Mindanao Journal of Science and Technology Vol. 20 (1) (2022) 87-100

Microhabitat Preference of Strombidae in Selected Intertidal Areas of Zamboanga del Norte and Misamis Occidental, Philippines

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Date received: January 5, 2021
Revision accepted: April 6, 2022

Abstract

This study aimed to identify the microhabitat preference of Strombidae species present in selected intertidal zones of Zamboanga del Norte and Misamis Occidental. A total of 406 individuals of Strombidae were collected and identified into 15 species. Most species of Strombidae were recorded to be abundant in seagrasses (Cymodocea rotundata and Thalassia hemprichii) and in algae (Gracilaria salicornia, Ulva lactuca and Ulva intestinalis). Strombidae were also observed along rocks, muddy sand, black sand, sediments and tide pools. A Kruskal-Wallis Test showed that there was a significant difference in species abundance among different microhabitat types (H[6] = 13.46, p = 0.036). This implies that the abundance of species among different habitats was not the same. Supporting this, the Cramer's contingency test revealed a significant association between the abundance of species to their microhabitat type with a contingency coefficient of 0.76. Canarium labiatum was observed to inhabit G. salicornia, while Canarium mutabile preferred both rocks and tide pools. Canarium urceus favored C. rotundata; Canarium (Canarium) esculentum occurred in G. salicornia and T. hemprichii. Conomurex luhuanus was observed in U. intestinalis and G. salicornia. Euprotomus aurisdianae inhabited the seagrass, while Euprotomus bulla occurred in T. hemprichii and muddy sand. Laevistrombus (Gonggonus) turturella inhabited the C. rotundata. Lastly, Lentigo lentiginosus and all Lambis species were noticed in G. salicornia. Strombidae preferred both seagrasses and algae apparently because these microhabitat types serve as food and nutrient sources to these species.

Keywords: intertidal zones, microhabitat preference, Strombidae

1. Introduction

One of the familiar molluscan groups that live mostly in sand and seagrass environments from the intertidal to the subtidal depths is the Strombidae. This family of marine gastropods comprises about 100 species worldwide, which are found in tropical to subtropical, mainly living in shallow water, on sandy, muddy, rubble bottoms, or on marine grass flats (Poutiers, 1998). These species are considered a popular food source in many tropical and subtropical regions all over the world (Oo, 2018; Ardila *et al*., 2020) and of local economic importance (Poutiers, 1998). Over the years, most Strombidae species have been victims of intensive overfishing, which led to a declining population that resulted in large-scale exploitation of the species (Ponder and Lindberg, 1997; Stoner *et al*., 2018; Ardila *et al*., 2020).

Several comprehensive studies (Bryant, 1994, 1996; Cantino *et al*., 1997; Dekkers, 2008; Kronenberg, 1986, 2002, 2012; Kronenberg *et al*., 2000, 2004, 2005, 2011) have been published concerning the taxonomic key and reorganization on the nomenclature of Strombidae, especially on the genus *Strombus*. Poppe (2008a, 2008b) reported 13 genera of Strombidae that are found in the Philippines with more than 50 different species. These include the accepted name of each species and also some hybrids that are considered rare and uncommon. ‘Aninikad’, ‘bongkawil’ and ‘manuk-manukan’ were some of the common names the locals used to refer to the different kinds of Strombidae present in the study area.

Animals are subjected to competing demands and motivations such as the need to acquire food, find mates, rear offspring, defend limited resources and avoid predators (Hebblewhite and Merril, 2009). With this, one can know the importance of habitat to an organism. The distribution of organisms to their habitat is of central importance to ecology (Schoepf *et al*., 2010). Habitat is defined as the regions in environmental space that are composed of multiple dimensions each representing a biotic or abiotic environmental variable – that is, any component or characteristic of the environment related directly or indirectly to the use of a location by the animal (Hirzel and Lay, 2008). The use of habitat relative to its availability in the environment and its conditional availability of the entire habitat to the animal is known as habitat preference (Aarts *et al*., 2008).

