

Identification and Biodiversity of Mollusks (Gastropods and Bivalves) in Lake Lanao

ABSTRACT

This study aims to identify and determine the mollusks fauna biodiversity in Lake Lanao. The selection of sampling stations was based on the thirty-two (32) mollusks (soso) vendors from fish/mollusk landings around the lake and public markets in the different municipalities. They were interviewed on the abundance of mollusks in the different municipalities. Modified Belt transect method was employed during the collection of mollusks utilizing a local-made hand-net (siyur) and was picked manually.

Out of the 3,693 individuals of mollusks collected, a total of 6 species were observed, with 3 species coming from the class Gastropoda, 2 from class Bivalvia. Among the Gastropods, the family Thiaridae has the highest number of species namely: *Melanoides* sp., *Thiara* sp., and *Vivipara* sp. On the other hand, two species comprised the Bivalves namely: *Lyonsia* sp. and *Corbicula fluminea*. While one species was unidentified. On the other hand, two invasive species of mollusk fauna were observed in Lake Lanao namely: *Pomacea* sp. and *Achatina* sp.

Results in the Shannon-Wiener Diversity index (H') ranged from 1.618 to 1.753 with its minimum value recorded at the municipality of Molundo and the maximum value recorded in the municipality of Bayan. Moreover, Simpson's dominance index (D) results ranged from 0.1795 to 0.2366 with its minimum value recorded at the municipality of Bayan and maximum value recorded at municipality of Molundo. The range of values recorded from the 9 study sites surrounding Lake Lanao indicated the absence of dominant species. Furthermore, given the values of dominance index were nearer to zero implies a relatively high species diversity.

Findings using the Evenness index (J) ranged from 0.9027 to 0.9782 in the 9 study sites surrounding Lake Lanao, where the minimum value was recorded at the municipality of Molundo while the maximum value was recorded at the municipality of Bayan. These values indicated high evenness index suggesting that the number of individuals in each species was almost the same, the absence of a dominating species, and a better-quality environmental condition due to the presence of ecological balance in the community.

Keywords: Mollusks, Gastropods, Bivalves Lake Lanao, Puket

INTRODUCTION

Lake Lanao is the largest lake in Mindanao and the second largest in the Philippines, located in Lanao del Sur in the southern island of Mindanao with a surface area of 340 square kilometers. Lake Lanao is one of the ancient lakes in the world. Lake Lanao plays a very important role in the life and economy of the Maranao people. The lake serves as their source of food (e.g. fish, shrimps, crabs, etc), the religious ritual of ablution, use the water for household and way of transportation. Also, Lake Lanao is the source of hydroelectric power in Mindanao.

Mollusks are invertebrates that play significant functions in the ecosystem: they are important in the system's food chain; they serve as sources of nutrients for human consumption; and lastly, they provide livelihood and income for the people. However, some mollusks are important hosts for parasitic flatworms such as the species that cause Schistosomiasis in humans. To date, they have caused millions of dollars in commercial damage by clogging the water pipes of power plants and cooling systems. They are driving many native freshwater bivalve species to extinction (Salvini-Plawen, 2014). On the other hand, mollusks provide a sensitive tool for monitoring environmental health.

Freshwater mollusks are classified into gastropods (snails and freshwater "limpets") and several groups of bivalves (mussels and clams) that have repeatedly colonized freshwater. Gastropods have a univalve shell and possess a file-like radula used in feeding on the periphyton coverings of rocks or plants. Mussels and clams have a hinged, bivalved shell and are generally suspension and/or deposit feeders. Freshwater mollusks are common animals in lakes and streams (Graf and Cummings, 2007).

OBJECTIVES

1. To observe mollusks available in the public market of the different municipalities surrounding Lake Lanao and the local catchers and their catches.
2. To interview mollusks' catchers and mollusks vendors in the mollusks landings around the lake and public market where mollusks are sold.
3. To identify and classify the mollusks fauna found in Lake Lanao.
4. To determine the biodiversity of mollusks fauna in Lake Lanao.

MATERIAL AND METHODS

Materials:

Dissecting seat	Snorkeling mask
Improvised hand net (siyor)	Gloves
Underwater camera	Reagent Bottles
Basins	Life Jackets
Boat	Detergent
Colman	Tissues
70% Ethyl Alcohol	Icebox

