Mollusks in the Mangrove Rehabilitation Areas in Western Pangasinan, Philippines

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Abstract-*Mollusks are predominantly found inmangrove ecosystems. Nowadays, these are declining due to habitat disturbances. This study was conducted in Western, Pangasinan, with mangrove rehabilitation projects under Community Based Forest Management Agreement. Four mangrove rehabilitation areas were looked into: Pilar and Victory, Bolinao; and Awile and Tori-tori, Anda, Pangasinan. Purposive sampling was done in selecting the mangrove rehabilitation areas. Ten percent sampling of the areas using the belt transect quadrat method was employed. Diversity, dominance , richness and evenness indices for mollusks were determined. Mann Whitney test, Student's t-test and Kruskal Wallis test were used. A total of fourteen kinds of mollusks species were identified. The species were Tectusfenestratus (fenestrate top), Terebraliasulcata (Sulcate swamp perith), Haliotisovinagemelin (oval abalone), Neritaplanospiraanton (flat spired nerite), Clithionoualensis(dubious nerite), Fasciolaria trapezium (trapezium horse conch), Nasarriuspullus (ribbed dog whelk), Trochusmaculatus (maculated top), Rhinoclavisvertagus (Common vertagus), Telescopium telescopium (Telescope Snail), Isognomonephippium (saddle tree oyster) Crassostriairedali (slipper oyster), Strombuslabiatus (Plicate conch) and Polymesodaexpansa (Yellowish mangrove clam). The highest mollusks species diversity and richness indeces were observed in Victory, Bolinao. Mollusks species dominance and evenness indeces were highest in Pilar, Bolinao and Tori-tori, Anda, respectively. The study revealed a significant difference in the probability of gathering mollusks species in the four mangrove rehabilitation areas. It is recommended that fisherfolkand coastal communities be educated about the need for mollusks conservation and habitat protection. It is expected that this study may provide light to future research on mangrove fauna particularly mollusks in Pangasinan.*

Keywords- *species diversity, dominance, evenness and richness*

INTRODUCTION

Mollusks is one of the two classifications of shellfish (the other being crustacean) which is considered to be the second most diverse group of animals in terms of number. They are very susceptible to changes in their environment because of their soft body with shell and permeable skin. However, they can be found in various habitats. Mangroves is one of the habitats of the mollusks. Nowadays, however, mollusks are declining due to habitat disturbances by dams, pollutions and indirectly from the abuse of terrestrial habitats. Several management approaches and methods are used to control or minimize its habitat destruction. One approach to bring back the habitat of marine species, mollusks in particular, is mangrove rehabilitation. This approach could be carried out by an organized community and the Department of Environment and Natural Resources (DENR) through entering into a production sharing agreement called community based forest management agreement (CBFMA).A specific portion of mangrove forest land will be granted to the community for 25 years to develop, utilize, manage and conserve consistent with the principles of sustainable development[1].

Pangasinan has an estimated old stand of mangroves of 283hectareslocated along the coasts of Bolinao, Bani, Alaminos City, Anda, Dasol, and Infanta[2]. The mangroves estimated to be 990 in hectares in 1978[2]. Majority of these old stand areas were already fragmented due to natural and anthropogenic disturbances. In 1960, large mangrove areas were converted into fishponds for the culture of

milkfish (*Chanoschanos*) and shrimps with the aim of government to increase fish production[3]. Towards the end of 1970, the government realized the fishery value of mangroves[3]. But only in 2000 when mangrove rehabilitation through CBFMA found its way into the coastal areas of western Pangasinan. A total of 15 CBFMA was awarded, 9 in Andaand 6 in Bolinao with rehabilitated area of 39.9 and 22 hectares, respectively.

