



# Distribution of Cowries in the Different Ecological Habitats in the Selected Sites in Davao Occidental

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

## Article Information

DOI: 10.9734/AJFAR/2023/v21i11524

## Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/94729>

Original Research Article

Received: 15/10/2022

Accepted: 23/12/2022

Published: 05/01/2023

## ABSTRACT

**Aims:** The primary aim of this study was to assess the species of cowries in the different ecological habitats of Barangay Buhangin, Tubalan, and Tanglad, Davao Occidental. Specifically, it sought to identify species of cowries found in the study area, population density, abundance, and diversity.

**Place and Duration of Study:** Barangay Buhangin, Tubalan, and Tanglad, Davao Occidental, April 10 – 30, 2022.

**Methodology:** The study employed a transect-line-quadrat method. There were three stations were established in the selected areas. The quadrat was used to determine the density, abundance, dominance, and diversity of cowries. A 1m x 1m quadrat was thrown randomly on the established layout of 50 m<sup>2</sup> (25m x 2m) parallel to the shore. Gears, such as diving goggles and snorkel were used to determine the cowries inside the quadrat and were hand-picked for species identification.

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**Results:** The study revealed that there were ten (10) species of cowries recorded and identified. In Station 1 (Barangay Buhangin), seven species were found namely: *Monetaria annulus* (Gold ring cowry), *Cypraea tigris* (Tiger cowry), *Mauritia arabica* (Arabian cowry), *Monetaria caputserpentis* (Serpent's head cowry), *Naria erosa* (Eroded cowry), *Monetaria moneta* (Money cowry) and *Luria isabella* (Fawn-coloured cowry). In Station 2 (Barangay Tubalan) two species were recorded and identified, namely: *Cypraea tigris* (Tiger cowry) and *Mauritia arabica* (Arabian cowry), while in Station 3 (Barangay Tanglad), eight species were recorded and identified, these were: *Monetaria annulus* (Gold ring cowry), *Cypraea tigris* (Tiger cowry), *Mauritia arabica* (Arabian cowry), *Naria erosa* (Eroded cowry), *Monetaria moneta* (Money cowry), *Lyncina vitellus* (Calf cowry), *Lyncina lynx* (Eyed cowry), and *Palmadusta asellus* (Littleless cowry). In Station 1, Coral Reef Habitat has the most diverse species with five (5) species found, while the seagrass bed habitat is the most abundant in terms of population with nine (9) cowries found, and the mangrove habitat only houses one (1) species of cowry with a population of three (3).

**Conclusion:** Station 3 was the most diverse in terms of cowry species with 8 species identified. Station 1 and Station 2 have the highest population of juvenile cowry species with a total of 127 juvenile species, and Station 2 has the highest population of adult cowry species with a total of 17 adult species. There were four (4) cowry species found in the mangrove habitat, four (4) cowry species were also found in the seagrass bed habitat and nine (9) cowry species were found in the coral reef habitat thus making it the most diverse among all ecological habitats.

**Keywords:** Cowries; mangroves; seagrass; coral reefs; Davao Occidental.

## 1. INTRODUCTION

Cowries (Cypraeidae) are mollusks with huge egg-shaped shells that live in the sea. Unlike most gastropods, the cowrie's exterior is hidden for most of its life by its dorsal body wall, known as a mantle. Calcium carbonate and conchiolin are secreted by the mantle, which makes shells glossy and smooth. Shells of species have long been used as payment in various parts of the world, as well as being utilized widely in jewelry and other decorative and ceremonial uses in the past and present.

It is believed to give fertility and sexual potency when cowries were plentiful and easy to acquire and trade. The microscopic shells found their way into numerous cultures over time, and their traces can still be found today. In China, for example, the symbol for the cowrie is still used in various characters for trade and money. Cowry shells were a common sight along the coast of southern California in prehistoric times. They were used to embellish people and goods [1]. The cowries are found in the Province of Davao Occidental, particularly in Sitio Tigdaliao, Sitio Agdao, and Sitio Tuwang which is in the Barangay of Tubalan as well as the other areas in Barangay Tanglad, Sta. Maria and Barangay Buhangin, Malita. This species has been spotted in these areas, and residents pick it up during low tides and sell it in the marketplaces, making it one of their sources of income.