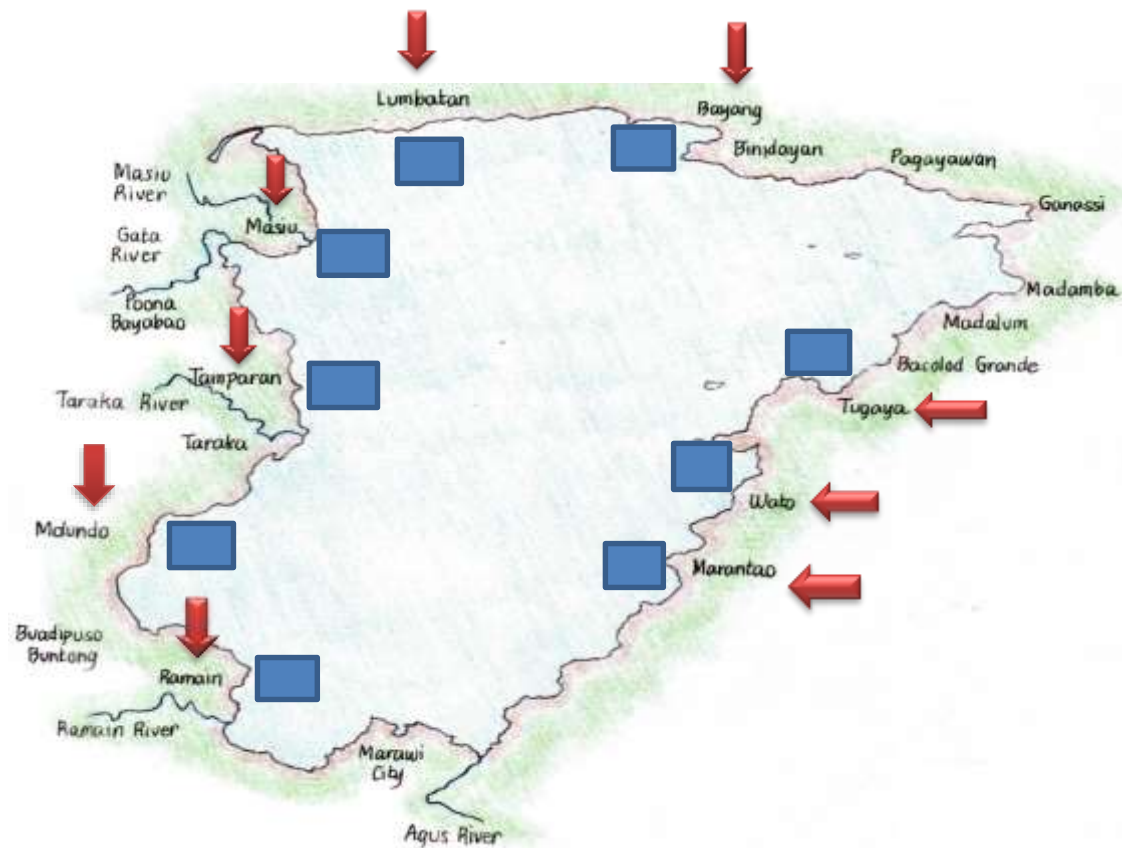


Figure 1. Map showing Lake Lanao and its surrounding Municipalities. Red arrow indicates the 9 sampling municipalities while the blue box indicates the sampling sites

Methods:

Part 1.

1. Entry protocols to the Office of Lanao del Sur governor and some local government offices (Mayor's office and barangay office). Ocular visit to the possible sampling sites on the 18 municipalities surrounding Lake Lanao namely; Ramin, Buadipuso, Molundo, Taraka, Tamparan, Poona bayabao, Masiu, Lumbatan, Bayang, Binidayan, Pagayawan, Ganassi, Madamba, Madalum, Bacolod Grande, Tugaya, Wato-Balindong, and Marantao. Also, an ocular visit was done in Marawi City port and Poblacion.
2. Observations of mollusks available in the public market from each municipality.
3. Observations and interviews of mollusks catchers at places where they land their catches.
4. Interviewed the mollusks' catchers and vendors. These mollusk's catchers and vendors provide broader information about the mollusks catch in Lake Lanao specifically their abundance distribution. The results of the interview were bases on the selection of the sampling sites.

PART II. Field Sampling

Sampling was done in a 200m x 6m modified belt transect method. Mollusks inside each quadrat were collected using a hand-net, locally known as *siyor*. Mollusks that were stuck on the substrate and lake grasses were picked manually. The collection of samples was done during daytime and lasted for about least three hours. Also, sampling was done monthly for the nine municipalities from January 2016 to March 2017.

Preparation of Specimens

The gathered samples were temporarily placed in an icebox. After the actual sampling, the samples were brought to MSU-IIT laboratory (Biology Teaching Laboratory, DSME-CED) the specimens were washed thoroughly to remove as much substrate as possible. Seventy percent (70%) ethyl alcohol was used to preserve the dead specimens for further identification and classification. Also, some samples of mollusks were placed in a refrigerator to preserve their color for further identification.

