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Survey and diversity of intertidal mollusks in Alabel and Maasim, Sarangani Province, Philippines

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Abstract. Sarangani Bay is an excellent site for surveying intertidal mollusks for different and diverse species were to be found. This study aimed to provide a concrete comparative analysis of the diversity of shoreline mollusks between the two shoreline sites: Kawas, Alabel and Tinoto, Maasim – both in Sarangani Province. A purposive sampling was conducted along the intertidal area of Alabel and Maasim. A transect with a length of 50-70 meters was established on site. The distance between transects was also about 50 meters. A total of 8 transects were installed perpendicularly along the shoreline. Each transect consist of 10 plots (1m X 1m) along the transect line. Samples were classified up to 57 species coming from class Gastropoda, Bivalvia and chitons. In Kawas, Alabel, the species *Cerithium echinatum* was found to be the most abundant species in the area while the species *Cypraea annulus*, *Arca navicularis* and *Onchidium daemelii* were the most abundant mollusks in the sampling site of Tinoto, Maasim. Several species such as *O. daemelli, Barbatia foliata, Nerita alveolus, Nerita maxima, Nerita chamaeleon,* and *Strigatella paupercula* were found to be common on both sites. The diversity indices on both sites showed significant results indicating that there was a significant difference on the diversity.
Key Words: bivalvia, gastropoda, chitons, transect.

Introduction. The intertidal zone is one of the most dynamic marine ecosystems for it is the crossing point between the sea and the terrestrial environment. Making it dynamic were the physical factors that include the existence of waves and the duration of exposure to sunlight that affect the life of the organisms inhabiting the intertidal zone (Datta et al 2009). Temperature fluctuations, intense solar radiation, and desiccation for considerable period also occur, that highly influence the activities of these species (Smith et al 2004). Some of these organisms thriving in intertidal zones are the mollusk species that is believed to be 22,000 species in existence in the Philippines (PBCPP 2002) and 70,000 species existing globally (IUCN 2004). Several studies have been conducted relating to mollusks in the country but it was still insufficient to supply systemic records about the taxonomy and ecology of these species. One of these studies was the one conducted by Masagca et al (2010) at Catanduanes Island in northern Philippines concerning the mollusks divesity in the island. As a result, much of the studies conducted about mollusk species in the Philippines were still based on the collections of mollusk species of many foreign researchers e.g. collections of Hugh Cummings from 1836 to 1840 (Batomalaque et al 2010).

Studies concerning the diversity and variations of intertidal mollusks in the Philippines were done mostly in Luzon and Visayas shorelines areas. One of these was the study performed by Batomalaque et al (2010) that focused on the spatial distribution of mollusks along the shoreline of Grande Island, Subic Bay. They have discovered that mollusks were distributed according to the substrate (composition and particle size) and concluded that the morphological adaptations of the different species enabled them to

occur in specific habitat types. In Visayas, a study about focal benthic mollusks of selected sites on Tubattaha Reef National Marine Park, Palawan was conducted by Dolorosa & Schoppe (2005). On the contrary, no complete studies concerning mollusks species across subject areas were conducted in Mindanao, especially along the shorelines of Sarangani Bay.

Sarangani Bay is known to be an environment where diverse marine organisms, specifically marine mollusks, inhabit. It provides an excellent site for the studying of the subject matter because within the perimeter of the intertidal zone, different mollusks species can be found and yet, no prior studies regarding species diversity have been conducted. With these, knowing that there was scarcity in studying mollusk species, the group was urged to have its study on the diversity of mollusks inhabiting on the two sites. Since there were no previous studies conducted related to the subject matter on the designated sites, the data and information that were collected in this research will be useful in the future studies.

The present paper aimed to determine and compare the diversity and the distribution of intertidal mollusks between the two sites: Kawas, Alabel and Tinoto, Maasim, Sarangani Province. Time-based distribution was not studied for shorter time was allotted in gathering sampling data.

Material and Method

Study area. The study was conducted from June-August, 2014, along the Sarangani Bay, which is located at south-eastern Mindanao geographically lies between 5°33`25" - 6°6`15"N and 124°22'45"- 125°19`45"E (Figures 1 and 2). The study group chose two sites along the shorelines of Sarangani Province: Kawas, Alabel and Tinoto, Maasim.