Cowries are prone to heavy harvesting nowadays for they were used to prepare charms and amulets that are known to bring good luck and to protect the spirit of the wearer, and many tribes use them in spiritual ceremonies. Because of collecting, cowries are smaller than they once were and are now rare in most places. Some species are considered extinct. Thus, this study was done to determine the status of cowries and identify species that are still present in Davao Occidental.

### 1.1 Objectives of the Study

The primary concern of this study was to determine the distribution of cowry species in the different ecological habitats in the selected sites in Davao Occidental. Specifically, it aims:

1. To identify the species of cowries found in each habitat and describe their morphological description.
2. To determine the abundance and diversity of the cowries in each habitat in the selected study sites.
3. To determine the development at stages of cowries as juvenile or adult found in each habitat in the selected study site.
4. To measure the prevailing physico-chemical parameters in the different habitats that could affect the distribution of cowries, including temperature, salinity, and pH.

## 1.2 Scope and Limitation of the Study

The study was conducted to determine the different cowry species from the different habitats-seagrass beds, mangrove forests, and coral reefs in the selected study sites in Davao Occidental. The study also determined the abundance, and diversity, and identify species of cowries in each habitat. It would raise awareness among the locals and is of great help to the community as inputs of proper management of the Family Cypraeidae considering that these species are used as ornaments, decoration, amulets, and high-value goods when it comes down to the color, condition, maturity, and rarity. Moreover, this study provides baseline information as a reference for future research and other developmental activities.

## 2. MATERIALS AND METHODS

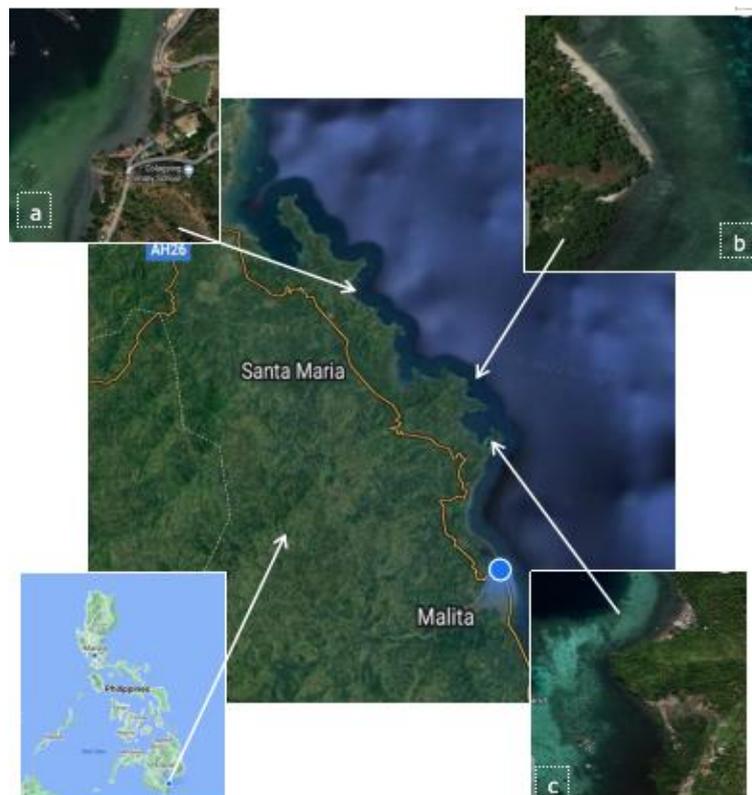
### 2.1 Research Locale

The study was conducted in the different ecological habitats in the selected sites of Davao Occidental. The Municipality of Malita is a 1st class municipality and capital of the province of Davao Occidental, Philippines. It has a

