# SURVEY OF MACROBENTHIC ORGANISMS ASSOCIATED IN SELECTED MANGROVE AREAS OF ORMOC CITY, LEYTE, PHILIPPINES

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Received: 07.02.2020 / Accepted: 12.09.2020

Abstract: Macrobenthic organisms are an important component of any aquatic ecosystem though limited studies have been conducted in areas like the Philippines. Hence, this study deals with macrobenthic organisms associated in the mangrove areas of Lao and San Juan, Ormoc City, Leyte with some parts converted into ponds conducted in the months of December 2014 and January 2015. A total of 52 (1 x 1 m) quadrats were utilized within a transect laid in the adjacent sampling sites and away from fish ponds. 24 species under 18 families were identified in this study. Twenty-one species were recorded in San Juan (13 gastropods, 3 bivalves and 5 crustaceans) with an abandoned fishpond and twenty-two species in Lao (14 gastropods, 3 bivalves and 5 crustaceans). Generally, the macrobenthic organism density, evenness and diversity indices between sites were highest in Lao (site 2). In terms of distribution per zones (towards the sea, middle and towards the land), the highest was obtained in the middle zone in San Juan (site 1) and highest towards the land in Lao (site 2) both in mangrove areas away and near fishponds. There were no significant differences in the density and diversity of macrobenthic organisms between and within sites. Cannonical Correspondence Analysis showed that species are affected by soil pH, soil temperature and substrate type.

**Keywords:** fishpond, Lao, macrobenthic organisms, mangrove, Ormoc, San Juan

## **Introduction:**

Mangrove forest is one of the extremely diverse habitats when it comes to variety of species occurring in high densities (Samidurai et al. 2011). It supports numerous diversified soil micro, meio and macro organisms. All these soil organisms, especially microbial flora, play a very active role in the degradation of mangrove foliage, which is continuously shed and decomposed in the mangrove substratum (Kumar 2000). Epibenthic species dominate the macrofauna where mollusks and crustaceans are rich in

species in mangroves forests. This dynamic ecosystem does not only support the flora and fauna but also plays a vital role in the environment, especially in its adjacent aquatic and terrestrial food webs by providing the basis for these ecosystems.

Nowadays, conversion of mangrove forest to ponds for aquaculture has been done for economic purposes in many countries. Ronnback (1999) stated that in terms of value per unit catch and total value of catch, the penaeid shrimps are among the most important resources for coastal fisheries

Fretzeljane O. Olor-Pogado and Julissah C. Evangelio Department of Biological Sciences Visayas State University Baybay City, Leyte 6521-1 Philippines e-mail (for all authors): fretzeljane.olor@vsu.edu.ph worldwide thus providing a considerable percent of the large number of seafood produced. People have long been reliant on the mangrove forest for many purposes but such resources are continuously disappearing in many parts of the world due to anthropogenic investments such as commercial harvesting, overexploitation, conversion to agricultural lands, aquaculture, urbanization and extraction of minerals (Adeel and Pomeroy 2002).

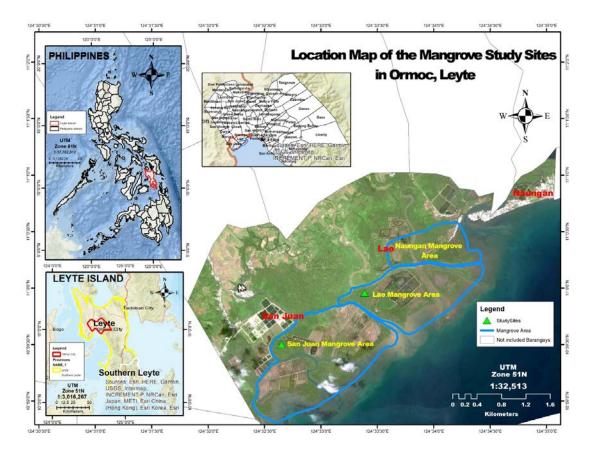
Many studies are conducted in mangrove areas to determine the abundance macrobenthic organisms, which mainly depend on the physical and chemical properties of the substratum. Benthic invertebrates play a vital role in the storage, transformation and release of nutrients (i.e. nutrient cycling) to the overlying water column. It is important to assess benthos since they are reliable bioindicators of a habitat quality because of their limited mobility, reason for which they cannot migrate to avoid stressful conditions associated with the changes occurring in the substrate and helps in the recycling of nutrients, which in turn promotes primary productivity (Thilagavathi et al. 2013).