FINDINGS

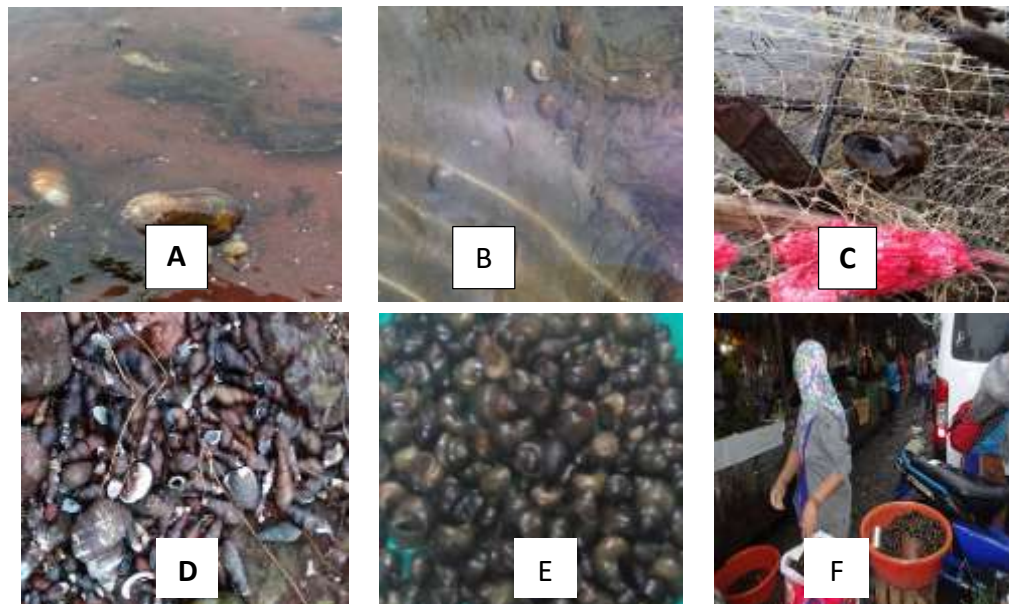


Figure 2. (A) Sampling site at Masiu **(B)** Sampling site at Lumbatan **(C)** Sampling site at Rmain **(D)** Sampling site at Wato Balindong **(E)** Samples of collected mollusks and **(F)** Marawi City Public market

The figure above shows the different some of the sampling sites, samples of mollusks, and a public market of Marawi City where mollusks sold.

Mollusks are soft-bodied, unsegmented animals, with a body organized into a muscular foot, a head, a visceral mass containing most of the organ systems, and a fleshy mantle that secretes the calcareous shell. It is divided into seven classes (Ruppert et al., 2004) and is present on nearly every continent. Freshwater mollusks are classified into mollusks (snails and freshwater “limpets”) and several groups of bivalves (mussels and clams) that have repeatedly colonized freshwater. Mollusks have a univalve shell and possess a file-like radula used in feeding on the periphyton coverings of rocks or plants. Mussels and clams have hinged, bivalve shells and are generally suspension and/or deposit feeders. Freshwater mollusks are common animals in lakes and streams.

Biologists classify mollusks into seven groups: Aplacophora, Monoplacophora, Polyplacophora, Cephalopoda, Scaphopoda, Bivalvia, and Gastropoda based on physical characteristics. Some of these characteristics are the presence of a shell, the type of shell, the type of foot, the arrangement of teeth in the radula, and the complexity of the nervous system. The three major groups of mollusks are gastropods, bivalves, and cephalopods, Grigg (2009).

They are important ecosystem engineers, helping to structure aquatic bottom environments and providing habitat, protection, and food to a wide array of other taxa. Mollusks have been historically important to humans in many ways, and are today an economically important group worldwide (Fortunato, 2015).

Identification of Mollusks fauna

One of the aims of the present study was to determine the biodiversity of mollusk fauna in Lake Lanao, Lanao del Sur. The summary of mollusk fauna composition found in Lake Lanao is shown in Table 1:

Table 1 Identified mollusk fauna in Lake Lanao, Lanao del Sur

Mollusk class	Family	Scientific Name	Local Name	I	II	III	IV	V	VI	VII	VIII	IX
Gastropods	Thiaridae	<i>Melanoides</i> sp.	Banisel	x	x	x	x	x	x	x	x	x
	Viviparidae	<i>Vivipara</i> sp.	Rambuwan	x	x	x	x	x	x	x	x	x
	Thiaridae	<i>Thiara</i> sp.	Maito a soso	x	x	x	x	x	x	x	x	x
Bivalves	Corbiculidae	<i>Corbicula fluminea</i>	Gtik ka mala (ambiat)	x	x	x	x	x	x	x	x	x
	Lyonsiidae	<i>Lyonsia</i> sp.	Gtik ka maito	x	x	x	x	x	x	x	x	x
Unidentified		<i>Unidentified</i>	Mala a soso (soso a kakowak)	x	x	x	x	x	x	x	x	x

Study sites: I-Marantao; II-Wato Balindong; III-Tugaya; IV-Bayan; V-Lumbatan; VI-Ramain; VII-Molundo; VIII-Tamparan; IX-Masiu