Habitat preference is the consequence of habitat selection resulting in the disproportional use of some resources over the others. Most strikingly observed phenomenon is when animals spend a high proportion of time in habitats that are not abundant on the landscape (Krausman, 1999). Strombidae migrate over time and across a defined range. As the conch grows, the movement rate increases and changes in habitat requirements occur resulting in a wider variety of bottom types (Randall, 1964; Stoner and Sandt, 1992; Doerr and Hill, 2007). Juvenile aggregations of Strombidae form mass migrations resulting in the formation of groups with smaller-scale. According to Stoner and Ray (1993), a typical migration stays across the tidal current axis for several months and is usually arranged in long (15-200 m) and narrow (1-3 m) bands. An earlier study by Abbott (1960) and Cob *et al*. (2012) highlighted that habitat preferences of the Strombidae were highly associated with mud, sandy mud and algae bottom of shallow coastal waters and their distribution extends from the intertidal area to a depth of about 6 m. However, data on the present microhabitat selection of the species in the Philippines are scarce and a re-evaluation of their current status is necessary.

This study was designed to identify the microhabitat preference of gastropod species, Strombidae, among selected intertidal regions in the Southern part of the Philippines. Specifically, it aimed to identify the Strombidae species, determine their abundance among different microhabitats and ascertain whether there was a significant difference in terms of abundance of species and microhabitat type.

2. Methodology

2.1 Sample Collection

The study was conducted in selected intertidal zones of Zamboanga del Norte, namely Barangay Sicayab (Lat. 8° 37’ N, Long.123° 21’ E) (sampling site one) and Aliguay Island (Lat. 8° 45’ N, Long. 123° 13’ E), Dapitan City (sampling site two) and Punta Sulong (Lat. 8° 38’ N, Long. 123° 36’ E), Baliangao, Misamis Occidental (sampling site three). Figure 1 shows the map of the three sampling sites wherein the data collection was made during low tide from May 19, 2015 to May 26, 2015. The belt-transect method (60 x 50 m) was established in each sampling site (Faladu *et al*., 2014). Different microhabitats were observed in the study area: a microhabitat composed of algae, seagrass, black sand, muddy sand, rocks, sediments and tide pools. Each of these was surveyed along the belt transect. Representative specimens of Strombidae species found inhabiting the different types of microhabitats were collected.

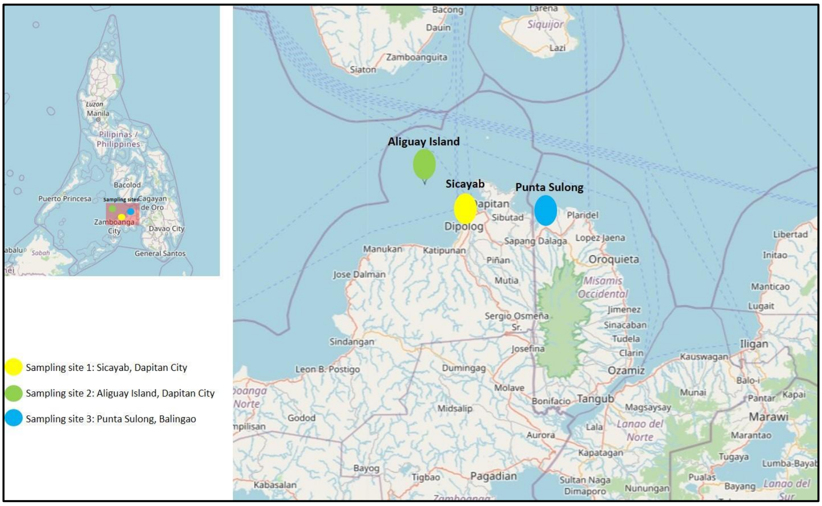


Figure 1. The Philippine map showing the relative location of the three sampling sites

2.2 Preservation and Identification of Samples

Collected samples were stored in reserved bottles with 95% ethanol (Scharlab, Spain). Different shell characteristics (size, weight, aperture opening, aperture width, aperture height, shell length, width, depth and weight, digitations, spire whorls, outer lip, and the presence or absence of stromboid notch) were considered in identifying the specimens. Samples' identification was verified using the data and information from published illustrations and journal publications on different shell characteristics such as that of Kronenberg (1986, 2002, 2012), Kronenberg *et al*. (2000, 2004, 2005, 2011), Dekkers (2008), Poppe (2008a, 2008b, 2010) and Maxwell *et al*. (2021). Moreover, scientific names were checked and validated against legitimate marine databases, namely Mollusca Base (2022) and World Register of Marine Species (WoRMS) (2022).

