



Intertidal marine mollusks on selected coastal areas of Iligan Bay, Northern Mindanao, Philippines

Angelyn C. Magsayo, Maria Lourdes Dorothy G. Lacuna*

Department of Biological Sciences, Mindanao State University-Iligan Institute of Technology, Iligan City, Philippines

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Abstract

Considering the vital role benthic mollusks occupy in the marine food web and its significance in the world economy, this study was realized so as to give valuable information on the composition, diversity and abundance of benthic mollusks on the intertidal zones of Iligan City and Kauswagan, Lanao del Norte in Mindanao, Philippines. Samplings were done along the intertidal flats during low tide between the months of June and July 2015 using the transect-quadrat methods. A total of 66 molluscan species were classified, with 56 species categorized as gastropods, while 10 species are bivalves. Diversity profiles were calculated using Shannon-Weaver Index and results revealed diverse living assemblages of molluscan community in both study sites with several *Nassarius* species and *Cerithium corallium* being abundant. Comparing the abundance of mollusks among the 4 stations showed station 3 as having the lowest total number of individuals per m². The result of the CANOCO indicated that total organic matter may have been responsible to such low abundance of molluscan assemblage in station 3. The current findings obtained from this study are of immense importance in understanding the reason behind the successful existence and dynamicity of intertidal communities in the coastal zones of Northern Mindanao as well as in the continuous monitoring and conservation efforts in these 2 areas considering that several industries are present along the coasts as well the existence of unregulated gleaning activities.

*Corresponding Author: G. Lacuna ✉ mileskung12@gmail.com

Introduction

Marine molluscs is a group of highly diverse organisms which are considered to be the most prominent and well-recognized invertebrate animals and include the snails, oysters, clams, octopus, squids and cuttlefish.

In terms of species abundance, this group make up the second largest invertebrate phylum on Earth succeeding the arthropods (Ruppert and Barnes, 2004). Over 70,000 living species have been described globally and roughly one-third (22,000 species) occurred in the Philippine Archipelago of which 2-4% (440-880 species) are endemic in the country (Ong *et al.*, 2002). Among the constituents of Phylum Mollusca, the gastropods and bivalves (pelecypods) are the most dominant where they comprised 98% of the molluscan population (Anandaraj *et al.*, 2012).

The role of gastropods and bivalves in the benthic community cannot be ignored since they form an essential link in the aquatic food web as food source of wide array of molluscivorous intertidal animals (Creswell, 1990; Castell and Sweatman, 1997; Burkepale and Hay, 2007) as well as indicators of the health condition of certain habitat or environment (Daka *et al.*, 2006; Gomez-Ariza *et al.*, 2006) and as source of protein (Schoppe *et al.*, 1998; Del Norte-Campos *et al.*, 2003).

Insight in the distribution and abundance among molluscs is essential in understanding the ecology of these species since this may demonstrate the external parameters (abiotic and biotic factors) that are responsible in influencing their distribution.

Most often, variability in the spatial structure of molluscs (*i.e.* high species richness) is related to the sediment size (Rahman and Barkati, 2012; Esqueda-Gonzalez *et al.*, 2014), organic matter and calcium carbonate contents of the sediment. Conversely, other parameters such as biotic, (*i.e.* predation, competition and recruitment) may also affect the abundance of molluscan population. Since no single environmental factor can solely control the distribution patterns of molluscs,

it is suggested that interplay between the abiotic and biotic parameters can therefore influence these assemblages (de Arruda and Amaral, 2003).

Despite numerous ecological studies documented around the globe, studies on molluscan diversity in the Philippines were limited to the Northern and Central regions of the country (Dolorosa and Schoppe, 2005; Batomalaque *et al.*, 2010; Dolorosa and Jontila, 2012; Dolorosa and Dangan-Galon, 2014; Picardal and Dolorosa, 2014), with relatively few works done in Southern Philippines (Tabugo *et al.*, 2013; Manzo *et al.*, 2014; Masangcay and Lacuna, 2017). In order to address this gap, this study aim to document the species diversity and abundance of gastropods and bivalves and determine the environmental factors that may have influenced their diversity and abundance.

Materials and methods

Study area and sampling stations

Iligan Bay is recognized by the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) as a major fishing ground for its rich fishery resources such as fish, algae and mollusks and as an important food producer and as a living space for human and for wildlife. Four coastal areas along Iligan Bay were chosen as sampling stations, with three coastal areas located in Iligan City and the other one in Kauswagan, Lanao del Norte (Fig. 1).