Table 1 is the list of species of mollusk fauna found in the 9 sampling sites. A total of 3,693 individuals of mollusks surveyed and attributed to 6 species, with 3 species coming from the class Gastropoda, 2 from class Bivalvia. Among the Gastropods, the family Thiaridae has the highest number of species namely: *Melanoides* sp., *Thiara* sp., and *Vivipara* sp. On the other hand, two species comprise the bivalves namely: *Lyonsia* sp. and *Corbicula fluminea*. An identified species was also found that was locally called Mala a soso (soso a kakowak). All the identified species were found in all the 9 study sites in Lake Lanao, Lanao del Sur.

Diversity

A key tool for the quantitative characterization of community statistics is the computation of diversity indices (Van Strien, Soldaat, & Gregory, 2012). According to Danilov & Ekelund (1999), the changes in the diversity of habitats by allogenic forces and pollutants can be assessed using biotic or diversity indices. The study utilized the statistical software PAST (Paleontological Statistics Software Package For Education And Data Analysis) (Hammer et al., 2001) to determine the following diversity indices of mollusk fauna found in Lake Lanao: Shannon-Wiener formula (H') (Ecological Society of America, 2011), Simpson's Diversity Index (Magurran, 2004), Simpson

Dominance Index (D) (Magurran, 2004), and Species evenness index (J) (Ecological Society of America, 2011) are illustrated in figures 3, 4, and 5.

Shannon Diversity Index

The Shannon-Wiener Diversity Index (H') was utilized in this study to determine the species diversity of molluscan fauna found in Lake Lanao, Lanao del Sur. According to Pielou (1975), the index assumes that individuals were randomly sampled from an infinitely large community. The Shannon-Weiner index (Barnes et al. 1998), was developed from information theory and is based on measuring uncertainty.

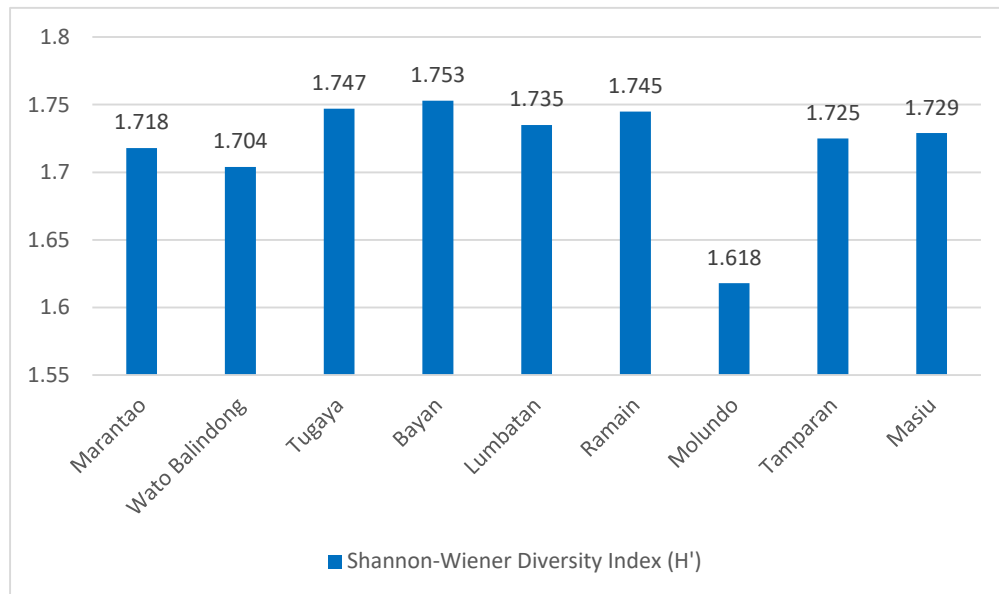


Figure 3. Shannon-Wiener Diversity Index (H') of molluscan fauna in Lake Lanao

Figure 3 illustrates the results of the calculations of the Shannon-Wiener Diversity Index from the data of molluscan fauna collected from the nine municipalities surrounding Lake Lanao using PAST software. Shannon-Wiener diversity index (H') ranged from 1.618 to 1.753 in the nine municipalities surrounding Lake Lanao namely: Marantao, Wato Balindong, Tugaya, Bayan, Lumbatan, Ragain, Molundo, Tamparan, and Masiu, showing minimum value in Molundo and maximum value in Bayan. According to Chen (2020), a large number of species can increase diversity, and increasing the uniformity of individual distribution among species will also increase diversity. This explains the lower result of the diversity index in Molundo at 1.618 compared to the other 8 municipalities and the municipality of Bayan with the maximum diversity index at 1.753. This suggests that each individual belongs to a different species and is close to being equally distributed among species in Bayan with its higher diversity index. On the other hand, where each individual belongs to the same species, and its distribution is unequal, its diversity index is the smallest which could be the case in Molundo.