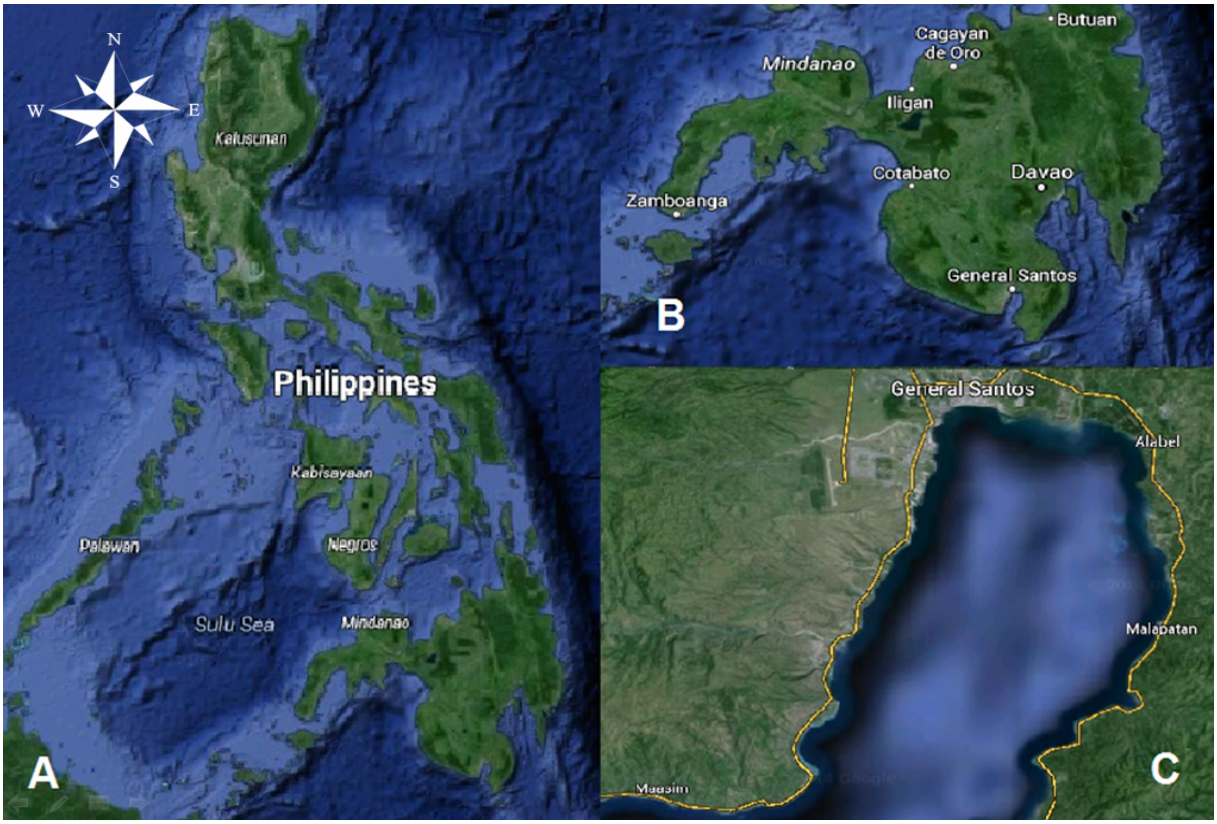

Figure 1. (A) Map of the Philippines; (B) Map of Mindanao, Philippines and; (C) Map of South Central Mindanao where the sampling sites: Alabel and Maasim, Sarangani Province are located (http://www.google.com/maps/).

Figure 2. (A) Map showing the sampling site of Kawas, Alabel and; (B) Map showing the sampling site of Tinoto, Maasim, Saragani Province.

Establishment of transects and quadrats. A purposive sampling was conducted along the intertidal area of Kawas, Alabel and Tinoto, Maasim. Transects with a length of 50-70 meters were established on each site. The distance between transects were also about 50 meters. A total of 8 transects were installed perpendicularly along the shoreline. Each transect consist of 10 quadrats (1m X 1m) along the transect line.

Species survey. Only live mollusks were accumulated. In every species there were sample specimens that were brought to laboratory for the verification of the identifications of the individual species and morphological examinations. The samples were identified down to the species level, where it was possible, identifications were based on different references e.g. the collections of mollusks in the Philippines by Poppe (2008a, 2008 b, 2008c), the guidelines for identifications of bivalves and gastropods by Carpenter & Niem (1998), the biography of mollusks in the Philippines by Vallejo Jr. (2001), the collections of Philippine mollusks by Springster et al (1986). Some identifications were taken from inyternet websites e.g. www.gastropods.com, www.seashellhub.com, www.jaxshells.com.

