HAYATI
Journal of Biosciences

Vol. 31 No. 1, January 2024 153-160
DOI:10.4308/hjb.31.1.153-160
ISSN: 1978-3019
EISSN: 2086-4094

Diversity of Harvested Gastropods in Guang-Guang, Mati City, Davao Oriental, Philippines

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ARTICLE INFO

Article history:
Received July 13, 2023
Received in revised form October 2, 2023
Accepted October 24, 2023

KEYWORDS:
abundance,
low diversity,
gastropods,
gleaners,
harvesting

ABSTRACT

Gastropods are a highly abundant group of mollusks in the marine environment. Marine gastropods primarily function as prey for other animals, grazers which help recycle nutrients and increase bioturbation activities in the marine ecosystem. Edible gastropods are significant to the economy of coastal communities. However, overexploitation leads to harming the population of marine gastropods. The study aimed to determine the diversity of gastropods harvested at Guang-guang, Mati City, Davao Oriental. It also assessed the abundance of the identified gastropods in the area. This study used purposive sampling to enroll gleaners (N = 30) who collected shells and monitored their gastropod harvest. The harvested gastropods were segregated, counted, and identified with the help of gleaners. A total of ten gastropod species were identified from the family of Strombidae, Conidae, Neritidae, Cypraeidae, and Turbinidae. The most abundant group after harvest was *Canarium urceus*, with a relative abundance of 67%, followed by *Ilyanassa obsoleta*, with 22%. However, the least harvested species was Nerita, with a relative abundance of 0.18%. The findings revealed that the harvested gastropods in Guang-guang have a diversity index of 0.99, indicating a low diversity of gastropods in the area. This low diversity could mean the area experienced overexploitation through time as gleaners have heavily harvested gastropods. With that, it is highly recommended that conservation should be prioritized to preserve the seashells.

1. Introduction

Gastropods are a highly diverse group of mollusks having single-valve, soft bodies protected by shells (Brown and Lydeard 2010). The gastropods are highly abundant in marine, terrestrial, and freshwater habitats. This group of mollusks has approximately 85,000-100,000 described species of mollusks, including snails, slugs, and limpets (Strong *et al.* 2008). The most abundant and diverse marine species are molluscs, with approximately 32,000 to 40,000 species. This total number of gastropods represents about 23 to 32 percent of the total population of marine gastropods (Smith *et al.* 2011; Appeltans *et al.* 2012; Zapata *et al.* 2014). The biotic and abiotic factors and the gastropods' tolerance to environmental influences determine how gastropods are distributed in the marine environment (Fadliyah *et al.* 2021). The mangrove ecosystem provides suitable habitat characteristics with nutrients or organic matter for marine gastropods and other molluscan shells where it dominates (Kabir *et al.* 2014; Baderan *et al.* 2019).

Moreover, gastropods also act as predators and filter feeders that provide organic materials in the marine ecosystem (Sharma *et al.* 2013; Bhosale *et al.* 2016). A previous study of the diversity of gastropods revealed a high abundance of gastropods such as *Pomacea canaliculata* (Golden Apple Snail) in rivers and lakes in Bukidnon, Philippines (Galan *et al.* 2015). Another study of gastropods from Malaysia concluded that the study area has high species diversity due to the high number of various species present (Hamli *et al.* 2012). The abundance and

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diversity of gastropods depend on different factors such as rates of exploitation level, protection of habitat, and other anthropogenic pressures in the area like tourism, collection, and waste management (Cardoso *et al.* 2012; Seddon *et al.* 2014; Gümüş *et al.* 2022).

Gastropods can also serve as an indicator in the marine environment. Their abundance indicates good environmental quality (Bondarev 2014; Wu *et al.* 2017; Ezraneti 2021). The distribution of gastropods is influenced by environmental factors that affect the behavior and diversity of the organisms (Koperski 2010; Scrosati *et al.* 2011; Marques *et al.* 2013). There are environmental factors that influence the distribution and diversity of gastropods, such as temperature, pH, salinity, and CO_2, and these changes in the environment cause stress and significantly affect the intertidal organisms, including gastropods (Parker *et al.* 2013; Wittmann and Pörtner 2013; Llovel and Terray 2016). Additionally, the presence of biological disturbances, such as invasive species, will also influence the distribution of the gastropods (Raffo *et al.* 2014). Moreover, because of their nearshore habitat and accessibility to human settlements, several gastropod species have been used as a source of protein and livelihood through gleaning, particularly in many coastal communities (Flores-Garza *et al.* 2012; Salim *et al.* 2017; de Guzman 2019; Furkon and Ambo-Rappe 2019; Balisco *et al.* 2022; Maynawang and Macusi 2023). This human access resulted in trampling, marine pollution, and threats of overcollection and gastropod population (Nieves *et al.* 2010; Akele *et al.* 2015; Ibarra 2018).