Station 1 was positioned in a seagrass bed in Dalipuga, Iligan City, while station 2 was located in Fuentes, Iligan City which is distinguished by a rocky shore often mixed with some fine sands. Station 3, situated in Buru-un, Iligan City, is categorized as a sandy shore which is mixed with boulders, whereas station 4 was established in Kauswagan, Lanao del Norte that is adjacent to a port where seagrass beds are present.

Field collection of mollusks and "in situ" determination of environmental parameters

Three transect lines (50 m long), with a distance of 50m from each other, were laid down on the intertidal flat in each sampling stations.

Four quadrats (1.0 m²), which were 10 m apart, were set along each transect line. All transect lines were positioned perpendicular to the coastline with each transect being placed starting from the shoreline

going towards the sea. Live epifaunal mollusks encountered on the surface of the sediment in each quadrat were handpicked.

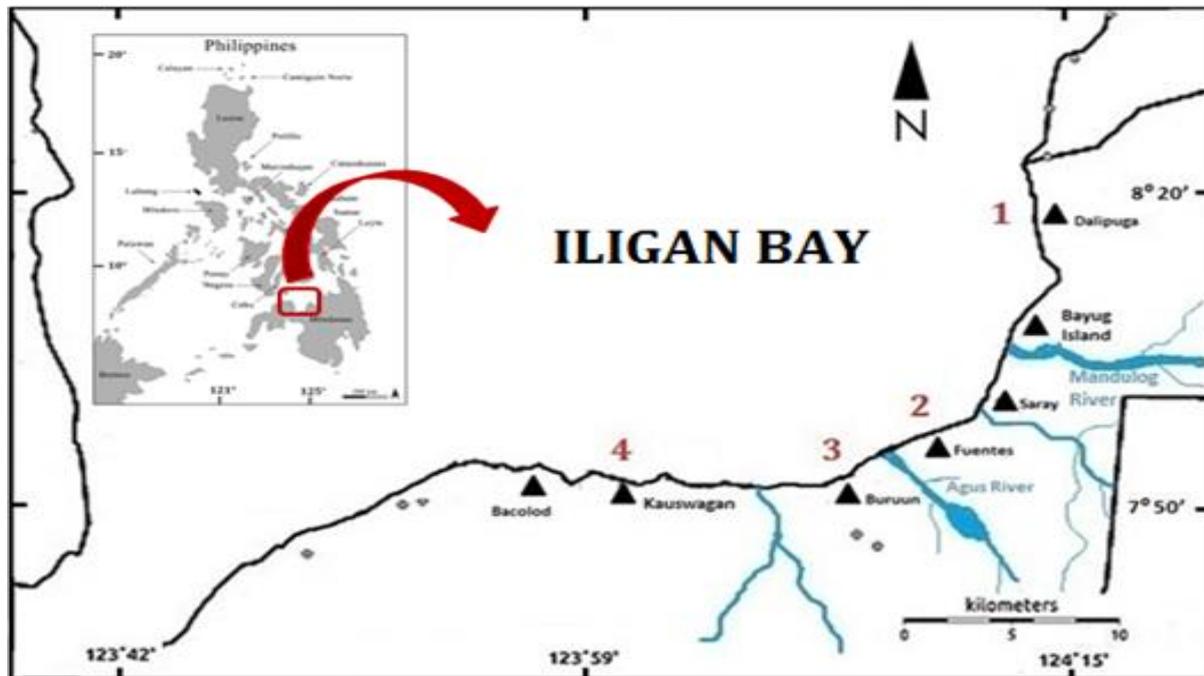


Fig. 1. Geographical locations of the four sampling stations on the intertidal zones of Iligan Bay where mollusk samples were gathered. (www.map-hill.com).

Afterwards, live infaunal mollusks in each quadrat were likewise obtained by collecting sediments which were dug to a depth of 15 cm and these sediments were then sieved using a sieve screen with a 1.0mm mesh opening. Dead mollusks and empty shells were not included in the collection.

All mollusks gathered were preserved in 10% seawater-formalin solution. Measurement of the environmental parameters such as temperature, pH and salinity of the sediments were done directly on the field using the field thermometer, pen type pH meter (PH-009) and refractometer (ATAGO), respectively.

In each transect line, all environmental factors were determined three times. On the other hand, three sediment samples for the determination of total organic matter, calcium carbonate and grain size were gathered in each transect, separately deposited in a Ziplock bag and then stored in a freezer until analysis.