population of 118,197 people (2020, Census of Population and Housing). Malita is known for the various cultural arts and heritage of its people and tribes. Tubalan and Buhangin are one of the 30 barangays in the municipality of Malita, in the province of Davao Occidental. Barangay Tubalan has a population as determined by the 2015 Census was 4,323 and Barangay Buhangin has a population of 4,637 as determined by the 2020 census. Sta. Maria is a 2nd class municipality in the province of Davao Occidental, Philippines. It has a population of 57,526 people (2020, Census of Population and Housing). The municipality is about 40 kilometers (25 mi) northwest of the province capital municipality of Malita and about 1,023 kilometers (636 mi) south-south-east of the Philippine main capital Manila. Barangay Tanglad in the municipality of Sta. Maria is in the province of Davao Occidental.

### 2.2 Sampling Design and Technique

The study employed a transect-line-quadrat method. There were three stations that were established in the selected areas. The quadrat was used to determine the density, abundance, dominance, and diversity of cowries.



**Fig. 1. Map showing the three study sites: (a) Barangay Tanglad, (b) Barangay Buhangin, (c) Barangay Tubalan via google maps**

In terms of gathering data in the mangrove habitat, a 50 m<sup>2</sup> (25m x 2m) was set parallel to the shore using a 2-meter stick and a rope. Ten (10) numbers from 1-25 were randomly handpicked where a 1m x 1m quadrat was placed. The species found inside the quadrat were hand-picked for species identification. A 1m x 1m quadrat was thrown randomly on the established layout of 50 m<sup>2</sup> (25m x 2m) parallel to the shore for the seagrass bed habitat. Gears, such as diving goggles and snorkel were used to determine the cowries inside the quadrat and were hand-picked for species identification. In terms of data collection, the coral reef habitat, a 50 m<sup>2</sup> (25m x 2m) was set parallel to the shore and the study was conducted during the lowest low tide, 10 numbers from 1-25 were randomly handpicked where a 1m x 1m quadrat was put in place. Gears, such as diving goggles and snorkel were used to determine the cowries inside the quadrat and were hand-picked for species identification. The cowries found inside the quadrats were recorded, identified, and photographed for identification up to the species level with the aid of a dichotomous key by Oliver, [2]. Furthermore, verification and validation of cowry species were made by shell experts from Silliman University.

### 3. RESULTS AND DISCUSSION

#### 3.1 Decapod Species Composition

The study revealed that there were ten (10) species of cowries recorded and identified. In Station 1 (Barangay Buhangin), seven species were found namely: *Monetaria annulus* (Gold ring cowry), *Cypraea tigris* (Tiger cowry), *Mauritia arabica* (Arabian cowry), *Monetaria caputserpentis* (Serpent's head cowry), *Naria*

*erosa* (Eroded cowry), *Monetaria moneta* (Money cowry) and *Luria isabella* (Fawn-coloured cowry). In Station 2 (Barangay Tubalan) two species were recorded and identified, namely: *Cypraea tigris* (Tiger cowry) and *Mauritia arabica* (Arabian cowry), while in Station 3 (Barangay Tanglad), eight species were recorded and identified, these were: *Monetaria annulus* (Gold ring cowry), *Cypraea tigris* (Tiger cowry), *Mauritia arabica* (Arabian cowry), *Naria erosa* (Eroded cowry), *Monetaria moneta* (Money cowry), *Lyncina vitellus* (Calf cowry), *Lyncina lynx* (Eyed cowry), and *Palmadusta asellus* (Littleless cowry). In Station 1, Coral Reef Habitat has the most diverse species with five (5) species found, while the seagrass bed habitat is the most abundant in terms of population with nine (9) cowries found, and the mangrove habitat only houses one (1) species of cowry with a population of three (3).

Table 1 presents the taxonomic classification of cowries found in the different ecological habitats in the selected sites of Davao Occidental including their local name. The IUCN Red List of Threatened Species is the world's most comprehensive inventory of plant and animal species' global conservation status. It employs a set of criteria to assess the risk of extinction for thousands of species and subspecies. Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, and Extinct are the nine categories. These criteria apply to all species and all parts of the world. The IUCN Red List is recognized as the most authoritative guide to the status of biological activity due to its strong scientific foundation IUCN [3]. The IUCN red list is included in the table to know the current conservation status of each species collected from the study area. It was found that all cowry species were not yet assessed.