Guang-guang is a marine protected area known for its muddy-sandy substrate, coverage of mangroves, and diverse marine organisms (Macusi and Tipudan 2020; Nallos and Macusi 2023). However, the area is also open to the public for harvesting seashells and other marine species, threatening their population. The study aimed to determine the species composition, relative abundance, and diversity of the identified gastropods from the gleaners in Guang-guang, Davao Oriental, to measure the balance of the ecosystem or if there was a need for the conservation of the species. Given this assessment, the status of gastropods in Guang-guang would result in a corresponding local government policy action.

2. Materials and Methods

2.1. Description of the Study Area

The study area was located at Guang-guang, Barangay Dahican, Mati City, Davao Oriental (Figure 1). The area is characterized by sandy, sandy-coralline, and sandy-muddy substrate and is part of the mangrove area. The area is part of the protected area in Mati City, Davao Oriental.

2.2. Data Collection

A total of 30 gleaners participated in the recording of their harvested marine gastropods in the shoreline of Guang-guang, Dahican, and Davao Oriental. The gleaners randomly collected the gastropods regardless of the species available. On the other hand, gleaners used modified forks and knives to dig any marine seashell. The collected gastropods were segregated, identified through their local names with the help of the gleaners, counted, recorded, and how many hours they were gleaned. The harvesting and recording of data were repeated for three months. After recording the data, the gastropods were returned to the participating gleaner for consumption or marketing. After recording the marine gastropods, the researchers kept a few samples of gastropods from the gleaners to identify every species.

2.3. Data Analysis

Gastropods were identified to the lowest taxonomic level based on morphological characteristics such as shape, color, and shell using journal publication (Dharma 1988; Poppe 2008a, 2008b). The species were also identified and double-checked in the World Register of Marine Species (WoRMS) database. Moreover, the relative abundance of the gastropods was calculated using the equation adopted from the study of Laheng *et al.* (2023):

$$\mathrm{Pi} = \frac{n_i}{N} \times 100$$

Where n_i is the number of species (individuals), and N is the total number of all species. The diversity index was also calculated using the formula of the Shannon-Wiener diversity index (H'):