Laboratory analysis of the samples collected

Epifauna and infauna samples were cleaned by washing it with seawater and by removing epiphytes that adhered on the shells and then preserved with 70% ethanol (Rueda *et al.*, 2009). Each collected mollusks were classified to species level and then counted.

The soft tissues of a voucher specimen representing each identified molluscan species were removed, then the shells were cleaned, measured to the nearest 0.1 mm using a Vernier caliper and then photographed using a digital camera (Sony Cyber-Shot, 16 MP).

Molluscan data were computed as density and relative abundance. Density was expressed as number of individuals per m², while relative abundance for each species was expressed as a percent of total molluscan species present. Identification of mollusks were based on books (Springsteen and Leobrera, 1986; Poppe *et*

al., 2006) and the illustrated guides to marine gastropods (www.gastropods.com) and seashells (www.seashellhub.com, www.jaxshells.com).

For calcium carbonate determination, sediment samples were dried in an oven at 70°C for about 8 hours. Afterwards, twenty-five grams were weighed (W_1), mixed with HCl (0.1 N) and stirred until no CO₂ bubbles appeared before it was stored. After 24 hours, the sample was filtered and the upper liquid phase discarded.

The residual sediments were dried at 70°C for 8 hours and reweighed again (W_2). Calcium carbonate percentage was measured by the following formula:

$$\text{CaCO}_3(\%) = \frac{100 (W_1 - W_2)}{W_1}$$

For the analysis of total organic matter (TOM), sediment samples which filled up half of the pre-weighed crucibles were placed inside an oven for drying at 70°C for 24 hours. Following the designated time period, the sediments were weighed (A) and then put inside a furnace for 12 hours at 550°C. Afterwards, the sediments were allowed to cool before it were being reweighed again (B) until constant weight was attained. The total organic matter was calculated as follows:

$$\text{TOM}(\%) = \frac{100 (A - B)}{A - C}$$

For the grain size analysis, a 100g oven-dried sediment were sieved using a series of screen sieves of 2.36 mm, 1.77 mm, 0.850 mm, 0.425 mm, 0.150 mm, and 0.075 and 0.053 mm mesh opening. The remaining soil particles in each sieve were carefully removed and weighed separately. The percentage of each particle fraction was calculated as shown below:

$$\text{Percentage Weight} = \frac{\text{Dry weight of sediments}}{\text{Total dry weight of sediments}} \times 100$$

Molluscan data were represented as density and relative abundance. Density was expressed as number of individuals per m², and was computed as follows:

$$\text{Density}(\text{ind}/\text{m}^2) = \frac{\text{Total no. of species A}}{\text{Total area examined}}$$

Relative abundance for each species was expressed as a percent of total molluscan species present and was calculated using the following formula:

$$\text{Relative abundance}(\%) = \frac{\text{Abundance of Species A}}{\text{Abundance of all Species}} \times 100$$

Statistical analyses

Diversity indices were computed using Shannon-Weaver Index in order to determine changes in the molluscan composition. The difference on the abundance of molluscan species between sampling stations was determined using Kruskal-Wallis Test. The relationship between abiotic parameters, sediment contents and the numerical abundance of molluscan assemblage was determined using the Canonical Correspondence Analysis (CCA). All analyses were done using PAST (Paleontological Statistical) software version 2.17 (<http://folk.uio.no/ohammer/past/>) (Hammer *et al.*, 2001).

Results and discussion

Molluscan species composition

A list of molluscs encountered in all sampling stations in the intertidal zones of Iligan City and Kauswagan is presented in Table 1.

A total of 66 species of molluscs belonging to Class Gastropoda and Bivalvia were recorded, with 56 species being gastropods under 19 families, while 10 species are bivalves belonging to 6 families. Further, 44 of these gastropods are epifauna, while 12 species are infauna.

The present study recorded more gastropods when compared to the other molluscan classes and this is in agreement with other studies done in most intertidal flats where gastropods were reported to be the most dominant group (Noseworthy and Sik, 2010; Vera *et al.*, 2013; Leopardas *et al.*, 2016).

Physico-chemical parameters, organic matter and grain size

The mean values of the physical and chemical parameters of the sediment as well as its organic contents and sediment texture are presented in Table 2.

The values for sediment temperature ranges from 28.19 °C to 34.47 °C, with station 1 showing the lowest temperature reading but highest in station 2. The differences in the temperature readings are associated with the time of sampling and determination of these abiotic parameters.

