in the province of Capiz: Roxas City, Panay, Pontevedra, Pres. Roxas, Pilar, Ivisan, and Sapian.

Global positioning system (GPS) was utilized in this study to pinpoint the temporal and spatial aspects of the environment. In ecological studies such as this, it is important to note the position of the sampling sites because this will serve as baseline data to locate the species and for future use.

Table 1.0 Sampling site and its corresponding GPS coordinates.

Sampling Sites	GPS
Panay	
Buntod	11.592795, 122.834719
Latasan	11.557651, 122.862056
Navitas	11.530189, 122.898477
Pontevedra	
San Pedro	11.439671, 122.860941
Gabuc	11.446450, 122.890391
Cabugao	11.441161, 122.876253
Pres.Roxas	
Madulano	11.451893, 122.915864
Marita	11.444539, 122.916500
Quiajo	11.460177, 122.925603
Pilar	
Dulangan	11.459813, 122.946355
Poblacion	11.488091, 122.996532
Casanayan	11.518531, 123.056562
Roxas City	
Barra	11.585767, 122.714205
Punta Cogon	11.606959, 122.794160
Cagay	11.571579, 122.710190

Table 1.0 Continued.

Ivisan	
Agustin Navarra	11.545666, 122.677821
Balaring	11.570698, 122.647336
Basiao	11.555677, 122.635047
Sapian	
Agsilab	11.507701, 122.572294
Agtatacay Norte	11.502835, 122.575777
Maninang	11.497497, 122.577455

Physical Characterization

The area of this site was measured using a pre-measured rope and GPS. The edges of the site were plotted and the approximate area was calculated from a scaled plot. The profile of the intertidal zone was measured by transect over a distance of 25 m. The linear distance provides an estimate of the rugosity and complexity of the habitat. Physical parameters like water pH and temperature and salinity were determined. The water samples were collected and were analyzed for parameters such as temperature, salinity, and pH.

Transect Plotting

Transects and quadrats are two ecological tools that allow us to quantify the relative abundance of organisms in an area. Place a quadrat with intersecting lines along with predetermined points on the transect line (usually the same points as used for the visual estimate) and record what is underneath each intersection within the quadrat frame. A 25-meter rope was laid out in the nearshore area of the site and a 1x1 meter quadrat was laid out along the transect. This method is similar to that used on the transect, but there are multiple intersections within the square frame counted.

Biological Characterization

A species diversity check-list was compiled by observation throughout the area of the intertidal community. Species were identified using a field guide "Compendium of Economically Important Seashells of Panay, Philippines by Liberato V. Laureta," 2003. Photos were also taken and sent to Southeast Asian Fisheries and Development Center (SEAFDEC), Iloilo City for further identification. Species abundance and distribution of intertidal fauna were measured using a 1m2 best quadrat sampling method along a 25 m transect. Species abundance and diversity were recorded. All collected samples were washed thoroughly with tap water and cleaned. The samples were segregated group-wise and all taxa were identified to specific, generic or other higher levels to the greatest extent possible with the help of standard taxonomic references (Clark & Rowe, 1971; and Carpenter & Niem, 1998).

Data Analysis

The crude list was generated from the data gathered in the field surveys. Raw data was analyzed using PAST Software. Diversity indices were also determined using PAST software.