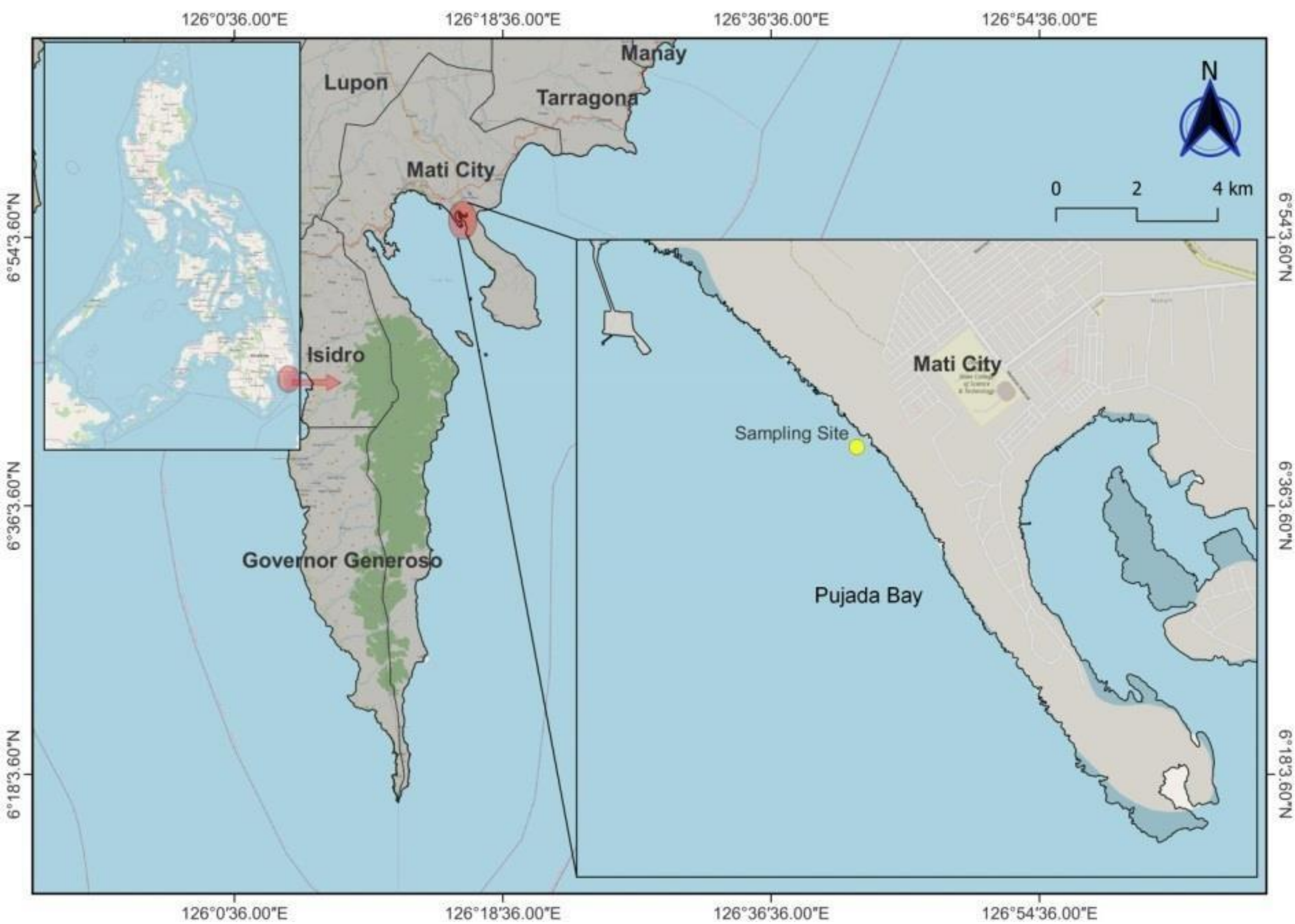

Figure 1. Map of the study site in Guang-guang, Mati City, Davao Oriental

$$H' = -\sum P_i (ln\ P_i)$$

Where *ln* represents the logarithm of P_i. There are three classifications of the Shannon-Wiener diversity index: H' < 1 (low species diversity), 1 < H' < 3 (medium species diversity), H' > 3 (high species diversity) (Brower and Zar 1990).

3. Results

3.1. Species Composition

A total of 10 different species of gastropods were gleaned in Guang-guang, Dahican, Mati City, Davao Oriental (Table 1, Figure 2). The gastropods were identified under eight families: Nassariidae (1 species), Trochidae (1 species), Conidae (1 species), Strombidae (2 species), Turbinidae (1 species), Cypraeidae (2 species), and Neritidae (1 species). The Strombidae are more common gastropods in the gleaning area. Species of *Canarium urceus* and *Ilyanassa obsoletea* are primarily harvested in Guang-guang to be sold in the public markets.

3.2. Abundance of Gastropods

The highest relative abundance value was dominated by *C. urceus*, with 67.15% (n = 115,341) among other harvested gastropods. In addition, the relative abundance of *T. sulcata* from the family of Potamididae is valued at 22.21% with n = 38,143 collected, followed by I. obsoleta at 6.33% (n = 10,880), *M. annulus annulus* at 1.25% (n = 2,144), *C. viridis* at 0.91% (1,560 individuals), *S. limacina limacine* at 0.61% (n = 1,048), *C. capitaneus* at 0.57% (n = 981), *T. sparverius* at 0.54% (n = 925), *E. chrysostomus* at 0.25% (n = 433), and *N. undata* having the lowest value of relative abundance at 0.18% with n = 313 (Figure 3). With these, it signifies that only a few gastropod species were caught but were highly abundant in the area (Figure 4). Most of the identified gastropods, include *C. urceus, M. annulus annulus, C. viridis, C. capitaneus, T. sparverius, N. undata*, were commonly harvested in muddy-sandy and sandy-coralline substrates in the coastal area. However, the *T. sulcata* and I. obsolete were commonly harvested in the

Table 1. The composition of the taxa of harvested gastropods in Guang-Guang, Mati City