Collections and measurements of temperature in stations 2 and 3 were done from noon time to mid-afternoon on the same day where the intensity of the sun is at its highest peak, and it is expected that these stations records high temperature values.

Table 1. Comparison of intertidal molluscan species in Iligan City and Kauswagan, Lanaodel Norte, Northern Mindanao, Philippines.

Class	Family	Species name	Station			
			1	2	3	4
Bivalvia	Arcidae	<i>Barbatia foliata</i> *	-	+	-	-
		<i>Anadara labiosa</i> *	-	-	+	-
	Isognomonidae	<i>Isognomon californicum</i> *	-	+	-	-
		<i>Isognomon ephippium</i> *	-	+	-	-
	Lucinidae	<i>Anodontia cf. edentula</i> *	+	-	+	+
		<i>Codakia tigerina</i> * ^e	-	+	-	+
	Mytilidae	<i>Hormonia mutabilis</i> *	-	+	-	-
	Psammobiidae	<i>Garipallida</i> *	+	-	-	-
		<i>Psammotaea virescens</i> *	-	+	-	-
	Pinnidae	<i>Atrina lamellate</i> *	-	+	-	+
Gastropoda	Angariidae	<i>Angaria melanacantha</i> *	+	+	-	+
	Buccinidae	<i>Engina incarnate</i> *	+	-	-	-
	Bullidae	<i>Bulla ampulla</i> *	+	-	-	+
		<i>Bulla vernicosa</i> *	+	-	-	-
	Bursidae	<i>Bursa tuberosissima</i> *	+	-	-	-
	Cerithiidae	<i>Cerithium coralium</i> *	-	+	+	+
		<i>Cerithium punctatum</i> *	+	-	-	-
		<i>Cerithium rostratum</i> *	+	-	-	-
		<i>Cerithium zonatum</i> *	-	+	-	-
		<i>Clypeomorus pellucida</i> *	-	+	+	-
	Conidae	<i>Conus barbara</i> *	+	-	-	-
		<i>Conus ebraeus</i> *	+	-	-	-
	Costellariidae	<i>Austromitra aff. canaliculata</i> *	+	-	-	-
		<i>Vexillum virgo</i> *	+	-	-	-
	Cypraeidae	<i>Monetaria annulus</i> *	-	-	-	+
		<i>Monetaria moneta</i> *	-	-	-	+
	Liotiidae	<i>Loitinariaperonii</i> *	-	-	+	+
	Littorinidae	<i>Littorina undulate</i> *	+	-	-	-
	Mitridae	<i>Mitra pediculus</i> *	-	-	-	+
	Muricidae	<i>Murex negros</i> *	-	+	-	-
		<i>Semiricinula turbinoides</i> *	-	+	-	-
		<i>Nassarius albescens</i> *	+	-	-	+
	Nassaridae	<i>Nassarius ecstilbus</i> *	+	-	-	-
		<i>Nassarius globosus</i> *	+	+	+	+
		<i>Nassarius livescens</i> *	+	+	-	-
		<i>Nassarius luridus</i> *	+	+	+	+
		<i>Nassarius macrodon recidivus</i> *	-	-	-	+
		<i>Nassarius marmoreus</i> *	-	-	-	+
		<i>Nassarius nigra</i> *	+	-	-	+
		<i>Nassarius nodifer</i> *	+	-	-	+
<i>Nassarius Pyrrhus</i> *		+	-	-	-	

Table 1. (Cont'n). Comparison of intertidal molluscan species in Iligan City and Kauswagan, Lanaodel Norte, Northern Mindanao, Philippines.