Moreover, as the Shannon-Wiener diversity index is based upon the information theory based on measuring uncertainty (Barnes et al. 1988) if a community is dominated by one species (low diversity) the uncertainty of prediction is low where randomly sampled species is most likely going to be the dominant species which could be the case in Molundo. While if diversity is high, uncertainty is high where randomly

sampled species is most likely from different species which could be the case in Bayan.

Given that the range of Shannon-Wiener Diversity Index (H') ranging from 1.618 to 1.753 of the 9 municipalities surrounding Lake Lanao, these values based on the categories of diversity by (Restu, 2002), where: $H' < 1$ = low, $1 < H' < 3$ = moderate and $H' > 3$ = high indicates a moderate diversity index.

According to Fitriana (2006), the value of diversity index can demonstrate the condition of the ecosystem, ecological pressure present, and productivity. The Shannon-Wiener diversity index in the 9 municipalities surrounding Lake Lanao fall to the moderate criteria of the diversity index. This indicates that the mollusk community in the 9 municipalities surrounding Lake Lanao shows high enough productivity, balanced ecosystem conditions, and moderate ecological pressures (Restu, 2002). In addition, diversity index falling in the moderate criteria with moderate ecological pressure suggests that water productivity was sufficiently high that supporting the number of species found is possible due to the maintenance of the balance of ecosystem conditions (Susetya et al., 2018).

Simpson's Dominance Index

Simpson's Dominance Index (D) was calculated to determine the probability of two randomly sampled individuals belonging to the same species (Siddique et al., 2010).

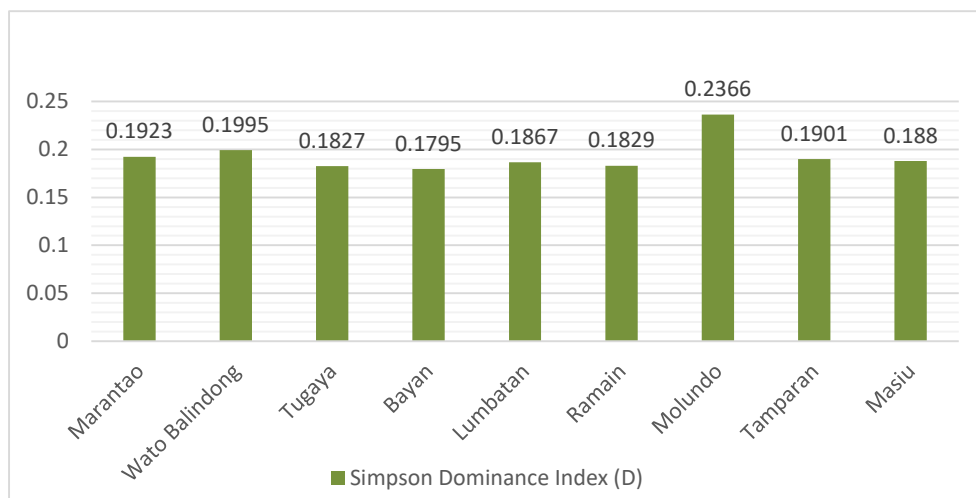


Figure 4. Simpson's Dominance Index (D) of the 9 study sites in Lake Lanao

Simpson's Dominance Index (Figure 4) of molluscan fauna was carried out using PAST software where the evenness index ranged from 0.1795 to 0.2366 in the 9 municipalities surrounding Lake Lanao. The minimum value was observed in Bayan while the maximum value was observed at Molundo. Given that the range of Simpson's Dominance Index (D) is from 0.1795 to 0.2366 of the 9 municipalities surrounding Lake Lanao, these values indicate the absence of dominant species based on the categories of dominance by (Susetya et al., 2018), where: $0 < D < 0.5$ = absence of dominant species, $0.5 < D < 1$ = presence of dominance species. Given

that the values of the dominance index are nearer to zero, indicating a relatively high species diversity.

Evenness Index

Pielou's index was utilized in this study, where it measures how evenly the species are distributed in a sample community (Mulder et al., 2004).

