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Abundance and Diversity of Conidae and Cypraeidae in the Intertidal Zone of Bucas Grande Island, Surigao del Norte, Philippines

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ABSTRACT: Bucas Grande Island has rich marine biodiversity; however, little is known of these resources in scientific reports. Hence, a preliminary observation on the abundance and diversity of Conidae and Cypraeidae was carried out in the coastal shores of Bucas Grande Island, Surigao del Norte, Philippines. This study was conducted in the four sampling stations, *viz*., Socorro (Lungsod), Puyangi, Mabua, and Dapia. Sampling was done in May 2014 during low tide with plots of 20 × 20m laid on the intertidal flats for species acquisition. Beach combing and systematic snorkel surveys were done in the plots. All species under Conidae and Cypraeidae observed in the sampling plots were counted. Twelve (12) species were documented with 468 individuals: six for Conidae (*Conus coronatus, C. ebraeus, C. magus, C. marmoreus, C. miles* and *C. vexillum*) as well as for Cypraeidae (*Cypraea annulus, C. arabica, C. argus, C. eglantina, C. isabella* and *C. vitellus*). Abundance value of Conidae was greater (70%) than Cypraeidae (30%) with 326 and 142 individuals, respectively. *C. ebraeus* (25.85%) was the most abundant in Conidae, while *C. annulus* (26.50%) in Cypraeidae. The highets record of abundance (43.20%) and diversity (H`= 0.71) on these gastropod families were in Socorro (Lungsod) sampling station.

Keywords: Conidae, *Conus ebraeus*, *Cypraea annulus*, Cypraeidae, Marine Protected Area.

INTRODUCTION

The diversity of marine life is very high and is estimated to amount to 2.2 million species and only about 0.8 million species have been identified (Mora *et al.*, 2011). Molluscs are the second species-rich phylum in the world after arthropods (Prié, 2019), and consist of seven classes, *viz*., Polyplacophora (chiton), Gastropod (snail), Bivalvia (clam), Scaphopoda (hornshell), Cephalopoda (squid or chiton), Aplacophora and Monoplacopora (Manusawai *et al.*, 2020). Gastropod (limpets, snails, whelks and slugs) is by far the most diverse group of molluscs with *ca.* 100,000 species that inhabit all marine, freshwater and terrestrial habitats (Haszprunar & Wanninger 2012).

The gastropod families of Conidae and Cypraeidae, respectively known as cone snails and cowries, are widely distributed in the tropical zone of all oceans, particularly in the Indo-Pacific and Western Pacific regions (Keen, 1971). Aside from their ecological functions, many members from both families have significant economic values to man as food or ornamental items. All species in the genus *Conus* of family Conidae are known for its unique, efficient venom delivery system for defense or prey capture (Olivera, 2002), and generally, *Conus* are considered to be the most diverse of marine animals (Kohn, 1990). On the other hand, Cypraeidae is reported with highest species richness in the region spanning the Philippines to Melanesia. The main characteristic of cowries (also shared by some other gastropods) is the presence of a retractable mantle that covers the entire shell, when in full extension (Passamonti, 2015).

Bucas Grande Island belongs to the Siargao group of islands which is part of the eastern Mindanao Seaboard Marine Protected Area (MPA) lying off north eastern part of Surigao del Norte, Philippines. The Bucas Grande is officially designated as the municipality of Socorro and is popular for its beaches and its widely known tourist spot, the Sohoton Cove. Despite of the obvious abundance of the island's marine life, only few studies were conducted and reported in this area. A more recent one focused on seagrass species distribution (Dedel *et al.*, 2018). The only existing earlier data on gastropods in Bucas Grande Island is given in the work of Galan & Gonzales (2005) which reported 21 species. However, this is considerably modest when compared to the global figures of *ca.* 70,000 described molluscan species (IUCN, 2004), of which about 22,000 are believed to be found in the Philippines (PBCPP, 2002). Hence, this study was carried out to provide additional information on the abundance and diversity of Conidae and Cypraeidae in Bucas Grande Island, Surigao del Norte, Philippines.

MATERIAL AND METHODS

Entry Protocol: The Prior Informed Consent (PIC) was secured at the municipal and barangay levels prior to the conduct of the study. An ocular visit was made following the courtesy call with the Mayor.