Class	Family	Species name	Station			
			1	2	3	4
	Nassaridae	<i>Nassarius reeveanus</i> *	+	+	-	+
	Naticidae	<i>Mamillamelanostomoides</i> *	+	-	+	-
		<i>Natica fasciata</i> *	-	+	-	-
		<i>Notocochlisantoni</i> *	-	+	-	-
		<i>Notocochlisvenustula</i> *	+	-	-	-
		<i>Polinicesflemingianus</i> *	+	+	+	+
	Neritidae	<i>Neripteron cf. neglectus</i> *	-	-	+	-
		<i>Neripteron siquijoren sis</i> *	+	-	-	+
		<i>Nerita albicilla</i> *	+	-	-	-
		<i>Nerita nigerrima</i> *	+	-	-	-
		<i>Nerita picea</i> *	-	+	-	+
		<i>Nerita plicata</i> ^{ae}	+	-	-	-
		<i>Nerita polita</i> *	+	-	-	+
		<i>Nerita signata</i> *	-	-	-	+
		<i>Vittina waigiensis</i> *	+	-	-	-
	Planaxidae	<i>Fissilabia decollata</i> *	+	+	-	-
	Rhizoridae	<i>Volvulella cf. Paupercula</i> *	+	-	-	+
	Strombidae	<i>Canarium urceus urceus</i> ^{ae}	+	-	+	+
		<i>Canarium labiatum</i> *	+	-	+	+
		<i>Strombus auredianae</i> *	-	+	+	-
		<i>Strombus labiatus</i> *	-	+	+	+
	Trochidae	<i>Cantharidus suarezensis</i> *	-	+	+	-
		<i>Herpetopomaatrata</i> *	+	-	-	+
		<i>Herpetophobia Stratum</i> *	+	-	-	+
		<i>Tectus fenestratus</i> *	-	-	+	+
Total number of species			38	25	16	30

Legend: + present; - absent; *infauna*epifauna*ediblbe.

On the other hand, much lower temperature readings were noted in stations 1 and 4 since samplings were done late in the afternoon until evening. For sediment pH, the values ranges from 7.88 to 8.75 showing the slightly alkaline nature of seawater where it can buffer against changes in pH (Giere, 2009).

For sediment salinity, values recorded in all stations were much lower when compared with the standard values in Philippine waters set by DENR-

Administrative Order No. 2016-08 (DENR-Administrative Order, 2016). These lower values were expected considering that river tributaries exit along the coastal zones in Iligan City and Kauswagan.

The input of freshwater from these rivers may have diluted the salinity content of the marine waters resulting to the lowering of the salinity values. For CaCO₃, the value ranges from 10% to 13% with stations 2 and 4 obtaining the lowest value while

highest in station 1. For total organic matter (TOM), the values ranges from 9.3% to 18.6% with station 4 showing the lowest value while highest in stations 1 and 2. For the sedimentary structures, the type of substrate in stations 1, 2 and 3 are categorized as

sandy with mixtures of gravel that is made up of granules. However, station 4 is predominantly sandy mixed with small assorted stones, a characteristic often common in most seagrass beds.

Table 2. Environmental parameters in all four sampling stations in Iligan City and Kauswagan, Lanaodel Norte, Northern Mindanao, Philippines.

Physico-chemical parameters	Stations			
	1	2	3	4
Temperature	28.19	34.47	31.68	31.04
pH	8.15	8.53	8.75	7.88
Salinity (ppt)	30.16	23.33	21.39	30.83
CaCO ₃ (%)	13	10	11	10
TOM (%)	13	13	12	9
Gravel (%)	33.84	37.7	50.1	14.21
Sand (%)	66.07	62.29	49.83	84.79
Very Coarse Sand (%)	12.31	9.45	7.97	8.43
Coarse Sand (%)	14.09	11.27	14.72	12.89
Medium Sand (%)	17.91	14.35	13.5	18.41
Fine Sand (%)	19.64	21.43	12.18	27.99
Very Fine Sand (%)	2.13	5.79	1.46	17.07
Silt (%)	0.09	0.01	0.07	1
Sediment Texture	Sandy	Sandy	Sandy	Sandy

Species richness and diversity

The level of diversity of molluscan species in the four sampling stations on the intertidal flat of Iligan City

and Kauswagan, Lanaodel Norte are presented in Table 3.

Table 3. Diversity profile of the four sampling stations for the intertidal molluscs in Iligan City and Kauswagan, Lanaodel Norte, Northern Mindanao, Philippines.

Diversity index	Station			
	1	2	3	4
Taxa (S)	38	25	16	30
Individuals	232	261	53	233
Dominance (D)	0.05016	0.1145	0.1036	0.1062
Shannon (H)	3.227	2.524	2.478	2.727
Equitability (J)	0.8871	0.7841	0.8938	0.8017

The current results showed variations in the species diversity values with station 1 showing a much higher Shannon index value ($H=3.227$). Further, there is also a clear cut difference in the number of taxa among the four sampling stations with more species of molluscs noted in station 1 (38) but least in station 3 (16).

Although there are differences noted in the number of taxa between these stations, species were observed to be evenly distributed as reflected in the equitability value (J values=0.7-0.8) wherein there were no species dominating as noted in the low dominance value ($D<1$).