Procedural Design

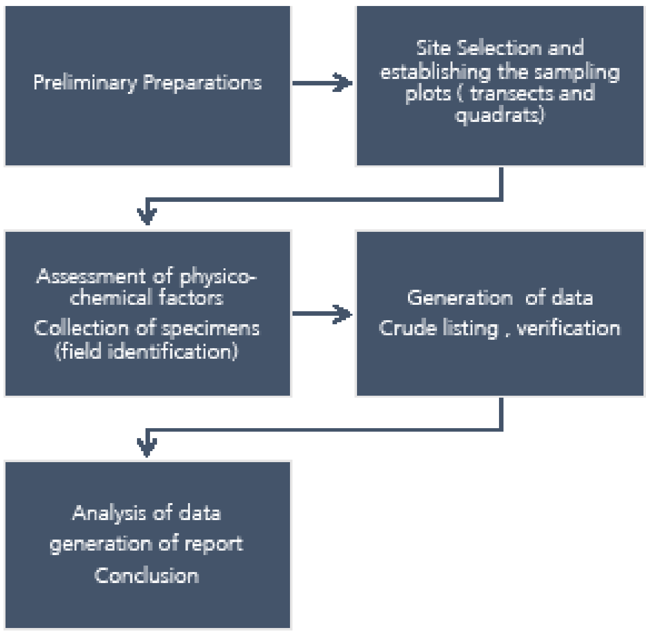

Fig. 2.0 Research flow diagram

Results and Discussion

Physico-Chemical Profile

Table 2.0 Average pH, temperature and salinity

Site	Average pH	Average T (°C)	Average salinity (psu)
Roxas City	7.75	24.7	35.36 +/- 0.42
Panay	6.65	25.6	34.85 +/- 0.50
Pontevedra	6.25	28.8	36.73 +/- 0.20
Pres. Roxas	6.9	26.7	35.42 +/- 0.12
Pilar	6.77	24.8	34.90 +/- 0.32
Ivisan	7.21	25.5	31.43 +/- 0.40
Sapian	6.89	24.7	34.42 +/- 0.17

The physicochemical parameters are the controlling factors in the distribution of living organisms, and varying environmental conditions such as dilution, evaporation, and rainfall play an important role in the coastal ecosystem (Balasubramanian & Kannan, 2005). Generally, mollusk faunal resources play a crucial role in the biodiversity of the coastal ecosystem. In this study, stable environmental factors such as temperature, pH, and salinity, played an important role in shellfish distribution around the coastal area. The mollusks are the major species and have developed a successful relationship between the environment and the biological mechanisms around the coastal areas of the province.

Average Temperature

Using a thermometer average temperature was determined by dividing the respective temperatures from each site. Data shows that Pontevedra sampling sites have the highest temperature compared to all other sites. The temperature of the coastal ecosystem conforms with the annual temperature range of the island which is between 25-32 degrees Celsius. With regards to the temperature, readings revealed that the eastern shoreline ecosystem has warmer temperatures compared to the western shorelines. It is safe to assume that since the area leads to an open sea, there is a high rate of thermal absorption in the nearby ecosystem. The increase in temperature associated with climate change can cause a tremendous impact on the different life stages of aquatic organisms, particularly on the tropical species. Studies have shown the effect of elevated temperature on hatching rate, growth and survival of larvae and breeders of tropical mollusk such as the donkey's ear abalone (Haliotis asinina) in (Pedroso, 2017)

Average Salinity

The salinity (or saltiness) of seawater varies considerably throughout the sampling sites. Results of the analysis revealed that Pontevedra (36.73 +/- 0.20) has the highest salinity recorded among the sampling sites, it is followed by Pres. Roxas 35.56 +/- 0.42. Salinity directly affects the physiology of the shellfishes, according to a study by the University of Florida in 2013, Salinity drops may have sub lethal effects, measured in reduced growth rate. Further, salinity drops may have a chronic impact on clam survival, causing increased mortality over a period longer than examined ,or by causing clam resistance to other environmental parameters. Thus, if salinity drops account for short-term commercial clam seed mortalities, effects may be compounded or moderated by other factors, such as sudden temperature shifts, low oxygen events, pathogens, or handling effects. As early as 1941, Young found out that the effects of low salinity on the survival of gametes and larvae of Mytilus californianus at Scripps Institution of Oceanography, La Jolla, California shows that susceptibility begins at salinities below about 30%. Moreover, even though fertilization still occurs at salinities as low as 21%, larval survival is poor. The author suggests that gamete and/or larval mortality may at least partially explain the absence of adults in brackish bays. Technical papers from the FAO suggest that in cultivating mussels, waterphysio-chemical parameters are also important factors toconsider. The area selected should have a water temperature ranging from 27–30 °C, which is the optimum range required for mussel growth. Water salinity of 27–35 ppt is ideal. A water current of 17–25 cm per second during flood tide and 25–35 cm per second at ebb-tide should be observed. Favorable water depth for culture is 2 m and above, both for spat collection and cultivation.

Species Distribution

The relative distribution of the species is the ratio or percentage of subplots which contain the species. From the crude list generated above, there are 27 occurring species across the sampling sites. From this observation sampling sites in Panay harbors 24 out of the 27 species, followed by Pontevedra with 19 species, Sapian with 17 species; Roxas City and Pres. Roxas with both 15 species and Pilar with 14 species and Ivisan with only 13 species.