**Table 1. Taxonomic classification of cowries in study sites**

Family	Scientific name	English name	Local name	IUCN red list
Cypraeidae	<i>Cypraea tigris</i>	Tiger cowry	sigay	NE
Cypraeidae	<i>Lyncina vitellus</i>	Calf cowry	sigay	NE
Cypraeidae	<i>Lyncina lynx</i>	Eyed cowry	sigay	NE
Cypraeidae	<i>Naria erosa</i>	Eroded cowry	sigay	NE
Cypraeidae	<i>Palmadusta asellus</i>	Littleless cowry	sigay	NE
Cypraeidae	<i>Monetaria annulus</i>	Gold ring cowry	sigay	NE
Cypraeidae	<i>Mauritia arabica</i>	Arabian cowry	sigay	NE
Cypraeidae	<i>Monetaria caputserpentis</i>	Serpent's head cowry	sigay	NE
Cypraeidae	<i>Luria isabella</i>	Fawn-coloured cowry	sigay	NE
Cypraeidae	<i>Monetaria moneta</i>	Moneycowry	sigay	NE

IUCN Red List Legend: LC – Least Concern; NE – Not Evaluated

### 3.2 Distribution of Cowries

Of the ten (10) species of cowries identified, four (4) species were recorded in the mangrove habitat, four (4) species in the seagrass bed habitat, and nine (9) species in the coral reef habitat (Table 2). The species of *Mauritia arabica* and *Naria erosa* were found to be present among the different ecological habitats.

### 3.3 Species Composition of Cowries

Of the ten (10) species of cowries identified, four (4) species were recorded in the mangrove habitat, four (4) species in the seagrass bed habitat, and nine (9) species in the coral reef habitat. The species of *Mauritia arabica* and *Cypraea tigris* were found to be present among different ecological habitats. *Monetaria annulus* has the highest population density because of the abundance of seagrasses and algae attached on which they feed, seagrass bed habitat also serves as an important habitat for nursing, refuging, and spawning, thus making it the reason why all species of *Monetaria annulus* found are juvenile, though the breeding season of the gold ring cowry (*Monetaria annulus*) is unknown, with some studies claiming that this species reproduces all year while others claiming a variety of different breeding seasons. *Monetaria annulus*'s brooding period is relatively short, but it is said to vary greatly depending on the season and may be affected by temperature or food availability [4].

### 3.4 Population Density of Cowries

Fig. 2 shows the population density of the species of cowries in the sampling area. A total of 174 individuals were found in the sampling

area with a total population density of 6.92 ind./m<sup>2</sup>. It was found that *Lyncina lynx* has the lowest density with 0.1 ind./m<sup>2</sup> while *Cypraea annulus* has the highest density of 2.42 ind./m<sup>2</sup>, others are shown in Fig. 2. The different ecological habitats of Barangay Buhangin, Barangay Tubalan, and Barangay Tanglad, Davao Occidental provides the species of cowries a sustainable habitat because of their abundance and favorable conditions.

### 3.5 Relative Abundance of Cowries

Fig. 3 shows the relative abundance of cowries found in the study area that was conducted during daytime and at the lowest low tide sampling. Based on the result, *Monetaria annulus* has the highest relative abundance at 66.1%, followed by *Mauritia arabica* at 10.9% and *Monetaria caputserpentis* has the lowest relative abundance at 0.6%. The *Monetaria annulus* was found abundant in the seagrass bed habitat since the relative safety of seagrass leaves provides an ideal environment for juvenile organisms to conceal themselves from predators. The abundance of other species is recorded below.