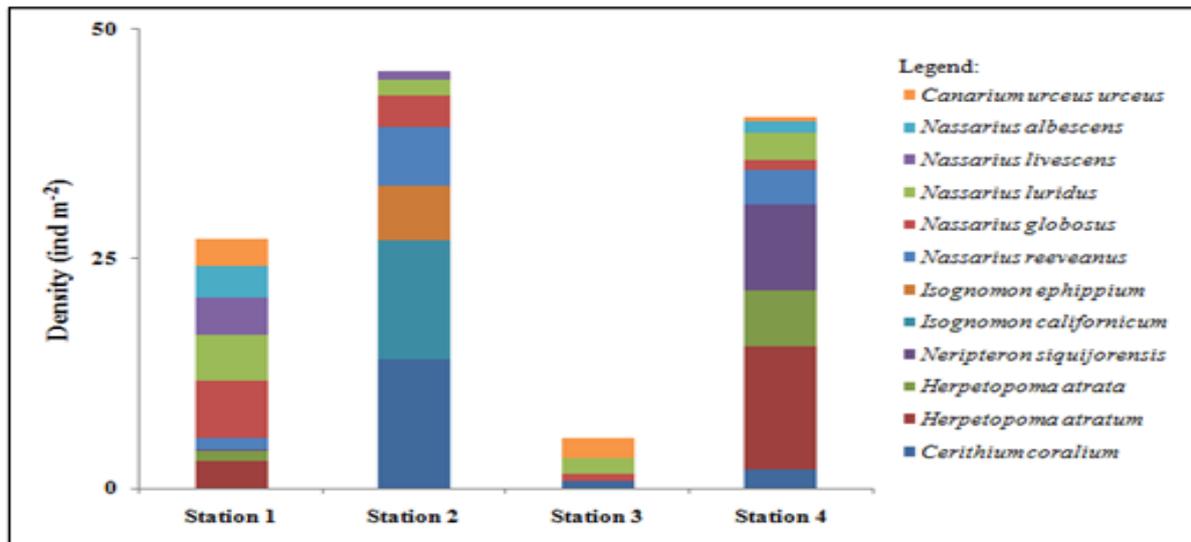


Fig. 2. Density of the top 12 benthic molluscan fauna in the 4 sampling stations on the intertidal zones of Iligan City and Kauswagan, Lanao del Norte.

These results may therefore imply that the intertidal flats of the study areas still host rich assemblage of molluscan community.

The current results are comparable with earlier reports which showed high species diversity of molluscs on intertidal flats with seagrass beds (Quintas *et al.*, 2013), unvegetated and rocky substrata (Jaiswar and Kulkarni, 2001; Nieves *et al.*, 2010; Flores-Rodriguez *et al.*, 2012; Galenzoga, 2016).

Species abundance

Among the 66 mollusc species recorded in the present study, only the 12 most abundant molluscan fauna in each station were considered for discussion. Fig. 2 exhibited the top 12 species that were commonly seen and most abundant in all 4 sampling stations. In station 1, the most frequently encountered species was *Nassarius globosus* representing 6.25 ind m⁻² of the total number of organisms. Next in rank was *Nassarius luridus* which accounted to about 5 ind m⁻² of the total number of organisms, followed by *Nassarius livescens* at 4 ind m⁻², while trailing behind were *Nassarius albescens* and *Canarium urceus urceus* garnering 3.5 ind m⁻² and 3 ind m⁻², respectively. In station 2, the most abundant species recorded was *Cerithium coralium* consisting to about 14 ind m⁻², followed in decreasing order by

Isognomon californicum and *Isognomon ehippium* at 13 ind m⁻² and 6 ind m⁻², respectively. Trailing behind was *Nassarius reeveanus* which consisted to about 6.3 ind m⁻², while *N. globosus* was the least abundant at 3.5 ind m⁻². Moreover, in station 3, species with the highest density was *C. urceus urceus* at 2.25 ind m⁻², followed by *N. luridus* which consisted to about 1.75 ind m⁻², whereas *N. globosus* and *C. coralium* were the least abundant which garnered at 0.75 ind m⁻². In station 4, the molluscan species that obtained the highest number of individuals was *Herpetopoma atratum* comprising to about 13.5 ind m⁻², whereas *Neripteron siquijorensis* or also known as *Neritasiquijorensis* followed in rank at 9.5 ind m⁻². Trailing behind were *Herpetopoma atrata*, *N. reeveanus*, *N. luridus* at 6 ind m⁻², 3.75 ind m⁻² and 3 ind m⁻², respectively, while the least abundant was *C. coralium* at 2 ind m⁻². Generally, several *Nassarius* species and *Cerithium coralium* predominate most of the 4 stations in both study areas, suggesting that these above-mentioned molluscan species occurred in a great variety of substrata in the intertidal zones. The nassariids, widely known as dog whelks (in the UK) or nassa mud snails (in the USA), are common and quite abundant in most intertidal flats with sandy (Aji and Widyastuti, 2017) to muddy substrata (Dittmann and Vargas, 2001) and even in rocky areas (Vohra, 1971).