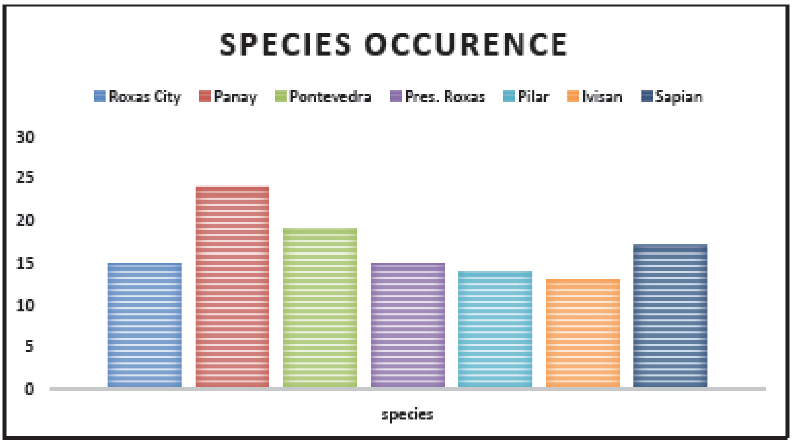

Fig. 3.0 Species distribution across the sampling sites.

Species Diversity

The number of individuals collected from the plots revealed that there is a high diversity of shellfishes found in the coastal barangays in the municipality of Panay. The table was generated from the data in the abundance and frequency of the species found in the sampling sites. The table above shows the Panay has the highest number of individual species collected followed by Pontevedra, Sapian, Roxas City and Pres. Roxas, Pilar, and Ivisan. All in all, in the sampling effort made it is detected that there are 27 species of shellfishes belonging to 17 families.

Species List

Table 3.0 Species list from the different sampling sites.

Family	Scientific Name	Common Name
Mytilidae	Pernaviridis	Tahong
	Septifer bilocularis	Barko-barko
	Modiousphilippinarum	Abahong
Aricidae	Anadaragranos	litob
	Hispidaphilippi	litob
Glycemeridae	Glycerisreevei	bug-aton
Nomiidae	Placuna placenta	kapis
Lucinidae	Eamesiellacorrugata	imbao
	Adontiaedentula	imbao
	Codaliatigerina	tuway-duyong
Cardiidae	Vasticardiumalternatum	litob-litob
	Vepricardiummultipinosum	litob-litob
Mactridae	Mactramaculata	butigis
Pharidae	Ensiculuscultellus	tikhan
Donacidae	Garitogata	bayoyan
	Azorinusacutidues	tikhan
Veneridae	Meritixmeritix	kagaykay
	Callistaerycina	halaan
	Lioncondacastrensis	Punaw
Pholadidae	Pholasorientalis	diwal
Haliotidae	Haliotisasinia	kapinan
Turbonidae	Turbo bruneus	bugtungan
Turritellidae	Turitellaterebra	torotot
Potamididae	Telescopiumtelescopium	bagongon
Cypraeidae	Cypreamoneta	sigay
Ostreidei	Crassostreairedalei	talaba
	Saccostreacurcullata	sisi

Species Frequency

Calculations from the initial crude listing of the species revealed that there 27 occurring species from the different sampling sites. Analysis of the data revealed that sampling sites in Buntod have the highest species frequency with 26% of the total species occurring in all the sampling sites, this was followed by Navitas with 25%, Agojo with 19%, Lat-asan with 18% and Pawa with the lowest with only 12%. The variability of the occurrences of the species is affected by the ecological factors of the environment.

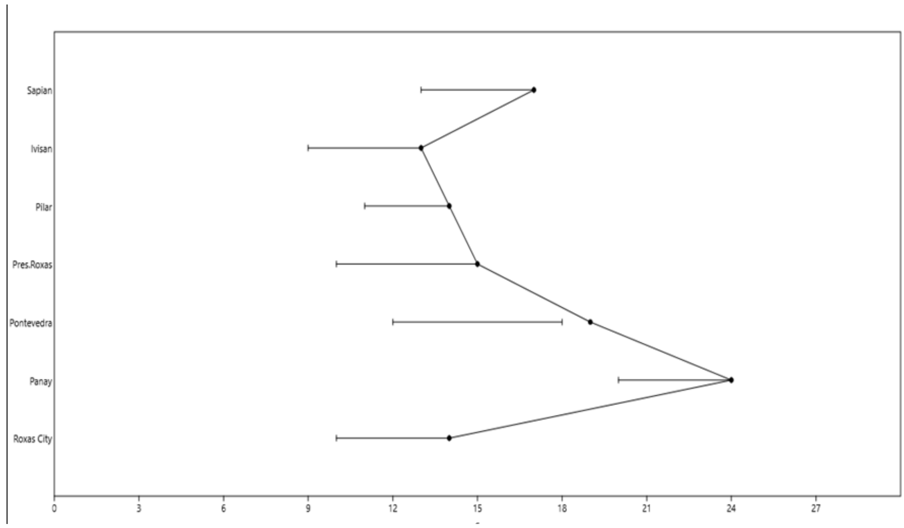

Figure 4.0 Frequency of species found in the sampling sites.