Data analysis. The important quantitative values were (a) Abundance, (b) Frequency and (c) Density and its relative values as per Curtis & McIntosh (1950). Formulas were given as:

(a) Abundance = Total number of individuals of a species in all quadrats / Total number of quadrats in which the species occurred;

(b) Frequency = Total number of quadrats in which the species occurred / Total number of occurrences in the study;

(c) Density = Total number of individuals of a species in all quadrats / Total number of individuals of all species in the study.

Species importance values (SIV) were calculated by summing up the relative abundance, relative frequency and relative abundance values.

(d) Relative abundance = Abundance value of a species X 100 / Abundance value of all species;

(e) Relative frequency (%) = Total number of occurences of a species X 100 / Total number of occurences of all species;

(f) Relative density = Total number of individuals of a species X 100 / total number of individuals of all species.

PAST Software (Hammer et al 2001) was used for the assessment of diversity values; biodiversity measurements considered were species richness, abundance, dominance, evenness and Shannon diversity. Biodiversity values were compwered in the two locations using T Test (De Winter 2013). Results were displayed in error bars using Microsoft Excel.

Results and Discussion. In Kawas, Alabel, there were 2096 individual mollusks surveyed and attributed to 32 species, with 31 species coming from class Gastropoda and 1 species from class Bivalvia. In Tinoto, Maasim, Sarangani Province, 2888 individual mollusks were sampled, accounting to 34 species - 29 species coming from class Gastropoda, 4 species from class Bivalvia and 1 species from chitons. In summing up, there were 4984 individual mollusks sampled in Alabel and Maasim and classified up to 58 species coming from class Gastropoda, Bivalvia and chitons (Table 1). Diversity indices considered were species abundance and frequency, dominance, evenness, species richness and Shannon's diversity, and they were calculated and assessed by PAST software along with the T-tests that were obtained from Microsoft Excel (Table 2). The comparison of the diversity indices were shown in graph and the results displayed in error bars (Figure 3).

Table 1 shows the list species that inhabit on the two sites and was specified whether the species was present or absent in the area. It was found out that there were more species inhabiting in Kawas, Alabel, with 13 families than in Tinoto, Maasim, with 12 families although Maasim contains more individual mollusks. Gastropods species *Nassarius polygonatus* from family Nassariidae, *Onchidium daemelli* from family Onchidiidae, *Turbo cinereus* from family Turbinidae, *Nerita alveolus*, *Nerita chamaeleon* and *Nerita maxima* from family Neritidae and *Strigatella paupercula* from family Mitridae were found to be common on the both sites. A bivalve species from family Arcidae, *Barbatia foliata*, was found to be inhabiting on both sampling areas. In contrary, there were 50 species that were found to be inhabiting only on one site and were unique to each area.

The level of the diversity of mollusks in Sarangani province of the two sites between Alabel and Maasim was shown on Table 2. Statistically, T-test shows that there was a significant difference on dominance, species richness and species abundance of mollusks between the sampling sites while there was no difference on evenness and Shannon's diversity. In Kawas, Alabel, the abundance of the mollusks showed lower value than in Tinoto, Maasim, showing that mollusks in Tinoto were more numerous and abundant. In contrary, it has higher values in terms of dominance, than in Maasim, signifying that in Alabel, there were some mollusks species that were dominant among all the individuals inhabiting in the area. Table 3 shows the different relative values on the two sites. It was found out that *Cerithium echinatum* with 10.22 and *Arca navicularis* with 28.36 relative abundance values were the most abundant species in Alabel and Maasim respectively. *Nassarius fragum, Mitromorpha philippinensis* and *Faunus ater* also showed larger values which means that these species were also abundant in Kawas, Alabel. *Conus radiatus, S. paupercula* and *Cypraea annulus* were also found to be abundant in Maasim. In relative frequency values, *C. echinatum,* having 3.1%, was the most frequent mollusk species in Alabel, followed by *N. fragum, M. philippinensis* and *F. ater* with RF values of 2.7%, 2.4% and 2.3%, respectively. *C. annulus* species was surveyed to be the most frequent species in Tinoto with 12.26%. *O. daemelli, Thais muricoides* and *Colubraria tenera* were also frequent in the shorelines of Maasim.