Salmo[4]says that a total of 11 mollusks species were recorded in planted mangrove stands of different ages in Tondol and Imbo, Anda; Mona, Alaminos; Pilar, Bolinao; and Bangrin, Bani. These mangroves areas were located along Lingayen Gulf of Western Pangasinan. The recorded mollusk species belonging to class Gastropodawere *Architectonicaperspectiva, Cancellariacancellata, Cerithideacingulata, Nassariusarcularius, Neritapolita, Peristerniaphilberti, Stombusurceus, Vexilliumvulpecula.* Three species belonging to class Bivalvia, *Anadaranodifera, Donaxfaba and Tellinalinguafelis* were also recorded. *Cerithideacingulata* and *Neritapolita* consistently appeared in all planted mangrove stands[4].

Salmo further[4]says that the 11 mollusks species recorded in Lingayen Gulf is comparable with the planted mangroves in Gazi Bay, Kenya, 13 species, but relatively low compared to ASEAN mangroves sites, 26 in Selangor, Malaysia, 34 in Ranong, Thailand, and 44 in Sarawak, Malaysia. The rehabilitated mangroves with increased forest structure and biomass can be effective in facilitating mollusks colonization.

Mollusks and other marine species diversity depends much on the sustainability of the CBFMA mangrove rehabilitation. Few studies have been conducted on mollusks in developed or planted mangrove stands particularly in the province of Pangasinan, hence,remains to be a challenge among researchers, development agents, academicians, policy-makers, regulators and other government authorities. Such challenge made this study to identify mollusks;recognize its diversity,dominance, richness and evenness indices;and compare and contrast data collected by similar methods between Anda and Bolinao mangrove rehabilitation areas in terms of species diversity. The information out of this study will be very useful to the coastal communities with mangroves, fisher folks, fishing industry and government with related fishery authority, and civil society organizations concerned.

OBJECTIVES OF THE STUDY

Generally, this study was conducted to assess the diversity of mollusks inhabiting the mangrove rehabilitation areas in Western Pangasinan. Specifically, it sought to identify mollusks; recognize its diversity, dominance, richness and evenness indices; and compare and contrast data collected by similar methods between Anda and Bolinao mangrove rehabilitation areas in terms of species diversity.

MATERIALS AND METHODS

Site Description

The study was carried out in Northwestern Pangasinan with two pronounced seasons, rainy season from May to October and dry season from November to April. But because of changing climate nowadays, seasonal pattern may vary.

The initial mangrove rehabilitation started in 1980s through the Integrated Coastal Management Programs[4]. In early 2000, mangrove rehabilitation continued and expanded in the municipalities of Anda and Bolinao, western Pangasinan through the Community-based Forest Management Agreement Program. Most of the mangrove species planted were mono-specific using the species *Rhizophoramucronata* and few *Rhizophoraapiculata and Rhizhophorastylosa.* Spacing of mangrove species planting ranges from 1m x 1m to 2m x 2m.

Awile and Tori-tori, Anda; andPilar and Victory, Bolinao were purposively selected as study sites. Awile and Tori-tori mangrove rehabilitated areas are one and two hectares, respectively. Pilar and Victory mangrove rehabilitated areas are six and eight hectares, respectively. Salmo says[4]that the average water depth of the sites is 1-2 m and exposed during high and low tides, respectively.

Sampling Design

Ten percent sampling of the said areas using the belt transect quadrat method was employed. Within the 10m x 10m quadrat, three 1m x 1m quadrat equally distributed were established as mollusks plots. Sampling was carried out starting from the shore going seaward.

Mollusks Collection

Mollusks in each sampling unit were collected down the roots of the mangroves up to the water surface and picking them by hand. Mollusks were immediately recorded and identified using a field guide to the identification of Philippine mollusks. Unidentified ones were referred to the fisherfolk and mollusk expert.

Data Analysis

Diversity, dominance, richness and evenness indices for mollusks were determined using the following formula:

a) Shannon index of diversity[5],

$$H = \sum_{i=1}^{s} - (P_i * \ln P_i)$$

where:

H = the Shannon diversity index

P_i= fraction of the entire population made up of species i

s = numbers of species encountered

$\sum$ = sum from species 1 to species S

Note: The power to which the base e (e = 2.718281828.....) must be raised to obtain a number is called the **natural logarithm** (ln) of the number.