2.3 Data Analysis

The species abundance between different habitat variables was computed using the encounter rate method (Mamaroba and Moneva, 2020). Kruskal-Wallis test was used to identify significant differences in species abundance among microhabitat types. In addition, Cramer's contingency coefficient was employed to determine the association between the abundance of species and the microhabitat type. All tests were performed using the Statistical Package for the Social Sciences (SPSS) version 16.0 software.

3. Results and Discussion

3.1 Species Abundance and Microhabitat Preference

A total of 406 individuals were gathered and identified into 15 species (Figure 2), namely *Canarium* (*Elegantum*) *radians* (Duclos, 1844), *Canarium labiatum* (Röding, 1798), *Canarium mutabile* (Swainson, 1821), *Canarium urceus* (Linnaeus,1758), *Canarium incisum* (N. Wood, 1828), *Canarium* (*Canarium*) *esculentum* (Maxwell, Rymer, Congdon & Dekker, 2020), *Conomurex luhuanus* (Linnaeus, 1758), *Euprotomus aurisdianae* (Linnaeus, 1758), *Euprotomus bulla* (Röding, 1798), *Gibberulus gibbosus* (Röding, 1798), *Laevistrombus* (*Gonggonus*) *turturella* (Röding, 1798), *Lambis lambis* (Linnaeus, 1758), *Lambis scorpius* (Linnaeus, 1758), *Lentigo lentiginosus* (Linnaeus, 1758) and *Lentigo pipus* (Röding, 1798).

The species *C.* (*Canarium*) *esculentum* was the most collected specimen with an abundance of 33.25%, followed by *C. urceus* with 17.49%. The least collected species were *C. incisum* and *L. pipus* both with 0.25% collected individually. The microhabitat gradients from which the individuals were collected were algae (*Gracilaria salicornia*, *Ulva intestinalis* and *Ulva lactuca*), black sand, muddy sand, rocks, seagrass (*Cymodocea rotundata* and *Thalassia hemprichii*), sediments and tide pools (Figure 3).

A Kruskal-Wallis test showed that there was a significant difference in species abundance among different microhabitat types, H (6) = 13.46, $p = 0.036$. Species abundance was at its highest in the muddy sand (M = 27.50) followed by *C. rotundata* (M = 19.50) and *G. salicornia* (M = 17.17) compared with tide pools (M = 7.250), sediments (M = 5.166) and *U. lactuca* (M = 2.800), which tallied the least number of Strombidae species (Table 1). A significant difference in the abundance of species among different microhabitats was recorded ($p < 0.05$) implying that the abundance of species among different habitats was not the same.

The majority of the species were found in muddy sand, *C. rotundata* and *G. salicornia*. Meanwhile, the least number of Strombidae species was found in *Ulva lactuca*, sediments and tide pools. Janssen *et al.* (2011) reported that diverse Strombidae species were noticed preferentially in the sand between coral patches and seagrass-associated sediments, deeper-water muds and muddy sands, and on hard substrata including reef flats, the conglomerate, rock bottoms, and coral carpets.