Ormoc City, Leyte comprises a total land area of 613.60 sq. kms as of 2014 with land classification of 62% agricultural, 16% forest, 15% grassland/open spaces, 5% built-up area and 2% mangrove, swamps or wetland (City Planning and Development Office 2020). This investigation of macrobenthic organisms associated with selected mangrove areas of Ormoc in coordination with OXFAM (Oxford Committee for Famine Relief) and LGU-Ormoc are to provide valuable information on the factors influencing the presence of these macrobenthic organisms. Given that only 2% of the area is covered with mangroves, it is important to understand the effect of anthropogenic activities including conversion of some parts of the site into fishponds. This study specifically aims to identify the macrobenthic organisms associated with selected mangrove areas of Ormoc, Leyte and to compare the community structure of the selected sites.

## **Materials and methods:**

Sampling of macrobenthic organisms was conducted in Lao and San Juan, Ormoc City (Fig. 1). These two barangays are adjacent to each other and some areas of the mangroves have been converted into fishponds. A site visit was undertaken prior to the conduct of the study to identify the different sampling stations. The first site was established in San Juan displaying a total mangrove area of ~185 ha and ~100 ha converted to ponds. It is situated at 11° North latitude, 124.54° East longitude and 30 meters elevation above the sea level. It is located at the northwest of Ormoc and neighbours the towns of Matagob and Merida. The mangrove stretches along the coastal areas of Lao and Naungan being generally characterized by sandy - muddy substrate. The second site was Lao, located between San Juan and Naungan having a mangrove area of ~138 ha with ~30 ha converted to ponds. Both barangays receive a considerable amount of freshwater from river inputs which makes it suitable aquaculture. The transect-quadrat method was used in assessing the associated macrobenthic organisms in the established mangrove sites with six transects per mangrove area. Transects were placed in strategic areas being accessible and safe. The transect length was increased based on the size of the mangrove area. A one x one m quadrat was randomly placed along the transect which totaled to 36 quadrats. The collected samples in the field were placed in a prior labelled ziplock bag and were fixed with 70% ethanol. Identification was done at the lowest possible taxon using Springsteen and Leobrera (1986), FAO Identification Guide for Fishery Purposes (Carpenter and Niem 1998) and Indo-Pacific Coral Reef Guide (Allen and Steene 1998). Physical parameters in the area like soil and water temperature, pH, salinity and percent organic matter were also measured. The community structure of the mangrove area was calculated using Shannon's Diversity Index and Shannon's index of evenness, Morisita's index. Density and Frequency were also recorded. One-way ANOVA was used to determine if there was significant difference among zones within site and Cannonical Correspondence Analysis to infer possible relationship between species and environmental variables.

**Figure no. 1** Location map of the study sites (bordered by blue line) in Ormoc City, Leyte (Inset is map of the Philippines and Leyte Island)



## Results and discussion:

The overall composition of macrobenthic organisms recorded in the mangrove areas of Lao and San Juan, Ormoc City, Leyte is presented in Figure 2. Gastropoda dominated most of the organisms found in macrobenthic assemblage, followed Malacostraca and Bivalvia; mudskippers were also present in the study site. Within the major taxa recorded, a total of 24 species belonging to 18 families, under 2 phyla were observed in both sites throughout the study period (Tab. Annexes). 1. Some representative macrobenthic organisms are