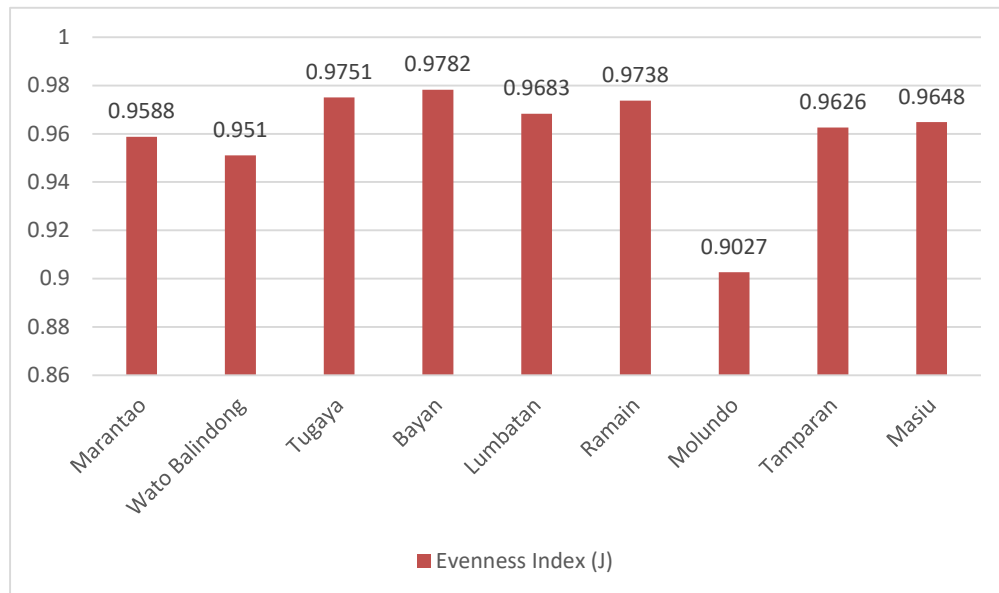


Figure 5. Evenness Index (J) of the 9 study sites in Lake Lanao

Pielou's Evenness Index (Figure 5) of molluscan fauna was carried out using PAST software where the evenness index ranged from 0.9027 to 0.9782 in the 9 municipalities surrounding Lake Lanao. The minimum value was observed in Molundo while the maximum value was observed at Bayan. Given that the range of Evenness Index (H') ranging from 0.9027 to 0.9782 of the 9 municipalities surrounding Lake Lanao, indicates a high evenness index based on the categories of evenness by (Susetya et al., 2018), where: $e < 0.4$ = low, $0.4 < e < 0.6$ = moderate and $e > 0.6$ = high. According to Basyuni et al., (2018), the high evenness index in a community illustrates that the number of individuals in each species was almost the same and indicates the absence of a dominating species.

In addition, a higher evenness index could also indicate better quality of the environment due to the presence of ecological balance in the community (Kharisma et al. 2012). As asserted by Zusron et al. (2015), that as the value of evenness index nears 1 the community can be identified as stable. This implies that the communities of mollusks in the 9 surrounding municipalities in Lake Lanao are stable.

Table 2 Diversity Indices of molluscan fauna in Lake Lanao, Lanao del Sur

No.	Parameter	Value	Category
1	Diversity index (H') Shannon wiener	1.7305	moderate
2	Dominance index (D) Simpson	0.1873	absence of dominant species
3	Evenness index (J)	0.9658	high

Note: **H' categories** $H' < 1$ =low, $1 < H' < 3$ = moderate, $H' > 3$ =high; **J categories** $J < 0.4$ =low; $0.4 < J < 0.6$ =moderate, $J > 0.6$ =high; **C categories** $0 < C < 0.5$ =Absence of dominant species, $0.5 < C < 1$ =there is dominant species

This study utilized a variety of biological tools to determine diversity for which are grounded to two assumptions by Quareshi and Gang (2013), where: 1) Stable community structure has high diversity value while unstable ones have lower diversity value and 2) Stability, in this case, diversity is an index of environmental integrity. The H' value obtained in this study was 1.7305 which is a value lesser than three which according to Akaahan et al. (2014), indicated a moderate diversity index of mollusks community in Lake Lanao, Lanao del Sur. According to Susetya et al. (2018), a moderate diversity index is an indicator that the mollusks community in an area is in good condition. In addition, the values of diversity index under 1.0 indicate that there is pollution and degradation (Shannon & Weaver, 1963). In contrary, during this study, the diversity index was at 1.7305 which is higher than this set index for pollution and degradation which indicates that Lake Lanao is stable and balanced.

The value of dominance index (D) in this study using the Simpson dominance index formula was at 0.1873. Based on the categories on dominance indicated in the study of Susetya et al. (2018), this value indicated the absence of dominant species.

The value of evenness index (J) derived in this study was 0.9658 which is categorized as high (Susetya et al., 2018). This indicates that there is a better environmental quality in the sampling site and it is more suitable for animal life despite the presence of some species having a higher number than the others (Kharisma, Adhi, & Azizah, 2012). As asserted by Odum (1994), that when the evenness index has a value of 0.06-0.8, fauna distribution is balanced or evenly spread. In addition, evenness index value near gr1.00 indicates that the community is stable (Odum, 1994) hence, Lake Lanao, Lanao del Sur possesses a stable mollusk community.