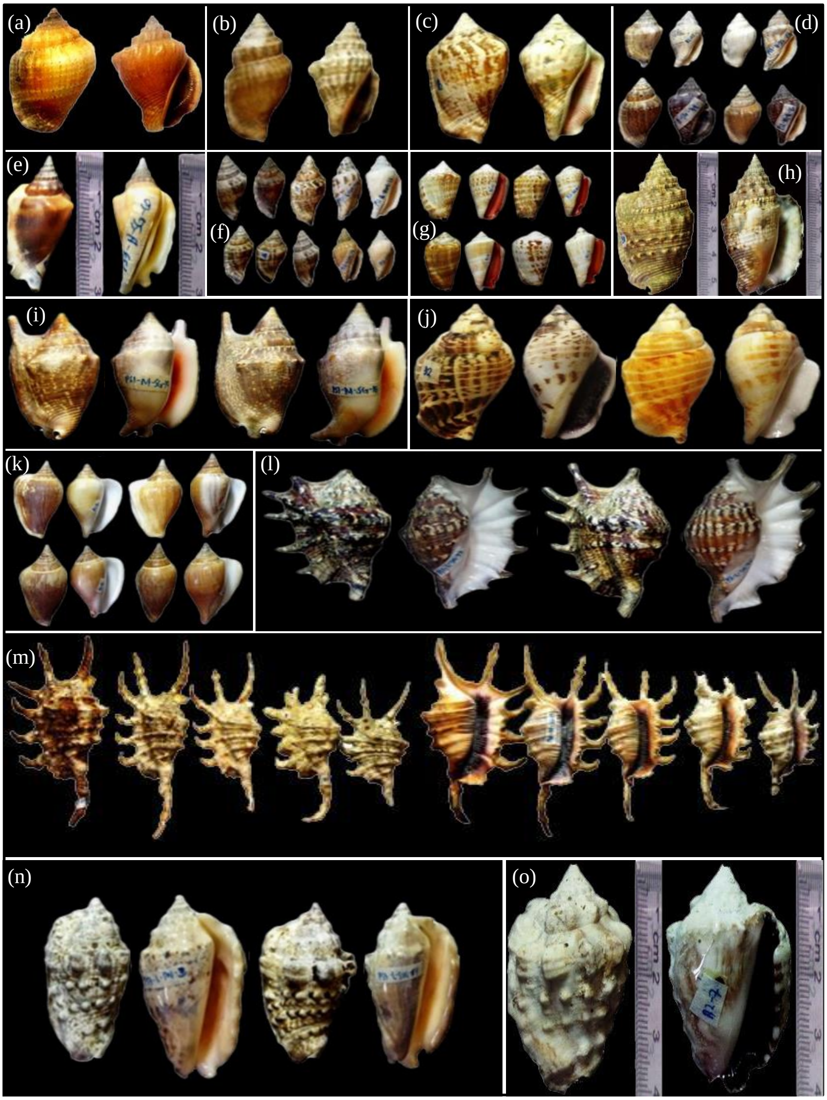
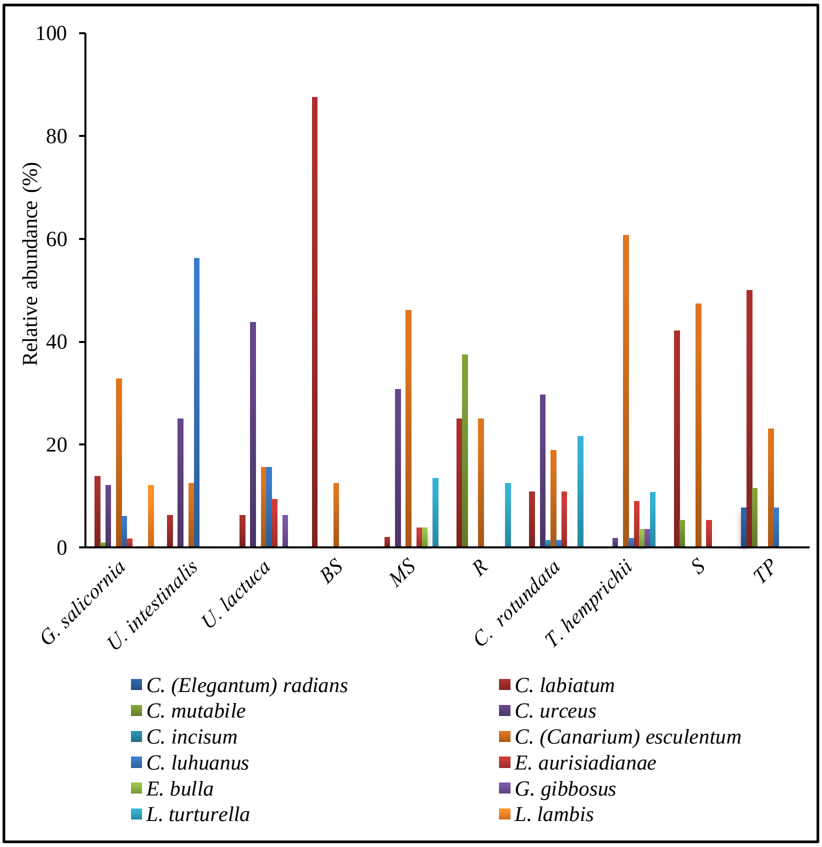