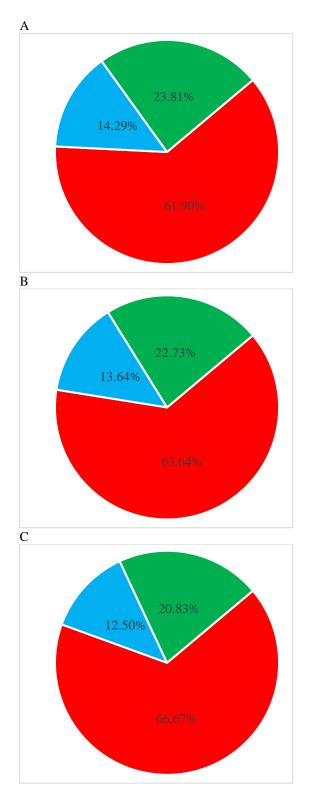
shown in Figure 3 and the density of macrobenthic organisms near and way fishponds for both San Juan and Lao is presented in Figure 4. In areas near the fishpond in San Juan (A), the highest macrobenthic density  $(3.78 \pm 1.55 \text{ indiv. m}^{-2})$  was obtained in the middle zone where it is characterized by sandy-muddy substrate. While, in areas away from ponds, the highest density of macrobenthic organisms was distributed towards the sea  $(1.64 \pm 1.27 \text{ indiv. m}^{-2})$ . In Lao (B), the highest density in areas near and away from the pond was obtained in the zone towards the sea characterized by muddy substrate.

Out of the 24 species, 21 species were found in San Juan and 22 were recorded in Lao (Tab. 1, Annexes). Few species were noticed to be present in either of the two sites which were Cassidula nucleus, Nerita sp. and Lophiotoma polytropa which were present only in San Juan, as well as Vexillum Chicoreus subdivisum, capucinus Nassarius olivaceus found only in Lao. Likewise, the presence of barnacles attached on mangal roots of Avicennia, Sonneratia, and Rhizophora sp. which offer a great surface for attachment. Bivalves under Family Veneridae were also found; the local people also collect these to generate additional income. These families of bivalves are known to tolerate high inundations of tide and fluctuations of salinity. In Ormoc, conversions of mangrove area to fishponds have been undertaken due to the need of fast economic development. Loss of this habitat, associated with the degradation of the macrobenthic community, may have the effect of reducing (or had the effect of reducing) the diversity in the areas. Salinity is one of the factors that drive the change in faunal communities as stated by Furota and Emmett (1993) and Bakus (1990) aside from depth, sediment grain size and predator density. Gastropods and bivalves obtained during the sampling generally live on the substrate or attached to the roots. Moreover, there was no significant difference in the density of macrobenthic organisms between sites (p > 0.05, t-test). The results showed that gastropods had high abundance distribution in both sites probably due to their mobile characteristic. Shanmugam Vairamani (2008) stated that gastropods are suitably adapted to various macrohabitats of the mangrove ecosystems that provide ideal conditions for their productivity. Because of the predatory nature of gastropods, they occupy a pivotal role in maintaining the productivity and functioning of mangroves through "cleaning" root system from encrusting fauna. In addition, Tee (1982) stated that almost all gastropods are

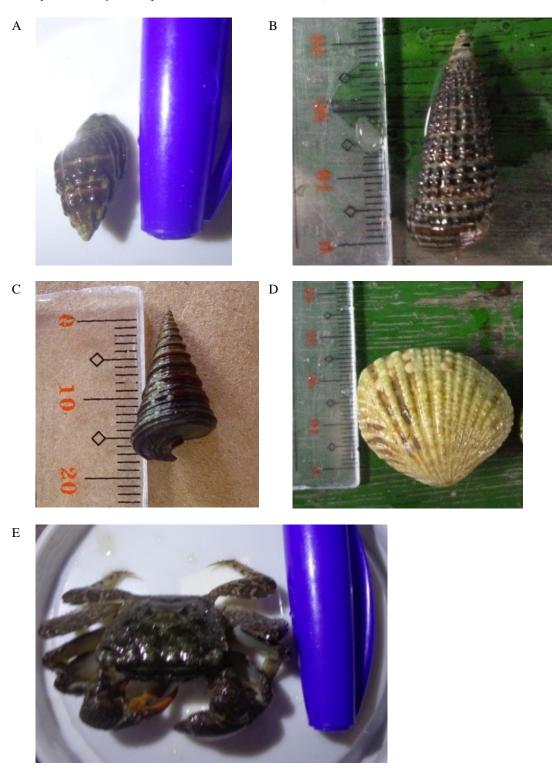
categorized as a tree climber, moving up and down to follow the tide, for example they go down to the ground that is not flooded during low tide. This is why during the sampling they are found on the surface. Bivalves were less encountered because of their behavior as infaunal organisms. The gastropods found in the study area during the study period were Cerithidea quadrata, Cerithidea obtusa, Telescopium telescopium, Terebralia sulcata, Cerithidea cingulata (Family Potamididae), Nassarius sp. (Nassaridae), Nerita picea (Neritidae), Natica lineata (Naticidae), Conus miliaris (Conidae), Chicoreus capucinus, Nassarius olivaceus (Muricidae), Mitra sp. Vexillum subdivisum (Mitridae). (Costelariidae), Littorina scabra Cassidula (Littorinidae), nucleus and Lophiotoma polytropa (Family Turridae). Species under Class Bivalvia where Gafrarium pectinatum, Pteria penguin and Fulvia papyracea while crustaceans where Uca spp., grapsid crabs, unidentified crabs and hermit crab.