The following are the photographs of mollusks that were caught during the gathering of the study which showed below:



Figure 6 . Photographs of Mollusks fauna found in Lake Lanao

Figure 6 depicts the different mollusks found in Lake Lanao. Lake Lanao is a freshwater body of water thus the mollusks found here are naturally, freshwater species. Freshwater animals have many different families. They are found throughout the world in various habitats, ranging from ephemeral pools to the largest lakes, and from small seeps and springs to major rivers. The great majority of freshwater mollusks have a shell, with very few exceptions. Some groups of snails that live in freshwater respire using gills, whereas other groups need to reach the surface to breathe air. In addition, some are amphibious and have both gills and a lung (e.g. Ampullariidae). Most feed on algae, but many are detritivore and some are filter feeders. The collected freshwater mollusks are as the following: *Thiara* sp., *Vivipara* sp., *Pomacea* sp., *Melaniodes* sp., *Lyonsia* sp., and *Achatina* sp. (*land snails*). The Characteristics of each mollusk are stated below.

Thiara occurs in freshwater habitats, preferring the headwaters and middle reaches of rivers, although it is also found often in their lower courses. According to Glaubrecht *et al.* (2009), *Thiara* species feed on algae and detritus. Females are parthenogenic and reproduce either ovoviviparous (*i.e.* releasing juveniles only as free-swimming veliger) or euviviparously (*i.e.* releasing crawling juveniles as more advanced in size and development). This species is widely distributed through the Indo-Pacific region, including Australia, Southern Asia, and the Indo-Malay Archipelago.

Vivipara, as defined by Meriam Webster's dictionary, it is a mollusk of the genus *Viviparus* or the Family Viviparidae. And as characterized by Fleming (1814), the shell

of the *Vivipara* is obtusely ovately turbinated, of four to five moderately ventricose whorls, closely convoluted, leaving merely a compressed umbilical clink.

Melanoids (Muller, 1774) is a highly polymorphic, tall-spined species that can tolerate a wide range of environmental conditions – both natural and manmade. It can be found in fresh and brackish waters in tropical Southeast Asia, the Indo-Australian archipelago to northern Australia. It has a thin elongated shell – usually narrower than *Thiara* sp. and without shouldered whorls. It is color brown or cream with darker flames and speckles.

Lyonsia, as described and characterized by Gmelin (1791), has a fragile shell, almost equivalve, with the left valve just a little more convex than the right. It is inequilateral, and it breaks in front of the midline. Approximately, it is oval in outline, with the posterior dorsal line straight and the posterior margin abruptly truncated and gaping. Periostracum often with agglutinated sand grains, echinoderm spines, etc. The Ligament is external, immediately below and behind the beaks, in an elongated, narrow, longitudinal ridge and with an underlying, supporting, white calcareous plate or lithodesma, which is broadest posteriorly. Its shell surface is with coarse granulations, which are gathered into radiating lines some of which are prominent as radiating ribs. Hinge line is without teeth. The inside shell is glossy, with external ribbing showing through. It can be colored white or rather translucent.

Moreover, these mollusks have been caught using improvised catching nets and/or by hand by the local catchers, then sold to the markets of the respective municipalities. They sell this catches to have a little more income to be added for their daily needs. Mollusks have been important to humans for thousands of years. Mollusks have been - and are still - important food sources for many people. Bivalves living in coastal areas, such as clams, oysters, and scallops, are the most commonly eaten mollusks. People also eat octopuses and squid (calamari), whelks, and land snails (escargot) according to Sears (2018). Local residents along the Lake Lanao find a livelihood in selling and eating mollusks – gastropods and bivalves.



Pomacea



Achatina (land snail)

Figure 7. Invasive mollusks caught in Lake Lanao

In Figure 3 it shows the invasive mollusks like the *Pomacea* and *Achatina*. These two species are invasive to the lake. During our interview to mollusks vendors they worried because of these introduced species to the lake. These invasive mollusks can be competitors to other organisms in the lake.

Pomacea, as classified by Perry (1810), its size ranges from large to very large globose smooth shells, suture channeled, or with top of the whorl shouldered and flat at the suture. Shells umbilicate with unthickened lip. Its color ranges from being uniform yellow to olive green with darker spiral bands. Its interior of the aperture is color orange to yellow. This animal has a distinctive head to foot. Its snout is unique with a pair of distal, long, tentacle-like processes. Its cephalic tentacles are very long. This genus is amphibious and can be found on sediment and weeds above waterline. This genus is widely known in the aquarium trade through the so-called mystery snail. In the countries such as the Philippines, the species *Pomacea canaliculata* (Lamarck) is a serious pest of rice crops. Introduction of this species to the wild could result in a serious pest problem. Any sightings of this species in the wild should be reported to the Biosecurity authority.