To calculate the index:

1. Divide the number of individuals of species #1 you found in your sample by the total number of individuals of all species. This is P_i
2. Multiply the fraction by its natural log ($P_1 * \ln P_1$)
3. Repeat this for all of the different species that you have. The last species is species "s"
4. Sum all the - ($P_i * \ln P_i$) products to get the value of H

b)Simpson index of dominance[5]

$$D = \frac{\Sigma\, n(n-1)}{N(N-1)}$$

where: D = index of dominance

n = number of individuals in a species

N = total number of individuals in all species

The value N is the total number of organisms of all species, and n is the total number of organisms of a particular species. Zero represents infinite diversity, and 1 represents no diversity. Since this is not intuitive, D is often subtracted from 1 to give the higher values. .

c) Species Richness index

$$S = n + \left(\frac{n-1}{n}\right)^{k}$$

where

S = species richness

n = total number of species present in sample population

k = number of "unique" species (of which only one organism was found in sample population)

Species richness is the number of different species present in an area. The more species present in a sample the 'richer' the area.

d) Species Evennessindex[6]

$$J = \frac{H}{H_{max}}$$

where J = species evenness

H = index of species diversity

$H_{max} = \log_n S$

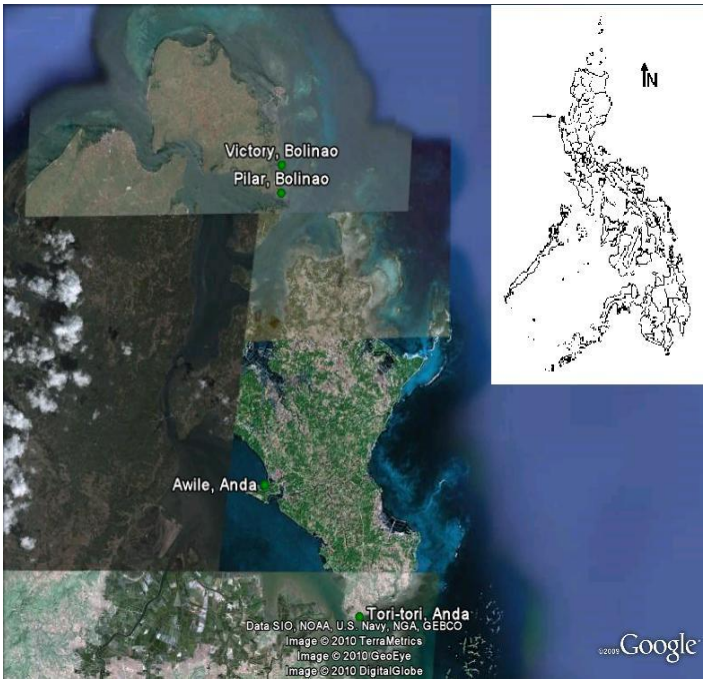

Figure 1. Location of the study sites in Anda and Bolinao, Pangasinan
Source: Google Earth 2010

Data were analyzed statistically using SPSS version 17.0 . Mann whitney test at 0.05 level was used in comparing mollusks diversity between two study sites with less than 30 sample plots. Student's t-test at 0.05 level was employed in comparing mollusks diversity between two study sites with more than 30 sample plots. Moreover, Kruskalwallis test was used in comparing mollusks diversity among four study sites.