Site Description: Bucas Grande Island lies off north eastern part of Surigao del Norte (Fig. 1) at coordinates

9° 37' 17" North, 125° 58' 0" East. Its total land area of 12,445 ha holds a count of more or less 20,000 inhabitants, which have settled in 14 barangays in the municipality. This island is about 3 hours motor boat ride from the capital city of Surigao, and is occupied by the lone municipality of Socorro.

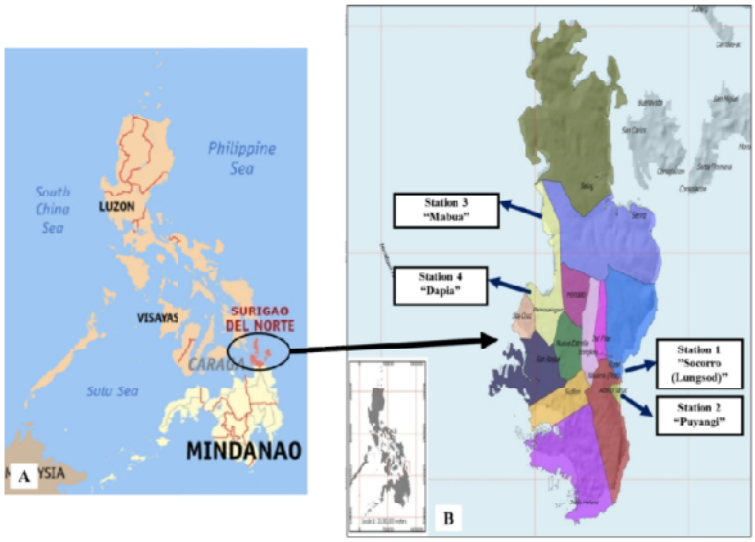

Fig. 1. Study Site. A) Philippine map; B) Surigao del Sur Island showing Station 1 "Socorro Lungsod", Station 2 "Puyangi", Station 3 "Mabua", and Station 4 "Dapia".

Four sampling stations were selected for the collection of gastropod species. Study station 1 Socorro (Lungsod) and study station 2 (Puyangi) are coastal areas of the town proper of Socorro and situated in the eastern side of the island facing the pacific. Study station 3 (Mabua) and study station 4 (Dapia) are coastal areas of Barangay Pamosaingan, in the western side facing the mainland of Surigao del Norte. The substrate of Socorro (Lungsod) site is predominantly rocky, while Puyangi, Mabua and Dapia is sandy-rocky. Of the four stations, Socorro (Lungsod) had the greatest extent of intertidal flat.

Sampling Scheme : A 20 × 20m sampling plot was laid on each study station for species acquisition. Sampling was done within the period of May 13–19, 2014 during low tide in the intertidal flats. Only one sampling trip was made for each station. Beach combing and systematic snorkel surveys were done in the plots. For consistency, only four gleaners were hired to do the sampling in these plots during the period of the study. Sampling time for each plot was only 30 minutes. Rocks, stones, and woods were moved and turned upside down for a thorough search. For muddy substrate, the surface was slightly swept and dug for burrowing species.

Collection and Identification of the Specimens: The number of individuals encountered was recorded for each plot and only live gastropods were collected. Representative specimens were placed inside labeled plastics or cellophanes and brought to the laboratory for processing of voucher specimens. All specimens were identified up to the species level following the works of Springsteen and Leobrera (1986); Abbot (1991); Abbott & Morris (1995); Esqueda *et al.*, (2000); Dolorosa *et al.* (2015); Poppe (2008); Laureta (2008); Abarquez *et al.*, (2019).

Species Abundance and Diversity: Relative abundance was used as measure of species adbundance and the Shannon-Weiner Index was used for diversity:

$$H` = -\sum_{i=1}^{s} p_i \log_e p_i$$

where:

$H`$ = the value of the Shannon-Weiner Index
p_i = the proportion of the $_i$th species
$\log_e$ = the natural logarithm of p_i
s = the number of species in the community

RESULTS AND DISCUSSION

Species Composition: The study revealed a total of 12 gastropod species (six species of Conidae and six species of Cypraeidae) with 468 individuals in the intertidal zone of Bucas Grande Island (Table 1). The recorded species of Conidae include *Conus coronatus*, *C. ebraeus*, *C. magus*, *C. marmoreus*, *C. miles* and *C. vexillum*, while the recorded species of Cypraeidae were *Cypraea annulus*, *C. arabica*, *C. argus*, *C. eglantina*, *C. isabella* and *C. vitellus* (Fig. 2). As previously reported by Kohn (1998), *Conus* is the most diverse genus of marine invertebrates and contributes substantially to the great biodiversity in the tropical Indo–Pacific reef environments. However, this study reports that the total number of Conidae and Cypraeidae collected during the sampling period is equal. The few collected species of Conidae can be attributed to the report of Terlau & Olivera (2004) that many cone snails are nocturnal predators and are hiding under rocks/coral rubble or are buried in sand during the day.