Another species of mollusks found in the lake is *Achatina* sp. *Achatina*, according to Lamarck (1799) and Bouchet (2014), is a land snail of medium-sized to very large, air-breathing land snail, a terrestrial pulmonate mollusks in the family Achatinidae. This species is believed to be native to West Africa. It is considered a potentially serious pest, an invasive species that could adversely affect agriculture, natural ecosystems, human health or commerce. This species' substantial size and potential for rapid population growth can make them a serious pests when introduced to non-native ecosystems. The population size of this species can be curtailed through disease by the bacterium *Aeromonas liquefaciens*. Physically, the shells of these snails often grow to a length of 18 centimeters (7.1 inches) with a diameter of 9 centimeters (3.5 inches). Certain examples have been surveyed in the wild at 30x15 cm, making them the largest extant land snail species known. Moreover, like almost pulmonates mollusks, these snails are hermaphrodites, having male and female sex organs. Each snail lays up to 1200 eggs per year. These species are an important source of animal protein for West African forest-dwelling ethnic groups, and there is potential for commercial farming.

SUMMARY AND CONCLUSIONS

After the implementation of the study summary and conclusions were made and are listed below:

1. Thirty-two (32) mollusks (soso) vendors from fish/mollusks landings and public markets around the lake were interviewed. Sixteen percent (16%) of these vendors were from Molundo, Lanao del Sur. The results of the interview from the vendors and mollusks catchers were the bases in the selection of the sampling sites among the 18 municipalities that surround the lake.
2. Out of eighteen (18) municipalities, nine (9) municipalities were chosen as sampling stations namely, Marantao, Wato Balindong, Tugaya, Bayang, Lumbatan, Ragain, Molundo, Tamparan, and Masiu.
3. Six species of mollusk fauna were identified, consisting of 3 gastropods, 2 bivalves, and one unidentified species. Among the gastropods, the family Thiariidae has the highest number of species namely: *Melanoides* sp., *Vivipara* sp., and *Thiara* sp. On the other hand, there were two species comprising the bivalves namely: *Lyonsia* sp.

and *Corbicula fluminea*. *Melanoides* sp., *Vivipara* sp., *Thiara* sp., *Corbicula fluminea*, *Lyonsia* sp., and identified species, were recorded in all study sites. Also two invasive mollusks namely *Pomacea* sp. and *Achatina* sp. were observed in the lake.

4. Recorded Shannon-Wiener Diversity index (H') ranged from 1.618 to 1.753 with its minimum value recorded at the municipality of Molundo and the maximum value recorded in the municipality of Bayan. These values recorded from the nine study sites (Municipalities surrounding Lake Lanao): Marantao, Wato Balindong, Tugaya, Bayan, Lumabatan, Ragain, Molundo, Tamparan, and Masiu indicated moderate diversity index. This implied that Lake Lanao showed high enough productivity, balanced ecosystem conditions, and moderate ecological pressures enabling it to support a number of species.

5. Simpson dominance index (D) results ranged from 0.1795 to 0.2366 with its minimum value recorded at the municipality of Bayan and maximum value recorded at the municipality of Molundo. The range of values recorded from the 9 study sites surrounding Lake Lanao indicated the absence of dominant species. Moreover, given the values of dominance index were nearer to zero implies a relatively high species diversity.

6. Evenness index (J) ranged from 0.9027 to 0.9782 in the 9 study sites surrounding Lake Lanao, where the minimum value recorded at municipality of Molundo while the maximum value recorded at Bayan. These values indicated high evenness index suggesting that the number of individuals in each species was almost the same, absence of a dominating species, and better quality environmental conditions due to the presence of ecological balance in the community.

7. Taking into account all the individual mollusk samples of each species from the 9 study sites (municipalities) surrounding Lake Lanao, an H' value of 1.7305 was obtained indicating a moderate diversity index of mollusks community in Lake Lanao. Moderate diversity index is an indicator that water productive was sufficiently high that supporting the number of species found is possible due to the maintenance of the balance of ecosystem conditions. On the other hand, Simpson's dominance index value was at 0.1873 which is nearer to zero indicating high diversity and absence of a dominant species. In addition, the value of evenness index (J) at 0.9658 is high indicating a better environmental quality in the sampling site where it is more suitable for animal life.

ACKNOWLEDGEMENT

- ❖ National Research Council of the Philippines (NRCP), DOST
- ❖ MSU-Iligan Institute of Technology
- ❖ Mindanao State University-Marawi Main Campus, Marawi City
- ❖ Provincial Office of Lanao del Sur
- ❖ The 18 Municipalities of Lanao del Sur and Marawi City Officials
- ❖ Maranao people of Marawi City and Province of Lanao del Sur
- ❖ Dr. Ian Kendrick Fontanilla, Institute of Biology, College of Science, UP Diliman
- ❖ Dr. Sherwin Nacua, College of Natural Sciences and Mathematics, MSU-Marawi Main

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