RESULTS AND DISCUSSION

Salmo[4] says that mollusk species have distinct pattern in their increase and decrease in biomass with stand age. The developed forest structure and biomass as mangroves mature provides shelter and food for mollusk species. Other study on mollusks assemblage had significant relationship with vegetation and sediment characteristics due to high forest biomass and organic contents. In Salmo's study, seven species were associated with sand, *A. perspectiva, C. cancellata, N. arcularis, N. polita, P. philberti, T. linhuafelis, and V. vulpecula*. *A. nodifera and C, cingulata*were species that increase in biomass in maturing stands. Rehabilitated mangroves facilitated mollusks colonization[4].

A total of fourteen species were identified as shown in Table 1. These species were Tectusfenestratus (fenestrate top), Terebraliasulcata (Sulcate swamp perith),Haliotisovinagemelin (oval abalone), *Neritaplanospiraanton*(flat spired nerite), *Clithonoualeniensis* (dubious nerite), *Fasciolaria trapezium* (trapezium horse conch),*Nasarriuspullus* (ribbed dog whelk), *Trochusmaculatus*(maculated top), *Rhinoclavisvertagus* (Common vertagus), *Telescopium telescopium* (Telescope Snail), *Isognomonephippium* (saddle tree oyster) *Crassostriairedali* (slipper oyster), *Strombuslabiatus* (Plicate conch) and *Polymesodaexpansa*(Yellowish mangrove clam).

The common species found in all mangrove rehabilitation sites were *Strombuslabiatus* (Plicate conch) and *Tectusfenestratus* (fenestrate top). *Terebraliasulcata* (Sulcate swampperith) were recorded in three sites, Pilar, Victory, and Awile. Vivencio[7] saysa total of 13 species of molluscsin the mangrove forest of Pinagbayan, San Juan Batangaswere recorded. Nine species of gastropods namely Bufon aria subgranosa, Cassidula nucleus, Chicoreus sp., Conusfigulinus, Littorariascabra, Nassarius (Zeuxis) olivaceus, Neritaalbicilla, Telescopium telescopium, Terebraliasulcata and four species of pelecypods - Isognomonephippium, Katelysia japonica, Lanceolariagrayana, Polymesodaerosa were identified. The said species fall under the category of common species as classified by the National Museum of the Philippines and the Bureau of Fisheries and Aquatic Resources and based on the IUCN Red List and the Molluscs in CITES[7].

Table 1. Identified mollusks species in Mangrove Rehabilitation Areas in Western, Pangasinan

	Family	Scientific Name	Common Name	Bolinao		Anda	
				Pilar	Victory	Awile	Tori-tori
Gastropoda	Cerithiidae	*Rhinoclavisvertagus*	Common vertagus	x			
	Fasciolariidae	*Fasciolaria trapezium*	Trapezium horse conch	x			
	Haliotidae	*Haliotisovinagemelin*	Oval abalone	x	x		
	Nassaridae	*Nassariuspullus*	Ribbed dog whelk	x			
	Neritidae	*Neriteplanospiraanton*	Flat-spired nerite	x	x		
		Clitonoualensis	Dubious nerite	x	x		
	Potamididae	*Terebraliasulcate*	Sulcate swamp cerith	x	x	x	
		Telescopium Telescopium	Telescope snail	x			
	Strombidae	*Strumboslabiatus*	Plicat conch	x	x	x	x
	Trochidae	*Tectusfenestratus*	Fenestrate top	x	x	x	x
		Trochusmaculatus	Maculated top shell	x			
Bivalvia	Corbiculidae	*Polymesodaexpansa*	Yellowish mangrove clam			x	x
	Isognomonidae	*Isognomonephippium*	Saddle tree oyster	x			x
	Osteridae	*Crassostriairedali*	Slipper oyster			x	x

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Diversity indices i.e species diversity, richness, dominance and evenness are shown in Table 2. The highest mollusks species diversity and richness indices were observed in Victory, Bolinao. Mollusks species dominance and evenness indices were highest in Pilar, Bolinao and Tori-tori, Anda, respectively.

Table 2. Mollusks Species Diversity, Richness, Dominance, and Evenness in the Mangrove Rehabilitation Areas in Anda and Bolinao, Pangasinan.