Table 1: Relative abundance of Conidae and Cypraeidae in Bucas Grande Island, Surigao del Norte.

Family	Scientific Name	Study station				Total number of individuals	Relative Abundance (%)
		1	2	3	4		
Conidae	*Conus coronatus* Gmelin, 1791	/		/		6	1.28
	Conus ebraeus Linnaeus, 1758	/		/	/	121	25.85
	Conus magus Linnaeus, 1758	/				37	7.91
	Conus marmoreus Linnaeus, 1758	/				92	19.66
	Conus miles Linnaeus, 1758				/	5	1.07
	Conus vexillum Gmelin, 1791	/				65	13.89
Cypraeidae	*Cypraea annulus* Linnaeus, 1758	/	/		/	124	26.50
	Cypraea arabica Linnaeus, 1758			/		2	0.43
	Cypraea argus Linnaeus, 1758	/				4	0.85
	Cypraea eglantina Duclos, 1833	/			/	6	1.28
	Cypraea isabella Linnaeus, 1758		/	/		4	0.85
	Cypraea vitellus Linnaeus, 1758			/		2	0.43

Remarks: 1 – Socorro (Lungsod), 2 – Puyangi, 3 – Mabua, 4 – Dapia

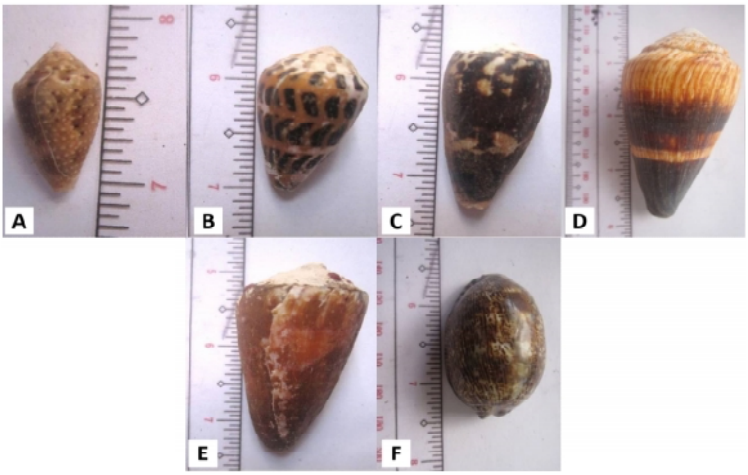

Fig. 2. Representative specimens from the two families. A) *Conus coronatus* Gmelin, 1791; B) *Conus ebraeus* Linnaeus, 1758; C) *Conus magus* Linnaeus, 1758; D) *Conus miles* Linnaeus, 1758; E) *Conus vexillum* Gmelin, 1791; and F) *Cypraea arabica* Linnaeus, 1758.

The collected species in this study is relatively high compared to the collected species of Febiansi *et al.*, (2018) at Krakal Beach in Indonesia with five Conidae species and five Cypraeidae species, Setyono *et al.*, (2019) in the intertidal zone of Watukarung in Indonesia with one species of Conidae and five species of Cypraeidae, and Ladias *et al*., (2020) with two species of Conidae and no species of Cypraeidae in the intertidal zone of Muduing Bay, Zamboanga Peninsula, Philippines. However, the collected species is lower compared to the studies of Benjamin Franklin *et al*. (2009) in TamilNadu Coast of India with 60 species of Conidae, Sary *et al.*, (2014) in Keral Coast in India with 10 species of Conidae, and Steger *et al*., (2017) at Vavvaru Island, Faadhippolhu Atoll, northern Maldives with 20 species of Conidae as the most speciose and followed by Cypraeidae with 17 species.