Family	Genus	Species
Strombidae	*Euprotomus*	*Euprotomus chrysostomus* (Kuroda, 1942)
Strombidae	*Canarium*	*Canarium urceus* (Linnaeus, 1758)
Potamididae	*Terebralia*	*Terebralia sulcata* (Born, 1778)
Nassariidae	*Ilyanassa*	*Ilyanassa obsoleta* (Say, 1822)
Conidae	*Conus*	*Conus capitaneus* (Linnaeus, 1758)
Trochidae	*Coelotrochus*	*Coelotrochus viridis* (Gmelin, 1791)
Neritidae	*Nerita*	*Nerita undata* (Linnaeus, 1758)
Turbinidae	*Turbo*	*Turbo sparverius* (Gmelin, 1791)
Cypraeidae	*Monetaria*	*Monetaria annulus annulus* (Linnaeus, 1758)
Cypraeidae	*Staphylaea*	*Staphylaea limacina limacina* (Lamarck, 1810)

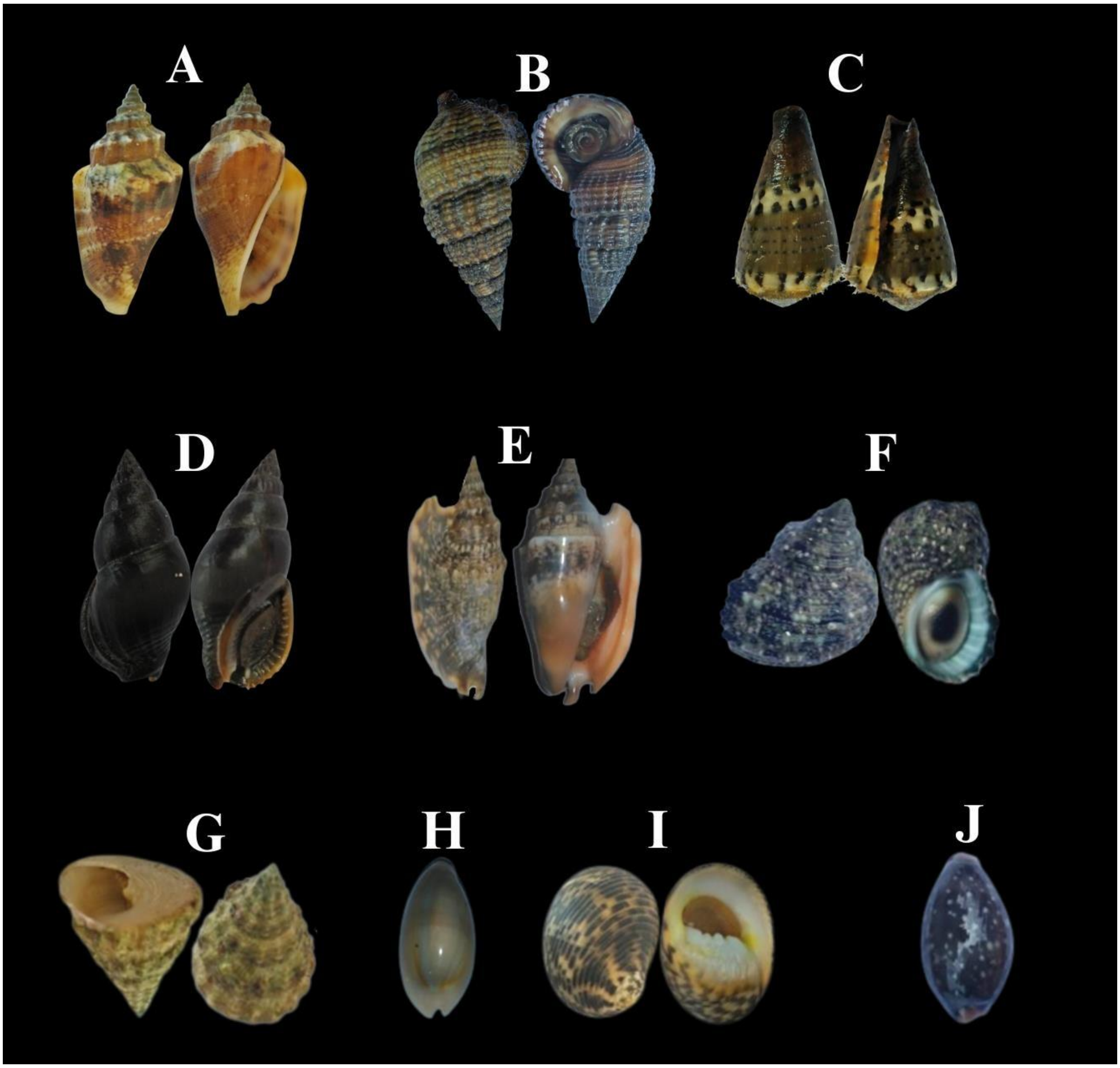

Figure 2. Species composition of gastropods: (A) *Canarium urceus* (Linnaeus, 1758), (B) *I. Terebralia sulcata* (Born, 1778), (C) *Conus capitaneus* (Linnaeus, 1758), (D) *Ilyanassa obsoleta* (Say, 1822), (E) *Euprotomus chrysostomus* (Kuroda, 1942), (F) *Turbo sparverius* (Gmelin, 1791) *Monetaria annulus annulus* (Linnaeus, 1758), (G) *Coelotrochus viridis* (Gmelin, 1791), (H) *Staphylaea limacina limacina* (Lamarck, 1810), (I) *Nerita undata* (Linnaeus, 1758), (J) *Monetaria annulus annulus* (Linnaeus, 1758)

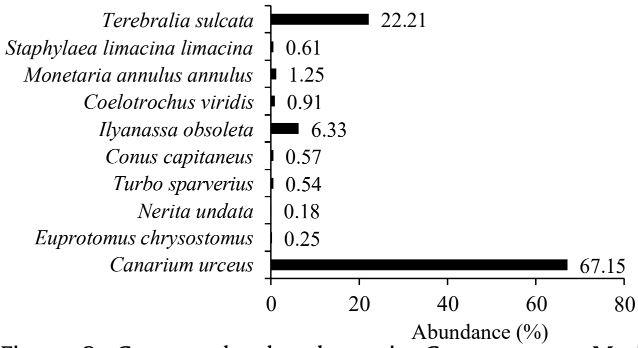

Figure 3. Gastropods abundance in Guang-guang, Mati City, Davao Oriental

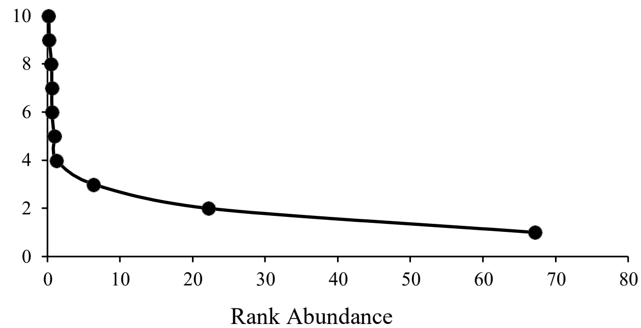