Diversity Indices	Mangrove Rehabilitation Areas			
	Pilar	**Victory**	**Awile**	**Toritori**
Species Diversity	0.1514	*0.5501	0.4936	0.5234
Species Richness	1.3095	*2.2778	2.0000	2.0556
Species Dominance	*0.8303	0.6072	0.5631	0.6057
Species Evenness	0.1870	0.2426	0.5292	*0.5519

*Legend: * highest value*

Table 3 shows the comparative difference in mollusks species diversity between and among mangrove rehabilitation areas in Anda and Bolinao. Table 3 reveals the difference of species diversity between MRAs in Awile and Toritori using Mann-Whitney U. The computed p value was 23 which is greater than 0.953 (Mann–Whitney $U = 1.5$, $n_1 = 4$, $n_2 = 1$, $P < 0.05$ two-tailed)and interpreted as no significant difference in the species diversity of mollusks between mangrove rehabilitation areas in Awile and Tori-tori. Results on the comparative difference of species between MRAs in Pilar and Victory in Bolinao using t-test showed that there is a significant difference on the probability of gathering a mollusks species in Pilar and in Victory. Further, the results of statistical test using the Kruskal Wallis H test showed that there is significant difference in the probability of gathering mollusks species in the four mangrove rehabilitation areas.

Table 3. Comparative Difference in Mollusks Species Diversity Between and Among
Mangrove Rehabilitation Sites in Anda and Bolinao.

Mangrove Rehabilitation Site	**Computed Value**	**P value**
Within Anda (Awile & Toritori)	23.00	0.953
Within Bolinao (Pilar & Victory)	-8.584	-.3817649
Between Anda and Bolinao (among MRAs)	36.641	0.000*

**Significant*

Dela Cruz and Camacho [8]have recorded nine mollusks species found in the natural stand of mangroves in the river mouth of Kayanga and Dasol Bay, Pangasinan. The number of mollusks species recorded in this study is fourteen in the manmade stand of mangroves of western, Pangasinan.The highest species diversity and richness observed in Victory, Bolinao can be attributed to the greater area planted with mangrove species. The presence of mangroves that provide a habitat structure and food could have influence in the mollusks species dominance and evenness in Pilar, Bolinao and Tori-tori, Anda, respectively. The Pilar mangrove rehabilitation area was planted with three species of Rhizophora and one Rhizophora species in Tori-tori, Anda[9].

The significant difference between Pilar and Victory, Bolinao and among the mangrove rehabilitation areasimply that the probability of selecting a mollusks species in one mangrove rehabilitation area is different with the probability of selecting a mollusks species in another mangrove rehabilitation area. This is in agreement with the findings of De Vera [9].

CONCLUSION AND RECOMMENDATION

Among the 14 species of mollusks identified, consisting of 11 gastropods and 3 bivalves, *Strombuslabiatus* (Plicate conch) and *Tectusfenestratus* (fenestrate top) were the common species found in all mangrove rehabilitation sites followed by *Terebraliasulcata* (Sulcate swamp perith) which were recorded all sites except Tori-tori. These mollusks species were regarded common speciesas classified by the fishery and mollusks authorities.

The highest mollusks species diversity and richness indeces were observed in Victory, Bolinao. Mollusks species dominance and evenness indeces were highest in Pilar, Bolinao and Tori-tori, Anda, respectively. The study revealed a significant difference in the probability of gathering mollusks species in the four mangrove rehabilitation areas. It is recommended that fisherfolkand the coastal communities be educated about the need for mollusks conservation and habitat protection.

In this study, an attempt was made to initiate research on mangrove mollusks in Pangasinan which receive little attention at present. It is expected that this study may provide light to future research on mangrove fauna particularly mollusks in Pangasinan.

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Further study on the identification of the mollusks species under threat and survey to determine the distribution of species, population, communities, their economic potentials and categorization is needing.

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