### 3.6 Species Diversity

The data gathered in the study area were computed and analyzed in terms of species diversity using the Shannon-Weiner index and evenness index. The coral reef habitat has a higher Shannon-Weiner index of 3.762 followed by the mangrove habitat with 2.954, and the seagrass bed habitat had 0.711. The seagrass bed habitat has the highest value of evenness with 3.002 followed by the coral reef habitat with 0.473 and the mangrove habitat had 0.296.

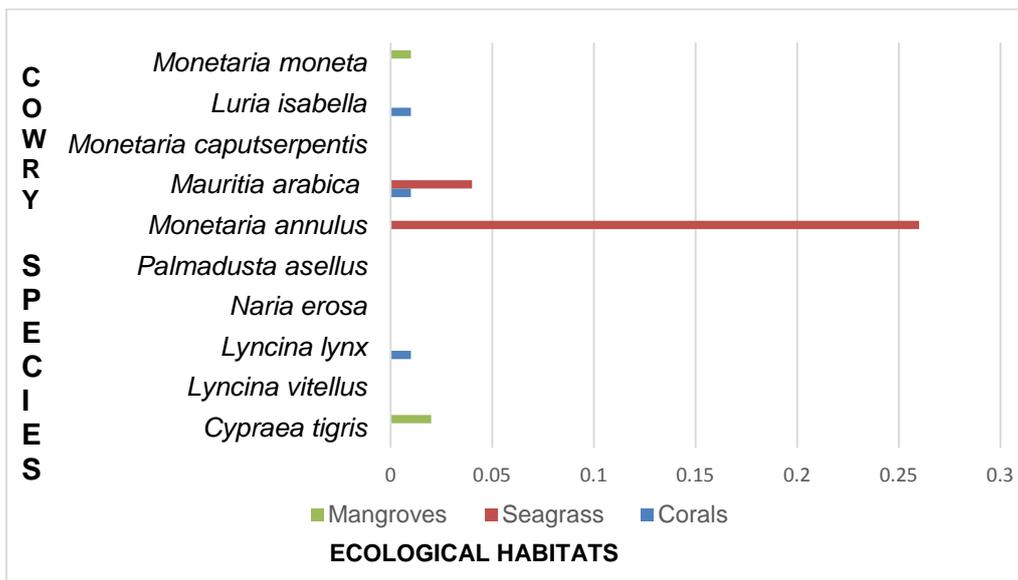
**Table 2. Distribution of cowries in the study sites**

Species	Ecological habitats		
	Mangroves	Seagrass	Corals
<i>Cypraea tigris</i>	X	√	√
<i>Lyncina vitellus</i>	X	X	√
<i>Lyncina lynx</i>	X	X	√
<i>Naria erosa</i>	√	√	√
<i>Palmadusta asellus</i>	X	X	√
<i>Monetaria annulus</i>	√	X	X
<i>Mauritia arabica</i>	√	√	√
<i>Monetaria caputserpentis</i>	√	X	X
<i>Luria isabella</i>	√	X	X
<i>Monetaria moneta</i>	√	X	√

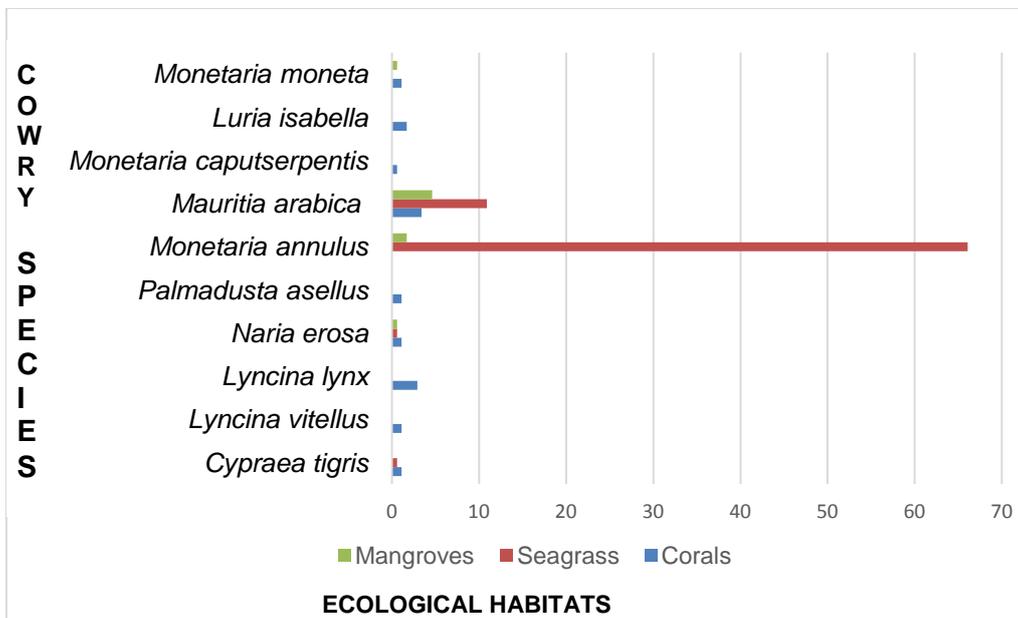
Legend: √ - denotes presence; x - denotes absence