For instance, the dog whelk *Nassarius livescens* was abundantly encountered on sandy seagrassbeds (Teh *et al.*, 2014); *Nassarius globosus* and *Nassarius luridus* predominates on muddy seagrass flats (Puturuhu, Unpublished Thesis), while *Nassarius albescens* prefers both sandy seagrass (Alfaro *et al.*, 2009) and rocky (Masangcay and Lacuna, 2017). The widespread distribution of nassariids within the intertidal zones is owed to their being carrion feeders or opportunistic scavengers where they often consumed bodies of dead animals as well as plants (Harasewych, 1998), although some are either herbivores, detritivores/detritus feeders (Scheltema, 1964) or carnivores (Morton and Britton, 2002). The presence of their very long extensible proboscis enables them to be well-suited to opportunistic

scavenging/predation as well as deposit feeding (Morton, 2011). Previous study reported *N. globosus* as deposit feeders which exploit the organic matter or detritus that are quite abundant on seagrass bed and leaves (Puturuhu, Unpublished Thesis), while *N. albescens* was observed as scavengers in sandy intertidal flats (Taylor and Reid, 1984), whereas *N. livescens* was shown to be carnivores (Edgar and Robertson, 1992). In the current study, *N. globosus*, *N. albescens*, *N. luridus* and *N. livescens* were dominant on sandy seagrass beds (station 1 and 4) as well as on sandy flat (station 3) and it is probable that these nassariids utilized the seagrass beds both for refuge and source of food and that of the sandy bottom as good supply of food.

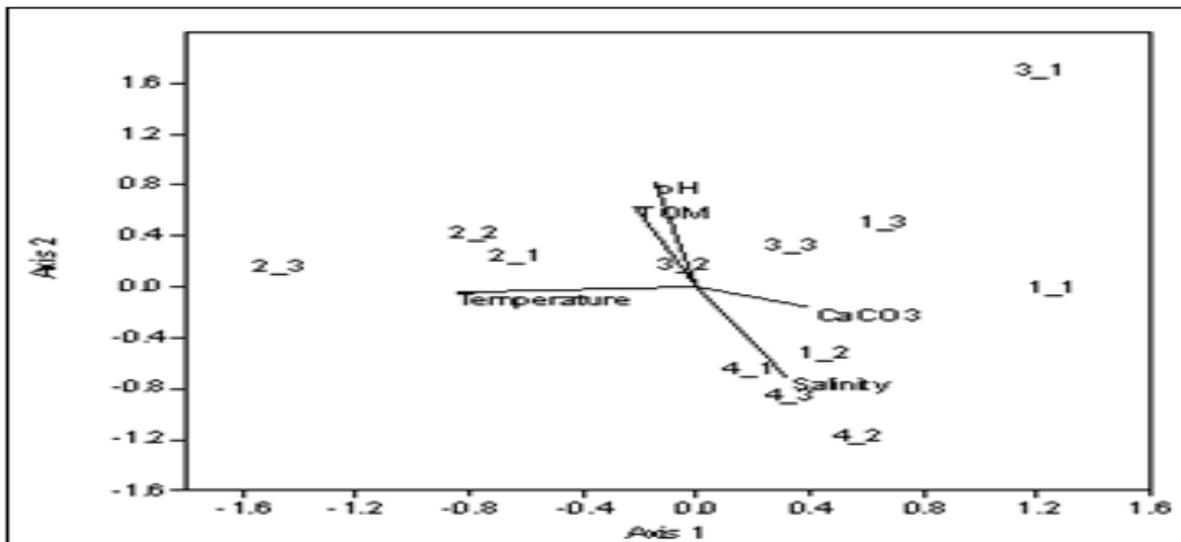


Fig. 3. Canonical Correspondence Analysis (CCA) biplot of the distance among the 4 sampling stations and the environmental parameters that influence the distribution and abundance of intertidal benthic mollusks.