Nassarius sp. was deemed to be the most common species in the middle zone, even with a uniform distribution all throughout the site. This species along with other Nassa snails have a limitation to salinity, they are not euryhaline thus their growth is impeded by low and higher salinities with an optimum range of 15 to 20 ppt (Global Invasive Species Database 2015). This could probably explain as to why they are not found in large numbers both in areas near and away from fishpond towards the sea because of the low salinity caused by freshwater input from the adjacent rivers. They are also less encountered towards the land, near the ponds due to increased salinity from the brackish water inundation and anthropogenic disturbances like fishpond development and their sensitivity to the degree of pollution in the environment, since they cannot tolerate highly polluted environment. The substrate type of the mangrove seaward was also characterized by deep mud promoting anoxic conditions which may not be suitable for some species.

Figure no. 2 The major taxa of macrobenthic organisms found include Gastropoda (red), Bivalvia (blue) and Malacostraca (green). Image A represents San Juan, B represents Lao and C represents the consolidated data from the two sites.

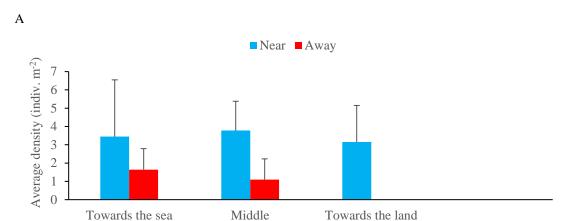


**Figure no. 3** Representative macrobenthic organisms common to the mangrove areas of Brgy. Lao and Brgy. San Juan, Ormoc City (A. *Cymatium* sp.; B. *Cerithidea cingulata*; C. *Telescopium telescopium*; D. *Gafrarium pectinatum*; E. *Persamia bidens*)

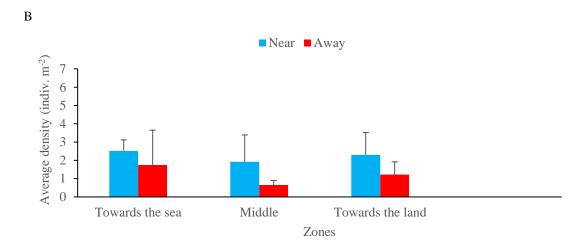


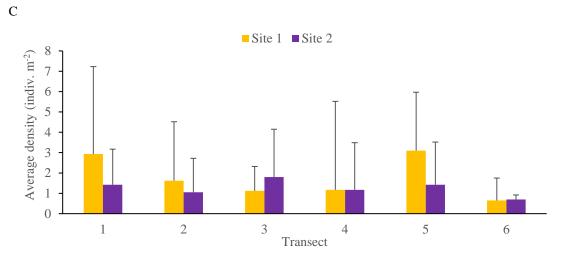
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**Figure no. 4** Average density of macrobenthic organisms per zone in San Juan (A), Lao (B) and per transect in both sites (C). Orange indicates San Juan (site 1), while purple indicates Lao (site 2). Note: Error bars are plotted to show standard deviation.