**Table 3. Species composition of cowries in the different ecological habitats**

Mangrove habitat	Seagrass bed habitat	Coral reef habitat
<i>Monetaria annulus</i>	<i>Cypraea tigris</i>	<i>Cypraea tigris</i>
<i>Mauritia arabica</i>	<i>Mauritia arabica</i>	<i>Lyncina vitellus</i>
<i>Naria erosa</i>	<i>Naria erosa</i>	<i>Lyncina lynx</i>
<i>Monetaria moneta</i>	<i>Monetaria annulus</i>	<i>Naria erosa</i>
		<i>Palmadusta asellus</i>
		<i>Monetaria moneta</i>
		<i>Mauritia arabica</i>
		<i>Luria isabella</i>
		<i>Monetaria caputserpentis</i>



**Fig. 2. Population density (ind./m<sup>2</sup>) of cowries in the sampling site**



**Fig. 3. The relative abundance of cowries in the study sites**

**Table 4. Developmental stage of cowries**

Species	Ecological habitats					
	Mangrove habitat		Seagrass habitat		Coral reef habitat	
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult
<i>Cypraea tigris</i>	0	0	0	1	0	2
<i>Lyncina vitellus</i>	0	0	0	0	0	2
<i>Lyncina lynx</i>	0	0	0	0	1	4
<i>Naria erosa</i>	0	1	1	0	0	1
<i>Palmadusta asellus</i>	0	0	0	0	2	0
<i>Monetaria annulus</i>	3	0	115	0	0	0
<i>Mauritia arabica</i>	3	5	6	13	0	6
<i>Monetaria caputserpentis</i>	0	0	0	0	1	0
<i>Luria isabella</i>	0	0	0	0	0	3
<i>Monetaria moneta</i>	0	1	0	0	0	2

To interpret the index, the value of H, the higher the diversity of species of cowries. Therefore, among the three ecological habitats, the coral reef habitat has the highest diversity. This can be attributed to the richness of corals as observed by the researchers, and the number of species collected in the area.

### 3.7 Index of Dominance

The higher the value, it indicates that a particular species occurrence is more dominating in number in a population of cowry species. *Mauritia arabica* has the highest index of dominance among other species with a combined value of 1.12 from all stations since it is found present in all ecological habitats.

### 3.8 Similarity Index

A similarity test of the three stations on the presence of cowries was computed to determine how similar the stations were in terms of species present. Mangroves versus Corals had the highest value of 33.33% due to the presence of five common species, namely: *Cypraea tigris*, *Lycina vitellus*, and *Mauritia arabica*. Mangroves versus Seagrass has a similarity index value of 20% due to the presence of two common species namely *Cypraea tigris* and *Monetaria arabica*. Seagrass versus Corals got the lowest value of 10% due to the presence of one common species named *Cypraea tigris*.