Relative density values of species in Alabel shows that *N. fragum, F. ater* and *C. echinatum* were the most dense in the intertidal zone of Kawas, Alabel. On the other hand, *C. annulus, A. navicularis* and *O. daemelli* species were found to be the most dense in Tinoto, Maasim.

Table 1

Summary of surveyed species on the two sites; species were marked to be present or not present on each site

Mollusks group	*Family*	*Species*	*Alabel*	*Maasim*
GASTROPODS	Family Buccinidae	*Babylonia areolata*	0	X
		Babylonia lutosa	0	X
	Family Cerithiidae	*Cerithium coralium*	X	0
		Cerithium echinatum	X	0
	Family Colubrariidae	*Colubraria tenera*	0	X
		Colubraria tortuosa	0	X
		Colubraria muricata	0	X
	Family Conidae	*Conus marmoreus*	0	X
		Conus radiatus	0	X
		Conus textile	0	X
	Family Cypraeidae	*Cypraea annulus*	0	X
	Family Littorinidae	*Tectarius coronatus*	X	X
	Family Mitridae	*Strigatella paupercula*	X	X
	Family Mitromorphidae	*Mitromorpha philippinensis*	X	0
	Family Muricidae	*Thais muricoides*	0	X
	Family Nassariidae	*Cyllene sibogae*	X	0
		Nassarius acuticostus	X	0
		Nassarius arcularius	X	0
		Nassarius bimaculosus	X	0
		Nassarius crenoliratus	X	0
		Nassarius fragum	X	0
		Nassarius himeroessus	X	0
		Nassarius luridus	X	0
		Nassarius polygonatus	X	X
		Nassarius semisulcatus	X	0
	Family Neritidae	*Nerita albicilla*	0	X
		Nerita alveolus	X	X
		Nerita chamaeleon	X	X
		Nerita erythrostoma	0	X
		Nerita guamensis	0	X
		Nerita histrio	X	0
		Nerita insculpta	X	0
		Nerita leguillouna	0	X
		Nerita litterata	0	X
		Nerita maura	0	X
		Nerita maxima	X	X
		Nerita negrita	0	X
		Nerita ocellata	0	X
		Nerita patula	X	0
		Nerita plicata	0	X
		Nerita polita antiquata	0	X
		Nerita polita polita	0	X
		Nerita sanguinolenta	0	X
		Nerita semirugosa	X	0
		Nerita spengleriana	X	0
		Nerita undata	X	0
	Family Olividae	*Oliva bulbiformis*	X	0
		Oliva semmelinki	X	0
	Family Onchidiidae	*Onchidium daemelli*	X	X
	Family Phyllidiidae	*Phyllidia pustulosa*	X	0
	Family Ranellidae	*Cymatium aquatile*	X	0
	Family Terebridae	*Faunus ater*	X	0
	Family Turbinidae	*Turbo cinereus*	X	X
BIVALVES	Family Arcidae	*Arca navicularis*	0	X
		Anadara granosa	0	X
		Barbatia foliata	X	X
		Barbatia fusca	0	X
CHITONS	Family Mopalidae	*Mopalia muscosa*	0	X

Legends: “x” – present; “0 – not present.

Table 2

Values of Mollusks' Abundance (a), Dominance (b), Shannon (c), Evenness (d) and Species Richness (e) on the two sampling sites of Sarangani Province

Site	*Abundance*	*Dominance*	*Eveness*	*Shannon diversity*	*Species richness*
Alabel	262	0.24	0.53	1.77	12
Maasim	361	0.15	0.51	2.27	19.25
T-Test	0.0063**	0.00037**	0.785^{ns}	4.87^{ns}	0.0015**

Legends – ns = not significant; ** = highly significant at p = 0.005 using T Test.