Figure 2. Strombidae species found in the three sampling sites showing its apertural (left) and abapertural (right): *C. (Elegantum) radians* (a); *C. labiatum* (b); *C. mutabile* (c); *C. urceus* (d); *C. incisum* (e); *C. (Canarium) esculentum* (f); *C. luhuanus* (g); *E. aurisdianae* (h); *E. bulla* (i); *G. gibbosus* (j); *L. (Gonggonus) turturella* (k); *L. lambis* (l); *L. scorpius* (m); *L. lentiginosus* (n); *L. pipus* (o)



BS – black sand; MS – muddy sand; R – rocks; S – sediments; TP – tide pools

Figure 3. Relative abundance of Strombidae along microhabitat variables

Table 1. Significant difference of relative abundance along microhabitat variables

Habitat	Mean number of species	Mean rank
Tide pool	7.2500	18.50
G. salicornia	17.1667	22.00
C. rotundata	19.500	18.05
Sediment	5.1667	15.25
U. lactuca	2.8000	6.40
T. hemprichii	9.9000	28.75
Muddy sand	27.5000	31.25
Total	10.5714	
Kruskal-Wallis test (Chi-square value) = 13.456	p = 0.036	Significant

Cramer's contingency test was employed to determine which of these microhabitat types were preferred by Strombidae species (Table 2). The association between the abundance of species and microhabitat type was significant ($p < 0.05$). *C. labiatum* was commonly observed in *G. salicornia*. According to Carpenter and Niem (1998), *C. labiatum* was noticed burrowing in seagrass beds and algal bottoms. *C. mutabile* was seen inhabiting rocks and tide pools, which corresponds to the study of Coleman (2015) wherein *C. mutabile* can be found on sand, rubble or hard reef substrate including rocks. *C. urceus* was mostly seen in *C. rotundata* while *C.* (*Canarium*) *esculentum was* observed in *G. salicornia* and *T. hemprichii*. *C. urceus* and *C.* (*Canarium*) *esculentum* were both found in seagrass areas on shores. Elsewhere, they were found on sand or sandy mud bottoms and sometimes associated with sparse algae (Tan, 2015). *C. luhuanus* occurred in *U. intestinalis* and *G. salicornia*. It was abundant on sandy bottoms of coral reef areas and among seagrass and coral rubble (Poutiers, 1998). *E. aurisdianae* preferred seagrass species, namely *C. rotundata* and *T. hemprichii*. This species was found to be common on various shallow water bottoms of coral reef areas such as grassy sand flats, coral sand, or dead coral (Poutiers, 1998).

E. bulla occurred in *T. hemprichii* and muddy sand. According to Carpenter and Niem (1998), *E. bulla* is detected on clean sand bottoms. *G. gibbosus* was recorded in *C. rotundata* and *U. lactuca*. *L.* (*Gonggonus*) *turturella* preferred *C. rotundata*. Dog conchs are highly associated with muddy bottom and seagrass bed areas (Abbott, 1960; Chuang, 1973; Purchon and Purchon, 1981; Cob *et al*., 2005). *L. lentiginosus* preferred *G. salicornia*. This species is reported to live in sandy and rubbly areas on lagoon reefs, pinnacles and shallow portions of the seaward reef where they are frequent (Colin, 2015). Abbott (1960) reported that Lambis occurs at the low tide mark and can also be found in shallow subtidal zones and on sand and weeds near corals. Results showed that most species of Lambis, namely *L. lambis* and *L. scorpius* were all obtained from the *G. salicornia* at the low tide zone. *L. lambis* was the only species observed to be restricted to a particular microhabitat – the *G. salicornia*. Silos *et al*. (2014) stated that *L. lambis* is common on reef flats and coral-rubble bottoms or in mangrove areas; it is usually associated with fine red algae on which it feeds.