### 3.9 Statistical Analysis

In Kruskal-Wallis Test, the result shows that the coral reef habitat is the most diverse in terms of cowry species followed by mangrove and seagrass habitat, thus, there is no significant difference between the numbers of species of cowries between habitats since the computed

value 0.091 is higher than the tabular value at 0.05. For the diversity, the result shows there is no significant difference in cowries between habitats and species since the computed value of 0.412 is greater than the tabular value of 0.05.

### 3.10 Developmental Stages of Cowries

The juvenile or immature cowry shell grows by marginal accretion. It bears a homogeneous color or color pattern. This pattern, which often consists of spiral bands, can be growth-friendly because the adult secondary layer is transparent.

### 3.11 Physico-chemical Parameters

The prevailing physicochemical parameters in the study area such as temperature, pH, and salinity were measured (See Table 5). The obtained overall temperature in the study area of Bagumbayan, Buhangin at day time is 30.33 °C, while in Barangay Tubalan the overall temperature is 31.3 °C, and in Barangay Tanglad, Sta. Maria the overall temperature is 28.98 °C. The obtained average salinity of the seawater in Bagumbayan, Buhangin is 32.8 ppt, while in Barangay Tubalan is 30.67 ppt, and in Barangay Tanglad, Sta. Maria is 29.87 pp. Compared to the standard salinity of the seawater which is 1-35 ppt, the data obtained are still at a normal level. The average pH of the sampling sites in the daytime for Bagumbayan, Barangay Buhangin is 7.74, while Barangay Tubalan is 7.53, and Barangay Tanglad, Sta. Maria is 7.45. The normal pH of seawater is 8.2 and it is believed that it continually becomes more acidic as time passed by. Though the pH is 7.7 and is still at basic condition its acidity increases, and it might affect the ecology of cowries. Sea water pH is typically limited to a range between 7.5 and 8.4.

**Table 5. Physico-chemical parameters in the study sites**

Ecological habitat	Sampling stations									Mean
	1			2			3			
	Temp. °C	Salinity (ppt)	pH	Temp. °C	Salinity (ppt)	pH	Temp. °C	Salinity (ppt)	pH	
Mangrove habitat	30.5	26.7	7.58	30.2	30.4	7.35	27.43	29.23	6.71	21.78
Seagrass bed habitat	29.6	31.3	7.79	32.2	30.1	7.47	29.7	30.5	7.84	22.92
Coral reef habitat	30.9	28.4	7.85	31.5	31.5	7.76	30.1	29.9	7.80	22.86

## 4. SUMMARY, CONCLUSION AND RECOMMENDATION

### 4.1 Summary

The selected study areas are composed of mangrove forests, seagrass bed habitats, and coral reef habitats. The seagrass bed habitat was found abundant in the study areas of Barangay Buhangin, Barangay Tubalan, and Barangay Tanglad. Seagrass beds are productive ecosystems that serve important ecological functions. A total of ten (10) species of cowries were assessed at the study site. Among these species, *Cypraea tigris*, *Mauritia arabica*, and *Monetaria annulus* were commonly found among sampling stations, while some other species of cowries such as *Monetaria moneta*, *Palamdusta asellus*, and *Lyncina vitellus* were less common.

Among the species with the highest population density was *Monetaria annulus*. It was also the most abundant species in all sampling stations because of the abundance of seagrasses and algae attached to which they feed on. The structurally complex seagrass beds not only provide an abundance of food for fish and invertebrates, but they also serve as an important habitat for nursing, refuging, and spawning [5]. *Monetaria annulus* is typically found on sandy-rocky and sandy-muddy flat coasts covered with coral rubbles or seagrass, whereas boulders on rough coasts and coral rubbles are required for the presence of this species in temperate and sub-tropical areas, respectively [6].

It is observed that the coral reef habitat is the most diverse with nine (9) cowry species found. Because of the diversity of life found in the habitats created by corals, reefs are often called the "rainforest of the sea". Fishes and other organisms such as the *Cypraea tigris* find food, reproduce, and rear their young in the nooks and crannies formed by corals. This cowry species also take shelter from predators in the coral reef wherein at night they eat algae and sponges, they can also eat fire coral and anemones despite their stings.