Figure 4. Dominance rank diversity of gastropods species in Guang-guang, Mati City

Table 2. Diversity of harvested gastropods in Guang-guang, Mati City, Davao Oriental (ni = number of species, P_i = relative abundance of species, *In* = logarithm of Pi)

Species	Count (n_i)	$P_i = (ni / N)$	*ln* (P_i)	(P_i) (*ln* P_i)
Canarium urceus	115,341	0.6715	0.3983	0.2674
Euprotomus chrysostomus	433	0.0025	5.9832	0.0151
Nerita undata	313	0.0018	6.3077	0.0115
Turbo sparverius	925	0.0054	5.2241	0.0281
Conus capitaneus	981	0.0057	5.1653	0.0295
Ilyanassa obsoleta	10,880	0.0633	2.7592	0.1748
Coelotrochus viridis	1,560	0.0091	4.7015	0.0427
Monetaria annulus annulus	2,144	0.0125	4.3835	0.0547
Staphylaea limacina limacina	1,048	0.0061	5.0993	0.0311
Terebralia sulcata	38,143	0.2221	1.5048	0.3342
Total individual	171,768			H = 0.99

mangrove area of Guang-guang. These gastropods were collected by handpicking or using a small knife.

3.3. Diversity of Gastropods

The numbers of gastropod individuals were analyzed to determine the overall diversity of gastropods in the area. The result showed a diversity of 0.99 or a low diversity index (H'<1) of 0.99 (Table 2). Moreover, the rarefaction curve showed that at about ten species, this curve was already reached in the area, showing just a few dominating species that were collected (Figure 5).