Species Abundance: Among the four study stations, Station 1 (Socorro Lungsod) obtained the highest abundance of Conidae and Cypraeidae with 43.20%, followed by Station 4 (Dapia), Station 3 (Mabua), and Station 2 (Puyangi) with 27.47%, 19.24% and 10.09%, respectively (Fig. 3). The Conidae dominated in all sampling stations with 70%, while Cypraeidae had 30%. This is because *Conus* species are widely distributed throughout all tropical oceans comprising one-fourth the earth's ocean area (Briggs, 1974). There were 326 individuals of Conidae recorded from the four sampling stations. With respect to the sampling stations, the species with the highest dominance was *C. ebraeus* (25.85%) with 121 individuals. On the other hand, a total of 142 individuals were collected representing the Cypraeidae. Of which, *C. annulus* had the highest number of individuals with 124 (26.50%), which is by far the highest in Cypraeidae being collected from the three sampling stations: Socorro (Lungsod) (87.10% or 27 individuals), Puyangi (97.10% or 67 individuals), and Dapia (78.95% or 30 individuals). This supported Richmond (1997), which reported that *C. annulus* is widely distributed is his study, and can found in shallow water, tide pools, under stones or among seagrasses.

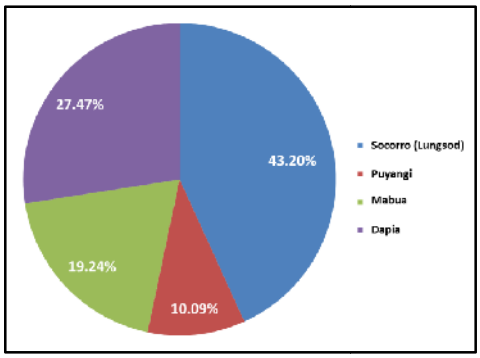

Fig. 3. Percentage abundance of Conidae and Cypraeidae in the four sampling stations.

Species Diversity: Socorro (Lungsod) had the highest diversity of gastropods. It was also supported by the result of Shannon-Weiner Index showing the H' values of the different sampling stations: 1) Socorro (Lungsod)–H'=0.71, 2) Dapia–H'=0.51, 3) Mabua–H' 0.46 and 4) Puyangi–H'=0.06.

Fig. 4 showed three clusters of environment in sampling stations. Mabua and Dapia had a similarity index of 39.78, Socorro (Lungsod) had a similarity index of 38.43 with Mabua and Dapia, while Puyangi had a similarly index of 37.5 with the other three sampling stations. Mabua and Dapia had the highest similarity index, since these stations are both found in the town of Pamosaingan. Although Socorro (Lungsod) and Puyangi are also both located in the town of Socorro, differences of the substrate in the area are observed since the former is found in the area near houses and pollution, while the latter is away from the main town. This could be due to the report of Dance & Cosel (1977), which reported that gastropods inhabit different bottom types, including rocky areas, and can found from the intertidal zone to depths greater than 1000 m.

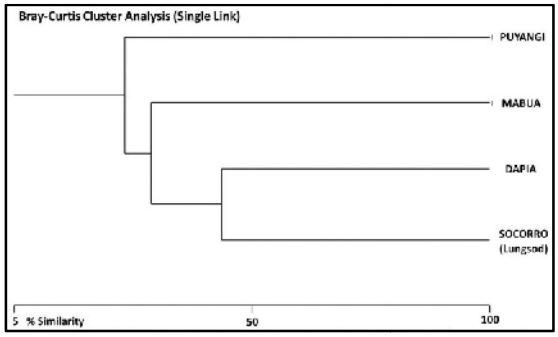

Fig. 4. Dendogram of similarity species composition of Conidae and Cypraeidae in the four study stations.

CONCLUSIONS

A total of 12 species (six species of Conidae and six species of Cypraeidae) were collected with 468 individuals. Gastropod abundance was highest in Socorro (Lungsod) with 43.20%. The Conidae (70%) was the most abundant family with 326 individuals, while Cypraeidae (30%) with 142 individuals. Among these species, *C. ebraeus* (25.85%) had the highest abundance in Conidae, while *C. annulus* (26.50%) in Cypraeidae. This paper bears significance, since it will be an added literature on gastropod species in poorly studied area in Bucas Grande Island.

FUTURE SCOPE

This study recommends that assessment of gastropods, specifically the Conidae and Cypraeidae species should be done yearly to generate concrete data to meet the adequate number of species present in Bucas Grande Island. Furthermore, future marine researches in the area should include the physico-chemical parameters.

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Conflict of Interest. The authors declare no conflict of interest.

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