According to Barbour et al. [7] an ecosystem is abundant when the H' value is greater than 2. Coral reef habitat was the most diverse habitat with a total of nine (9) species recorded. The areas provide a favorable condition for cowries abundance with the overall temperature obtained

in the study area of Bagumbayan, Buhangin at day time at 30.33 °C, while in Barangay Tubalan the overall temperature is 31.3°C and in Baranagay Tanglad, Sta. Maria the overall temperature is 28.98°C. Salinity measures in Bagumbayan, Buhangin is 32.8 ppt, while in Barangay Tubalan is 30.67 ppt, and in Barangay Tanglad, Sta. Maria is 29.87 ppt., and the normal salinity of seawater ranges from 1-35 ppt. According to Chester et al 2012, the normal pH of seawater ranges from 7.5 and 8.4, the pH of the study site for Bagumbayan, Barangay Buhangin was 7.74, while Barangay Tubalan was 7.53 and Barangay Tanglad, Sta. Maria was 7.45 which means it is still in normal condition. Salinity and temperature are known to be important factors driving species richness and species composition, but their effect and interaction are still not completely clear [8].

### 4.2 Conclusion

The following conclusions were deduced from the study.

1. A total of 10 species of cowries were found in the different ecological habitats namely: *Cypraea tigris*, *Lyncina vitellus*, *Lycina lynx*, *Naria erosa*, *Palamdusta asellus*, *Monetaria annulus*, *Mauritia arabica*, *Monetaria caputserpentis*, *Luria Isabella*, and *Monetaria moneta*
2. Station 3 was the most diverse in terms of cowry's species with 8 species identified, *Cypraea tigris*, *Monetaria annulus* and *Mauritia arabica* were revealed to be the most dominant species found in the study areas.
3. Station 1 and Station 2 have the highest population of juvenile cowry species with a total of 127 juvenile species, and Station 2 has the highest population of adult cowry species with a total of 17 adult species.
4. The areas provide a favorable condition for cowry's abundance with the overall temperature obtained in the study areas at day time is 30.33 °C, Salinity measures in all the study areas were 29.78 ppt, and the overall pH of the study sites 7.57.
5. There were four (4) cowry species found in the mangrove habitat, four (4) cowry species were also found in the seagrass bed habitat, and nine (9) cowry species were found in the coral reef habitat thus making it the most diverse among all ecological habitat.

### 4.3 Recommendation

The following recommendation was drawn based on the result of the study.

1. Further study shall be conducted to know more about the cowries in the different ecological habitats in other sites of Davao Occidental.
2. Study of the species diversity of cowries shall be conducted at nighttime because cowries are more active during nighttime and during the lowest low tide to record their distribution in the different ecological habitats.

### COMPETING INTERESTS

The authors have declared that no competing interests exist.

### REFERENCES

1. Chand B, Dean P, Pacific S. Natural Resource Inventory Report of the Fiji Islands Volume 1: Freshwater Resources Inventory of the Fiji Islands. 2010;1:1–36.

2. OLIVER, APH, Guide to Seashells of the World; 2004.
3. IUCN. The IUCN Red List of Threatened Species; 2018.  
Available:<https://www.iucnredlist.org>
4. Katoh M. Life history of the golden ring cowry *Cypraea annulus* (Mollusca: gastropoda) on Okinawa Island, Japan; 1989.
5. Hemminga MA, Duarte CM. Seagrass ecology. Cambridge University Press; 2000 Oct 19.
6. Villamor S, Yamamoto T. Reproductive seasonality of *Monetaria annulus* (Linnaeus, 1758) (Mollusca: Gastropoda: Cypraeidae) in a Temperate Area; 2015.
7. Barbour M, Boonsoong, Bsangpradub N. Development of rapid bioassessment approaches using benthic macroinvertebrates for Thai streams; 1999.
8. Kaya M, Fontaneto D, Segers H, Altindag A. Temperature and salinity as interacting drivers of species richness of planktonic rotifers in Turkish continental waters; 2010.

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