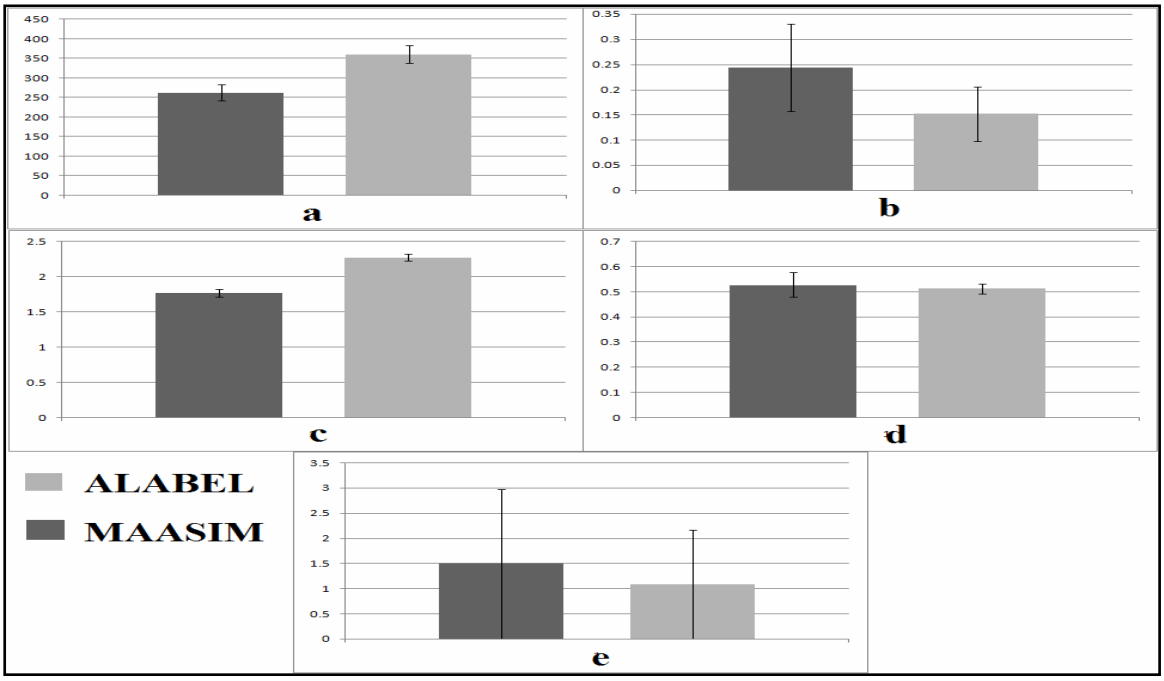

Figure 3. Statistical analysis of Mollusks' Abundance (a), Dominance (b), Shannon (c), Evenness (d) and Species Richness (e) on the two sampling sites of Sarangani Province.

Figure 4 shows that *N. fragum* has the largest value with respect to SIV with 37.6, indicating that this species is the most important among the species inhabiting in Kawas, Alabel. It is followed by the species *F. ater* with 25.6, *C. echinatum* with 24.1, *Nerita semirugosa* with 13.9, *Nassarius bimaculosus* with 13.1, *Nassarius crenoliratus* with 12.3, *M. philippinensis* with 12.2, *Cerithium coralium* with 11.6, *Barbatia foliata* with 9.1 and *Nassarius arcularius* with 7.0 SI value. These species have the highest species importance values in the sampling site of Kawas.

In Maasim, on the other hand, *C. annulus* has a SI value of 40.86, topping all the species thriving in the area. It was followed by *A. navicularis, O. daemelli, T. muricoides, C. tenera, S. paupercula, Nassarius polygonatus, Nerita plicata, C. radiatus* and *Colubraria muricata* with 40.35, 22.97, 16.52, 11.74, 11.03, 10.08, 10.08, 9.92 and 9.89 respectively. These species were the most abundant and most frequent species in the area. Since these species' importance values were high, indicating that these species were the dominant species in Tinoto, Maasim.

Species inhabiting on both sites like *Nerita maxima, N. alveolus* and *S. paupercula* do not show any similarities in their species importance values, hence, the difference in the location and type of habitat affect the distribution and diversity of the mollusks species.

It was also found out that mollusks species were more abundant in the less disturbed areas than in the areas under the influence of human activities since both sites have areas that were used for commercial purposes - renovated and used as beaches and resorts.