Zones





In addition, organic matter (OM) in this mangrove area decreased towards the land with the lowest OM near the ponds, hence explaining perhaps the lowest abundance and density in this zone. The presence of waste materials and garbage in the middle zone heading towards the land which were very observable during the sampling may be a reason which has probably limited the occurrence of macrobenthic organisms in these sites. A sandy substrate was observed in the mangrove area seaward with roots of Avicennia and Sonneratia sp. emerging from the substratum serving as attachment for gastropods and bivalves. Nerita picea, a nerite snail was commonly found in this zone. Nerita species are high-tide shore dwellers which are commonly found along the shoreline but climbs up mangal roots especially during high tide. They live either on rocks or mangrove trees. The highest density in areas near and away from the pond was obtained in the zone towards the sea characterized by muddy substrate. Different species have different substrate type preference. Percent organic matter in the seaward zone was the lowest among the areas sampled which was probably consumed and utilized by the plants and seedlings present upon sampling. Crabs were commonly found abundant in this zone due to their mobile characteristics with response inundation and the presence of leaf litter from the dense cover of mangrove trees. Furthermore, the top five most important species based on Relative density (RDe) and Relative frequency (RFe) is presented in

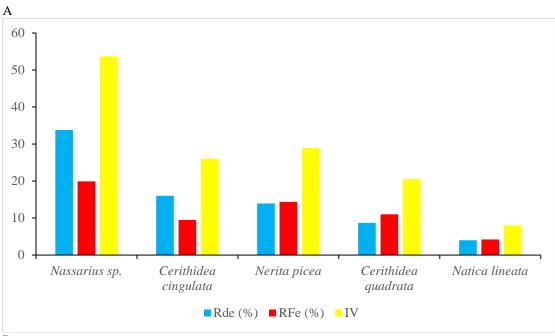
Figure 5. In San Juan, having 33.81% and 19.89% RDe and RFe respectively, *Nassarius* sp. obtained the highest importance value in site 1 with 53.69. *Nassarius* sp. had a random distribution (I = 0.62) where it is seen both in muddy and sandy substrates. This was followed by *Nerita picea* with a relative density of 13.93%, relative frequency of 14.36% and an importance value of 28.89 which is also randomly distributed (I = 0.11). They are found abundant in areas away from ponds. In site 2, *Cerithidea cingulata* had the highest importance value of 49.91 with a value of 30.08% and 19.28% for RDe and RFe respectively.

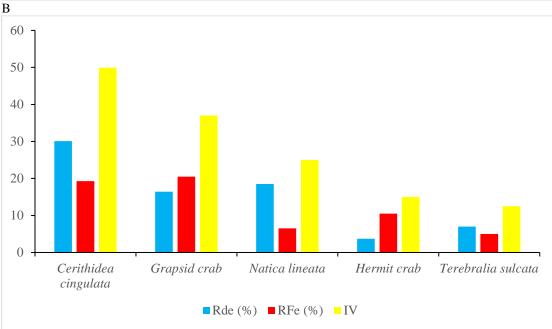
Ecological indices for both sites are enumerated in Table 2. For San Juan, areas near ponds obtained higher diversity and is supported by the value of Simpson's index (D) depicting no dominant species. While in Lao, areas away from ponds showed higher diversity compared to those areas near the ponds. This is because Lao of the two sites has the lesser mangrove area converted to ponds approximately 30 ha which is just 20% of the total mangrove area of the site. According to Primavera et al. (2013), Saenger et al. (1983) recommended that the amount of mangrove forest converted to ponds should not exceed one ha of four ha of mangrove or 20% of the mangrove area. Hence, Brgy. Lao can be said to support the diverse life of macrobenthic organisms. J (0.75) supports the diversity index (H'), since a value close to one indicates that the abundance of organisms is almost evenly distributed within the site with lower dominance (0.37).

**Table no. 2** Ecological indices in areas near and away from fishponds in both sites. Note: H' (Shannon's diversity index); D (Simpson's index) and J (Pielou's evenness index).

Sites		H'	D	J
San Juan	Near fishponds	1.39	0.38	0.57
	Away from fishponds	0.85	0.26	0.64
Lao	Near fishponds	1.15	0.32	0.52
	Away from fishponds	1.38	0.37	0.75

Figure No. 5 Top five species with the highest relative density (RDe), relative frequency (RFe) and importance value (IV) in San Juan (A) and Lao (B).