Cerithium coralium also known as coral horn was reported to occur in marine (Barnes, 2003) and estuarine (Houbrick, 1992) intertidal zones as well as on sandy substrates with the presence of the seagrass *Halophila ovalis* (Vohra, 1971) and on algal mats in sandy flats (Alfaro *et al.*, 2009). This species has been reported to be deposit feeders creeping over substrates and feeding on detritus containing high algae content (Yipp, 1980). In the present study, *C. coralium* was abundant in stations 1 and 4 where seagrass beds are found and in station 2 where algal mats were seen over the sandy bottom.

These habitats provide the source of food needed by this specific gastropod since they prefer feeding on detritus containing high algae content.

Isognomiids are epifaunal filter feeding bivalves that inhabit intertidal zones and often found attached to rocks, coral boulders, sponges (Tsubaki *et al.*, 2011) and on roots of mangroves (Springsteen and Leobrera, 1986). The species *Isognomon ephippium* which is well-known and common in the Indo-Pacific region, most often clumped on intertidal rocky or hard substrate (Tsubaki *et al.*, 2011) and mangroves (Printrakoon *et al.*, 2008).

In the current study, *I. ephippium* and *I. californicum* were observed to aggregate together on boulders and rocks, suggesting that the hard substrata were used by these 2 species of isognomiids to attached themselves firmly to the ground.

The trochid *Herpetopoma* species are herbivorous gastropods that dwell on rocky intertidal bottoms where hard/rocky substrate are often covered with seaweeds. In particular, *Herpetopoma atrata* was reported to occur on bottoms consisting of coarse sand mix up rubbles and rocks (Taylor and Glover, 2004). In the present study, *H. atrata* was observed in high abundance in station 4 where seagrass are found and where the substrate is made up of coarse to fine sands often mixed with loose small-sized stones.

Abundance of mollusks among the 4 sampling stations were compared using the Kruskal-Wallis Test and results demonstrated that only station 3 was significantly different between station 1 ($p=0.000288$), station 2 ($p=0.0371$) and station 4 ($p=0.005061$). Further, the result of the Canonical Correspondence Analysis or CCA (Fig. 3) indicated that total organic matter (TOM) may have been responsible to the low abundance of molluscan assemblage in station 3.

It has been recorded that station 3 contained low amount of TOM contents in the sediments (See Table 2) when compared to the 3 stations. It has been reported (Snelgrove and Butman, 1994) that organic matter contents in the sediments are the chief source of food for both deposit and suspension feeding organisms. Several studies had emphasized the importance of seagrass beds as good source of food specially among deposit/detritus feeders because detritus and organic matter usually settles on seagrass leaves and on the sediments in the seagrass bed in high abundance (Kitting *et al.*, 1984; Fredriksen *et al.*, 2004; Hily *et al.*, 2004).

These sources of total organic matter are essential for many organisms for their growth, reproduction and survival. It is probable that the low amount of total

organic matter in station 3 may not be enough to support the physiological needs of the molluscs assemblage in this station considering that majority of them are deposit/detritus feeders. Aside from low total organic matter content in the sediment, the physical setting in station 3 such as the absence of seagrass beds, rocks and boulders may likewise be attributed to low abundance and low species richness of molluscs population in the said station. It has been reported that seagrass beds, rocks and boulders on the intertidal zones hosts rich taxa of molluscan species (Marina *et al.*, 2012; Flores-Rodriguez *et al.*, 2014) since these habitats provide anchor (against wave action), refuge (against desiccation and predators) and appropriate supply of food among molluscs population in general.

Conclusion

High diversity and uniformity in the distribution of mollusks in the present study areas were observed indicating that the intertidal zones in Iligan City and Kauswagan, Lanaodel Norte support rich population of benthic non-edible molluscan fauna. Moreover, molluscs abundance were recorded to be significantly different among stations and it is assumed that total organic matter (TOM) contents in the sediments may have influenced these variations. Since the role of benthic molluscan fauna is very crucial in the function of the food webs of the marine ecosystems as well as their impact in the world economy, the current results are therefore of vital importance in understanding the reason behind the successful existence and dynamicity of intertidal communities in the coastal zones of Northern Mindanao.

The present findings can also be utilized in the continuous monitoring and conservation efforts in Iligan City and Kauswagan, Lanaodel Norte considering that several industries are present along the coasts as well as the existence of unregulated gleaning activities. It is recommended that monthly assessments on the areas must be done in order to obtain a record on the patterns of distribution of the intertidal molluscs as well as the effects of changes in seasons (i.e. NE and SW monsoons) to their distribution.

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