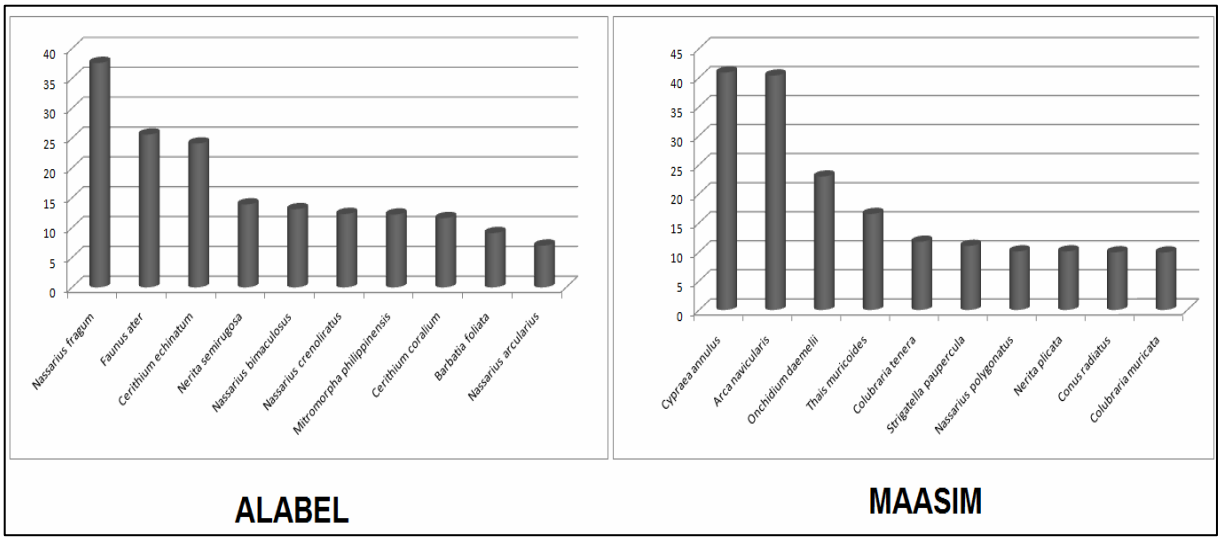

Figure 4. Species importance values (SIV) of mollusks surveyed in Kawas, Alabel and in Tinoto, Maasim, Sarangani Province.

Table 3

Relative values of the abundance, frequency, and density of mollusks species in Alabel and Maasim (only the top 10 species were shown)

Alabel		*Maasim*	
Species	*Value*	*Species*	*Value*
Relative abundance (%)			
Cerithium echinatum	10.22	*Arca navicularis*	28.36
Nassarius fragum	8.90	*Conus radiatus*	8.51
Mitromorpha philippinensis	7.86	*Strigatella paupercula*	5.14
Faunus ater	7.50	*Cypraea annulus*	4.71
Nassarius bimaculosus	6.00	*Nerita plicata*	4.60
Cerithium coralium	5.70	*Conus textile*	3.50
Nerita semirugosa	4.90	*Nerita polita polita*	3.28
Barbatia foliata	4.88	*Nerita chamaeleon*	3.22
Nerita undata	4.55	*Nerita guamensis*	3.19
Nassarius crenoliratus	4.31	*Nerita polita*	2.99
Relative frequency (%)			
Cerithium echinatum	3.10	*Cypraea annulus*	12.26
Nassarius fragum	2.70	*Onchidium daemelli*	11.63
Mitromorpha philippinensis	2.40	*Thais muricoides*	7.54
Faunus ater	2.30	*Colubraria tenera*	6.60
Nassarius bimaculosus	1.80	*Nassarius polygonatus*	6.60
Cerithium coralium	1.70	*Colubraria muricata*	5.66
Nassarius arcularius	1.50	*Conus marmoreus*	4.71
Nerita semirugosa	1.49	*Colubraria tortuosa*	4.40
Barbatia foliata	1.48	*Nassarius crenoliratus*	3.45
Nerita undata	1.40	*Barbatia foliata*	3.14
Relative density (%)			
Nassarius fragum	25.90	*Cypraea annulus*	23.80
Faunus ater	15.80	*Arca navicularis*	11.04
Cerithium echinatum	10.77	*Onchidium daemelli*	9.38
Nerita semirugosa	7.55	*Thais muricoides*	6.79
Nassarius crenoliratus	6.64	*Strigatella paupercula*	4.00
Nerita undata	5.53	*Colubraria tenera*	3.76
Nassarius bimaculosus	5.53	*Nerita plicata*	3.59
Cerithium coralium	4.18	*Nerita guamensis*	3.31
Nerita alveolus	3.57	*Colubraria muricata*	2.97
Barbatia foliata	2.77	*Conus marmoreus*	2.93

Conclusions. This study reveals a great view on how the shorelines of Sarangani Bay hold various species across classes of mollusks using 80 pcs. quadrats (1 x 1 m) as sampling instruments. Results from this study provide a preliminary idea in the diversity of different mollusks species inhabiting the two sites along Sarangani Bay – Kawas, Alabel and Tinoto, Maasim.