A diversity value which is below 1.5 to 3.5 is lower, thus more protection and management should be enabled in the area. Moreover, there is no significant difference in the diversity between sites (p > 0.05, T- test). Furthermore, the species found to be suited in

areas near the ponds in both sites, which could indicate that they can cope up with stress and change in the environment, are grapsid crab, Cerithidea quadrata, Cerithidea cingulata, Nerita picea, Persamia bidens and Telescopium telescopium. Due to the

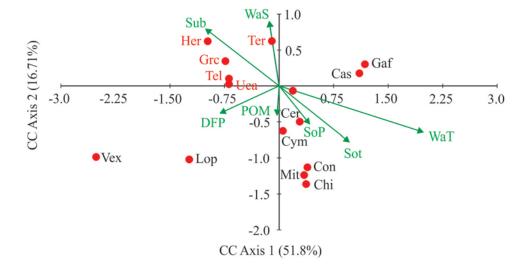
adaptations of *Cerithidea cingulata* to pollution they are able to live and survive in a polluted area (Salehi et al. 2015). The gastropods that obtained the highest value generally contributes to the overall health of the mangrove where if exploited may affect the community structure of macrobenthic organisms in the mangrove areas. Gastropods play a vital role as deposit and suspension feeders ingesting soil organic matter and serving as food for larger organisms, linking adjacent ecosystems and prevents fouling organisms like oysters in mangrove roots (Hutchison et al. 2014).

The environmental parameters in the area were obtained and deemed to be of a typical mangrove area, the salinity ranged from 14-24.33 ppt. The lowest pH was obtained from site Lao in areas without fishpond. Water and soil temperature ranges from 26-31.5 °C in both sites where the highest temperatures were obtained in areas away from ponds. The pH ranges from 6.5 to 7.68 for site 1 and site 2 respectively. Substrate type in both sites are

muddy (seaward), sandy to rocky (middle ward to landward). In addition, percent OM (POM) was found to be higher in areas away from fishponds.

Cannonical Correspondence **Analysis** showed that among all environmental variables, soil temperature (SoT), water temperature (WaT) substrate type (Sub) and water salinity (WaS) have the highest influence on the community structure of macrobenthic organisms in Ormoc City (Fig. 6). Specifically, an apparent relationship of some macrobenthic organisms to specific factors such as Cerithidea sp. with soil pH, Terebralia sulcata with water salinity, and *Nerita antiquata* with water temperature. DFP (Distance to fishponds) somehow did not have an apparent relationship regarding macrobenthic organisms. It should also be noted that all fishponds in the study sites are abandoned, thus this could have been a factor for the persistence of macrobenthic organisms regardless of proximity to fishponds.

**Figure no. 6** Canonical correspondence analysis (CCA) of macrobenthic organisms and environmental variables in selected mangrove areas of Ormoc City, Leyte. Note: mangrove snails (blue circles) where three-code names stand for Her - Hermit crab, Tel (*Telescopium telescopium*), Cym (*Cymatium* sp.), Cer (*Cerithidia cingulata*), Ner (*Nerita picea*), Mit (*Mitra* sp.), Chi (*Chicoreus capucinus*), Gaf (*Gafrarium pectinatum*), Cas (*Cassidula nucleus*), Lop (*Lophiotoma polytropa*), Vex (*Vexillum subdivisum*), Uca (*Uca* sp.), Grc (Grapsid crab) and (green) continuous environmental variables (vectors). SoT (Soil temperature), Sub (Substrate type), SoP (Soil pH), WaT (Water temperature), WaS (Water salinity), POM (Percent organic matter) and DFP (Distance to Fishponds).



#### **Conclusions:**

This study surveyed the macrobenthic organisms associated in the mangrove areas of Lao and San Juan, Ormoc City and the influence of fishponds in the community structure. The survey identified 24 species under 18 families from 2 phyla. With this, gastropods dominated with 66.67%, bivalves with 12.5% and crustaceans with 20.83% of the total composition. The species found to be suited in areas near the ponds in both sites which indicate that they can cope up with the stress and change are grapsid crab, Cerithidea quadrata, Cerithidea cingulata, Nerita picea, Persamia bidens and **Telescopium** telescopium. Results showed that Lao (site 2), which comprises a lesser area of mangroves converted to ponds have higher species richness.