Diversity Index

A diversity index is a mathematical measure of species diversity in a community. Diversity indices provide more information about community composition than simply species richness (i.e.,the number of species present); they also take the relative abundances of different species into account. The Shannon index is an information statistic index, which means it assumes all species are represented in a sample and that they are randomly sampled. In the Shannon, index is the proportion of individuals of one particular species found divided by the total number of individuals found.

The Simpson index is a dominance index because it gives more weight to common or dominant species. In the Simpson index, the proportion of individuals of one particular species found divided by the total number of individuals found, is still the sum of the calculations, and is the number of species.

Data from the sampling sites were collected and organized. It was subjected to statistical treatments using the PAST Ecological Statistics Software. The generated report from the software revealed that over-all, there is a high diversity of shellfishes in the coastal barangays of the Municipality of Panay. This is indicated by the Shanon's H (prime) value =3.143. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon index increases as both the richness and the evenness of the community increase. The fact that the index incorporates both components of biodiversity can be seen as both strength and a weakness.

Alpha diversity indices

Numbers | Plot

	Roxas City	Panay	Pontevedra	Pres.Roxas	Pilar	Ivisan	Sapian
Taxa_S	14	24	19	15	14	13	17
Individuals	24	46	25	20	23	17	30
Dominance_D	0.08333	0.04442	0.0592	0.075	0.0775	0.08651	0.06667
Simpson_1-D	0.9167	0.9556	0.9408	0.925	0.9225	0.9135	0.9333
Shannon_H	2.557	3.143	2.886	2.649	2.593	2.507	2.766
Evenness_e^H/S	0.9211	0.9654	0.9434	0.9428	0.955	0.9437	0.9346
Brillouin	1.96	2.541	2.154	1.943	1.973	1.808	2.161
Menhinick	2.858	3.539	3.8	3.354	2.919	3.153	3.104
Margalef	4.091	6.007	5.592	4.673	4.146	4.235	4.704
Equitability_J	0.9688	0.9889	0.9802	0.9783	0.9826	0.9774	0.9761
Fisher_alpha	14.06	20.25	36.13	27.26	15.18	25.27	16.26
Berger-Parker	0.125	0.06522	0.08	0.1	0.08696	0.1176	0.1
Chao-1	16.14	24.32	30.14	22.5	15	20.2	18.5

Figure 5.0 Diversity Indices generated from PAST 3.0 software of the sampling site

Model Analysis

Data generated were subjected to statistical analysis. The linear regression model was used to determine if the environmental parameters were predictors of the shellfish distribution. Results show that salinity, pH, average temperature were not predictors of the species distribution. Theoretically, ecological parameters influence the distribution, however in this study, since there are minimum sampling effort and cohort environmental data, these were unaccountable,

Table 4. Model summary.

Model	R	R Square	Adjusted R Square	Std.Error of the Estimate
1	.718a	.515	.030	2.12755

a. Predictors: (Constant), salinity, pH, Ave. temp

Table 5. ANOVA.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.421	3	4.807	1.062	.481b
	Residual	13.579	3	4.526		
	Total	28.000	6			

a. Dependent Variable: distribution *b. Predictors: (Constant), salinity, pH, Ave. temp*

Conclusion

Based on the foregoing findings, the following conclusions were drawn. Sampling made from the plots revealed that there are 27 species belonging to 17 families of shellfishes found across the 7 Municipalities of Capiz. Software analysis revealed that over-all, there is a high diversity of shellfishes in the sampling sites in the Municipality of Panay. This is indicated by the Shanon's H (prime) value =3.143. Comparing the distribution of the species, Panay has the highest species, with Pontevedra, Sapian and Roxas City. Distribution is not limited and exclusive per sampling sites.

Recommendation

In context of the results and conclusions, it is recommended that long-term monitoring and successive sampling should be done. Increasing the sampling effort will likely yield more significant data. It is also recommended that further morphometics and molecular phylogentics will be included in the continuation of this research. For the Coastal Municipalities to create a policy in regulating the harvest of mollusc considering its ecology and their benefits in the ecosystem.

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