Among all species, *C.* (*Elegantum*) *radians*, *C. incisum*, *L. lambis* and *L. pipus* were the least collected. *C.* (*Elegantum*) *radians* was usually limited to specific habitats. Nearly all specimens are found among algae stalks in lagoon Halimeda beds but they are almost absent elsewhere and are never found on the seaward reef (Wrinkler and Wrinkler, 2015).

Table 2. Microhabitat preference of Strombidae species using Cramer's contingency test

Species	Microhabitat variables										
	Algae						Seagrass				
	G. salicornia	*U. intestinalis*	*U. lactuca*	BS	MS	R	*C. rotundata*	*T. hemprichii*	S	TP	Grand total
C. labiatum	16	1	2	7	1	2	8	0	8	13	58
C. mutabile	1	0	0	0	0	3	0	0	1	3	8
C. urceus	14	4	14	0	16	0	22	1	0	0	71
C. (Canarium) esculentum	38	2	5	1	24	2	14	34	9	6	135
C. luhuanus	7	9	5	0	0	0	1	1	0	2	25
E. aurisdianae	2	0	3	0	2	0	8	5	1	0	21
E. bulla	0	0	0	0	2	0	0	2	0	0	4
G. gibbosus	0	0	2	0	0	0	0	2	0	0	4
L. (Gonggonus) turturella	0	0	0	0	7	1	16	6	0	0	30
L. lambis	12	0	0	0	0	0	0	0	0	0	12
L. scorpius	1	0	0	0	0	0	2	4	0	0	7
L. lentiginosus	22	0	1	0	0	0	2	1	0	0	26
Grand total	113	16	32	8	52	8	73	56	19	24	401
Contingency coefficient = 0.76					$p = 0.001$				Significant		

BS – black sand, MS – muddy sand, R – rocks, S – sediments, TP – tide pools; number in cells indicate the count/frequency of strombids found in each microhabitat.

Abbot (1960) reported that mud, sandy-mud, and algae bottom of shallow coastal waters were the preferred habitats of most Strombidae species in the intertidal area. However, recent work found an exceptionally high association between the conch and seagrass that covered sandy mud areas (Cob *et al*., 2009). Soeharmoko (1985) also reported a high association of the Strombidae with the turtle grass, *T. hemprichii*. Generally, Strombidae are considered herbivores mainly because they consume algae and probably the seagrass itself, and is highly associated with seagrass ecosystem (Randall, 1964; Stoner and Waite, 1991; Ray and Stoner, 1995). Carpenter and Niem (1998) added that Strombidae species browse on delicate algae, or swallow sand and detritus to digest the decomposing plant matter.

4. Conclusion

A total of 15 species of marine gastropods under the family Strombidae, namely *C.* (*Elegantum*) *radians* (Duclos, 1844), *C. labiatum* (Röding, 1798), *C. mutabile* (Swainson, 1821), *C. urceus* (Linnaeus, 1758), *C. incisum* (N. Wood, 1828), *C.* (*Canarium*) *esculentum* (Maxwell, Rymer, Congdon & Dekker, 2020), *C. luhuanus* (Linnaeus, 1758), *E. aurisdianae* (Linnaeus, 1758), *E. bulla* (Röding, 1798), *G. gibbosus* (Röding, 1798), *L.* (*Gonggonus*) *turturella* (Röding, 1798), *L. lambis* (Linnaeus, 1758), *L. scorpius* (Linnaeus, 1758), *L. lentiginosus* (Linnaeus, 1758) and *L. pipus* (Röding, 1798) were found to inhabit the selected intertidal areas of Dapitan City, Zamboanga del Norte and Baliangao, Misamis Occidental in Mindanao, Philippines. Strombidae were observed to prefer microhabitats such as black and muddy sand, rocks, sediments, tidepools, and species of algae and seagrass. There was a significant difference in the abundance of Strombidae among microhabitats where most species were frequently found inhabiting the seagrasses (*C. rotundata* and *T. hemprichii*) and algae (*G. salicornia*, *U. lactuca* and *U. intestinalis*). The microhabitat preferences of these species may reflect herbivory since seagrasses and algae are consumed by most Strombidae as food and nutrient sources. These findings provide information on the Strombidae's microhabitat in intertidal areas, which is crucial for their conservation. Similarly, they serve as baseline information as there are no existing records about the habitat preferences of Strombidae in the study area.

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