#### Rezumat:

STUDIUL ORGANISMELOR MACROBENTICE ASOCIATE IN ZONELE DE MANGROVE SELECTATE DIN ORMOC CITY, LEYTE, FILIPINE

Organismele macrobentice reprezintă o componentă importantă a oricărui ecosistem acvatic, desi au fost realizate foarte putine studii în zone precum Filipine. În acest sens, nostru tratează organismele macrobentice asociate în zonele de mangrove din Lao si San Juan, Ormoc City, Levte, cu unele teritorii transformate în iazuri, în perioada decembrie 2014 și ianuarie 2015. Au fost folosite un număr de 52 de pătrate (1 x 1 m) pe un transect directionat in siturile de prelevare a probelor și departe de iazurile piscicole. Au fost semnalate un număr de 24 de specii aparținând la 18 familii. 21 de specii au fost observate în San Juan și o pescărie abandonată (13 gasteropode, 3 bivalve și 5 crustacei) și 22 de specii în Lao (14 gasteropode, 3 bivalve și 5 crustacei). În general, densitatea, distribuția și indicii de diversitate a organismelor macrobentice între zonele de studiu au fost mai mari în Lao (situl 2). În ceea ce privește distribuția pe zone (spre mare, mijloc și spre țărm), cea mai mare a fost semnalată în zona de mijloc din San Juan (situl 1) și cea mai mare spre țărmul din Lao (situl 2), atât în zonele de mangrove, cât și în apropierea fermelor piscicole. Nu au fost înregistrate diferențe mari în ceea ce privește densitatea si diversitatea organismelor macrobentice atât între, cât și în interiorul zonelor de studiu. Analiza corespondenței canonice indică faptul că speciile sunt afectate de pH-ul solului, temperatura solului și tipul substratului.

# **Acknowledgements:**

The authors would like to thank OXFAM for granting funds in the conduct of the study. To Prof. Analyn M. Mazo and Eliza D. Espinosa of Visayas State University for the valuable inputs in the study. Also, to the City Planning and Development Office of the City of Ormoc for their assistance in the land use data (1991-2014) of Ormoc City.

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**Annexes:** 

**Table no. 1** Macrobenthic organisms recorded in selected mangrove areas of Ormoc City, Leyte. A total of 24 species identified with 21 species found in San Juan and 22 in Lao. Note: (+) present; (-) absent.

	Species name	English name	San Juan	Lao
Phylum Mollusca	•			
Class Gastropoda				
Family Cymatiidae	Cymatium sp.		+	+
Family Potamididae	Cerithidea quadrata	Horn shell	+	+
	Telescopium telescopium		+	+
	Terebralia sulcata	Swamp cerith	+	+
	Cerithidea cingulata	Cerith	+	+
Family Neritidae	Nerita picea	Nerites	+	+
Family Naticidae	Natica lineata	Moon snails	+	+
Family Conidae	Conus miliaris	Cone shell	+	+
Family Cerithidae	Cerithidea obtusa	Cerith	+	+
Family Muricidae	Chicoreus capucinus	Murex snails	+	+
	Nassarius olivaceus	Murex snails	-	+
Family Mitridae	Mitra sp.	Miter shell	+	+
Family Costellariidae	Vexillum subdivisum	Costate mitter	-	+
Family Littorinidae	Littorina scabra	periwinkle	-	+
Family Turridae	Lophiotoma polytropa	Turrids	+	-
Family Cassidae	Cassidula nucleus		+	-
Sub total	16		13	14
Class Bivalvia				
Family Veneridae	Gafrarium pectinatum	Venus clam	+	+
Family Pteridae	Pteria penguin		+	+
	Fulvia papyracea		+	+
Sub total	3		3	3
Phylum Arthropoda				
Subphylum Crustacea				
Class Malacostraca				
Family Ocypodidae	Uca sp.	Fiddler crab	+	+
ranning ocypoundae	Unidentified crab	crab	+	+
Family Sesarmidae	Persamia bidens	crab	+	+
Family Grapsidae	grapsid crab	grapsid crab	+	+
Family Coenobitidae	Hermit crab	Hermit crab	+	+
Subtotal	5	Ticiliii Ciab	5	5
Total			21	22
Overall percentage of p	87.50	91.67		