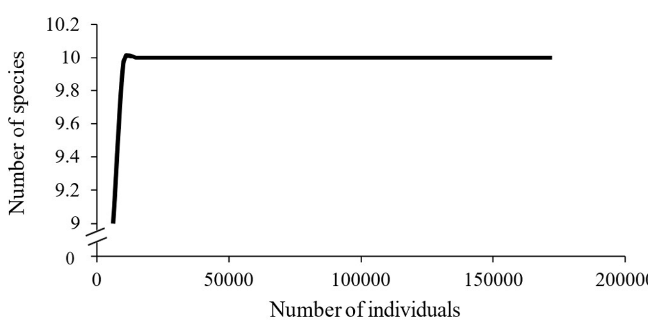

Figure 5. Rarefaction curve of the species

4. Discussion

Strombidae is one of the most familiar molluscan groups composed of about 100 species that mostly live in sand, seagrass, and mud flats area, and they are considered the source of food in many tropical and subtropical regions all over the world (Oo 2018; Ardila *et al.* 2020). However, Strombidae is affected by overexploitation caused by both natural and anthropogenic stressors, which leads to a large decrease in the population of marine species (Stoner *et al.* 2018; Ardila *et al.* 2020). There are about 13 genera of Strombidae, with more than 50 different species reported that are found in the Philippines (Poppe 2008a, 2008b), and these include the *C. urceus* (Pangarungan *et al.* 2022) and *C. urceus* (67.15%) is also the most abundant in the muddy-sandy substrate area in Guang-guang, Dahican, Davao Oriental. The substrate has a presence of seagrasses that serves as nutrient source of Strombidae (Cappenberg *et al.* 2023; Latuconsina and Buano 2021; Natsir and Dillenia 2023). On the other hand, the other study in Zamboanga del Norte and Misamis Occidental, Philippines, showed that the most abundant species found in the selected area is the *Canarium esculentum* with 33.25% species, followed by the *Canarium urceus* with 17.49%, and the majority of the Strombidae species are found in the sandy-muddy substrate (Pangarungan *et al.* 2022).

The collected gastropods in Guang-guang, Dahican, Davao Oriental consisted of 10 genera and 10 species. The diversity of gastropods in Guang-guang was low (H' = 0.99), which means that certain area need to be protected because the diversity of the gastropods is declining according to the result of the study. Other study in Baganga, Davao Oriental, Philippines shows that the mollusks diversity in Ban- ao is low (H' = 0.81) followed by Kinablangan (H' = 0.46) (Bantayan *et al.* 2023). However, the study in Kapas Island, Indonesia revealed that the diversity of gastropods in the area was medium (H' = 2.09) which means that the gastropod is in the area is in balance condition (Laheng *et al.* 2023). The poor diversity index of gastropods in Guang-guang might be affected by different factors which affect the distribution and composition of gastropods in the area (Setiawan *et al.* 2021). This includes environmental factors, such as pollution from nearby human activities e.g. proximity to residential areas and existing shrimp farms and from overharvesting (Bula *et al.* 2017). Similar findings were found in Surigao del Sur, Philippines, where overharvesting in the area resulted in low diversity of the gastropods (Abarquez *et al.* 2019). The increasing human settlement along coastlines have increased the stress on the coastal ecosystem (Yadav *et al.* 2019). This means that the abundance of invertebrate species depends on their environment for habitat and available food for survival.

In conclusion, the findings of the study revealed that the species with the highest relative abundance value was *Canarium urceus* from the Strombidae with 67.15%, and the least was Nerita undata from the Neritidae with 0.18%. It also revealed that the diversity index of harvested gastropods in Guang-guang, Mati City, Davao Oriental has a value of 0.99, indicating the category of low species diversity. This indicates that Guang-guang area is unstable due to various factors that need to be examined and investigated for management plans to conserve the diversity of the species in the area.

Acknowledgements

The authors are thankful to the gleaners who participated while monitoring their gleaned seashells, especially the patience that was given while sorting seashells. The study was successfully conducted with the gleaners' cooperation. The authors would also thank Mr. Michael Bersaldo for making map used in the study. Lastly, the authors want to express their gratitude to the Department of Science and Technology region 11 (DOST-XI) for providing financial assistance for the publication of this paper.

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