From the results, it can be inferred that diversity and range of mollusks species can be surveyed along the shoreline. It was found out that majority of the species surveyed vary between the two sites, thus, it proves that on different habitat, different species can be found. However, several species of mollusks, both from gastropod and bivalve classes, can be seen on both sites regardless of its habitat. It is suggested that more and further studies about mollusks should be made along the shorelines of Sarangani Bay, for it contain information about mollusks across different subject matters that were yet to be surveyed and discovered.

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References

Batomalaque G. A., Arce B. G. P., Hernandez M. B. M., Fontanilla I. K. C., 2010 Survey and spatial distribution of shoreline malacofauna in Grande Island, Subic Bay. Philippine Journal of Science 139(2):149-159.

Carpenter K. E., Niem V. H., 1998 The living marine resources of Western central Pacific. Volume 1: Seaweeds, corals, bivalves and gastropods. Rome, FAO, 686 pp.

Curtis J. T., McIntosh R. P., 1950 The interrelations of certain analytic and synthetic phytosociological characters. Ecology 31:434-455.

Datta S. N., Chakraborty S. K., Jaiswar A. K., Ziauddin G., 2010 A comparative study on intertidal faunal biodiversity of selected beaches of Mumbai coast. Journal of Environmental Biology 31(6):981-986.

De Winter J. C. F., 2013 Using the Student's t-test with extremely small sample sizes. Practical Assessment, Research & Evaluation 18(10). Available online at: http://pareonline.net/getvn.asp?v=18&n=10.

Dolorosa R. G., Schoppe S., 2005 Focal benthic mollusks (Mollusca: Bivalvia and Gastropoda) of selected sites in Tubbataha Reef National Marine Park, Palawan, Philippines. Science Diliman 1792):1-10.

Hammer O., Harper D. A. T., Ryan P. D., 2001 Past: Paleontological Statistics software package for education and data analysis. Palaeontologia Electronica 4(1):1-9.

International Union for the Conservation of Nature (IUCN), 2004 IUCN Red List of Threatened Species. Accessed on August 2014. www.redlist.org.

Masagca J. T., Mendoza A. V., Tribiana E. T., 2010 The status of mollusk diversity and physical setting of the mangrove zones in Catanduanes Island, Luzon, Philippines. Journal of Biotropia 17(2):62-76.

Philippine Biodiversity Conservation Priority setting Program (PBCPP), 2002 Philippine biodiversity conservation priorities: a second iteration of the national biodiversity strategy and action plan: final report. Ong P. S., Afuang L. E., Rosell-Ambal R. G. (eds), Quezon City: Protected Areas and Wildlife Bureau-Department of Environment and Natural Resources, Conservation International-Philippines, Biodiversity Conservation Program-University of the Philippines Center for Integrative and Developmental Studies, 114 pp.

Poppe G. T., 2008a Philippine marine mollusks. Volume 1: Gastropoda - Part I. Conchbooks. Hackenheim, Germany, 759 pp.

Poppe G. T., 2008b Philippine Marine Mollusks. Volume 2: Gastropoda - Part II. Conchbooks. Hackenheim, Germany, 848 pp.

Poppe G. T., 2008c Philippine Marine Mollusks. Volume 3: Gastropoda - Part III. Conchbooks. Hackenheim, Germany, 702 pp.

Smith J. E., Hunter C. L., Conklin E. J., Most R., Sauvage T., Squair C., Smith C. M., 2004 Ecology of the invasive red alga *Gracilaria salicornia* (Rhodophyta) on O'ahu, Hawai'i. Pacific Science 58(2):325-343.
Springsteen F. J., Leobrera F. M., 1986 Shells of the Philippines. Carfel Seashell Museum, Manila, Philippines, 377 pp.
Vallejo Jr. B., 2001 The biogeography of Philippine marine mollusks. Loyola Schools Review 1:58-77.
*** http://www.google.com/maps/.
*** http://www.gastropods.com/Taxon_pages/Class_GASTROPODA.shtml/.
*** http://www.seashellhub.com/marine.html.
*** http://www.jaxshells.org/marine1.htm.

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