Species composition of macromolluscs in Barangay Talao-talao, Lucena, Quezon province, Philippines

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J R Bernabe[1,4,5], K J B Acebron[2], C V Tejamo[2], M J D Aggabao[1,4], P C Bantigue[1,2], A Guinto[1,2], A Caril[1,2,3], and N A Saguil[2,3]

[1]Graduate School, Polytechnic University of the Philippines, Sta. Mesa, Manila, 1016, Philippines
[2]College of Science, Department of Biology, Polytechnic University of the Philippines, Sta. Mesa, Manila, 1016, Philippines
[3]Center for Engineering and Technology Research (CETR), Research Institute for Science and Technology (RIST), Polytechnic University of the Philippines, Sta. Mesa, Manila, 1016, Philippines
[4]Research Institute for Science and Technology, Polytechnic University of the Philippines, Sta. Mesa, Manila, 1016, Philippines

[5]Corresponding author: bernabejimiwell@gmail.com; jrbernabe@pup.edu.ph

Abstract. Degradation of upland vegetation and the continuous environmental insults on coastal ecosystems negatively impact the inhabiting molluscs. In particular, macromolluscs present in the intertidal zones of coastal communities in the Philippines are directly affected by human activities and the fast-changing climate. However, a limited number of studies have investigated the effects of habitat alteration and degradation on the composition and diversity of the Philippines' intertidal molluscs. Thus, this study assessed the species composition of macromolluscs in Lucena, Quezon, and the underlying environmental and habitat factors that may dictate the presence and abundance of these marine animals. To address these concerns, handpicking and purposive sampling of marine molluscs were conducted in the entire intertidal region of the sampling site. This study reported 62 different species at the intertidal zones of Lucena, Quezon, with species originating from the family *Olividae* being the most abundant organism among the sampled gastropod and bivalve species in the area. Analysis of the observational differences in molluscan habitat may highlight ecological factors affecting the diversity and abundance of the intertidal fauna. Continuous use of the shoreline for traditional fishing and the close proximity of the port of Lucena and human habitation to the coastal zone may also serve as underlying factors to the lack of live mollusc samples in the intertidal region nearest to the port. Together, these findings suggest a high species composition and abundance of macromolluscs inhabiting the intertidal zone of Lucena, Quezon, highlighting the drastic effects of changing marine ecosystems on the ability of various species to occupy a specific area in the marine environment.

Keywords: Climate change, molluscs, *Olividae*, *Strombidae*, intertidal zone

1. Introduction

Predicting the impacts of climate change and the multitude of anthropogenic activities on species composition and the structure of various biotic communities [1], particularly in the marine realm, poses a significant limitation to interpreting empirical findings regarding intertidal community dynamics [2]. Identification of the magnitude of marine biodiversity of coastal ecosystems has led to the conclusion that the phylum Mollusca contributes 23% [3] to 51% [4] of total biodiversity in the marine intertidal zones. High molluscan diversity in the Indo-Pacific region caused the taxon to be the centre of marine biodiversity surveys [5]. However, the assessment of molluscs' diversity and species composition in various Indo-Pacific localities, along with the underlying effects of the physicochemical components of water on species presence, is yet to be intensively analysed [6].

Measuring species richness in the tropical coastal environments of the Philippines after intensive sampling revealed higher species richness compared to other Indo-Pacific localities with an estimate of 14,000 mollusc species, dominated mainly by (41%) "micromolluscs," measuring below 2 mm in size. [3]. The majority of the Philippines' immense and richly diverse intertidal areas are yet to be explored by scientific studies, including the coastal communities of Quezon Province. Quezon is a province in the Philippines with a land area of 8,743.84 km^2. As a coastal community, along with farming, fishing is the major occupation of the proportion of the population. In the present time, the study of the biodiversity of these waters and the underlying effects of the physicochemical parameters of the area is yet to be exhaustively examined.

Overall, extensive sampling to assess the magnitude of biodiversity of the molluscan fauna and the effects of temporal changes on various physicochemical water parameters on the species composition and distribution of intertidal molluscs of Quezon Province is a monumental task. Hence, this study aimed to determine the species composition of macromolluscs in Barangay Talao-talao, Lucena, Quezon Province, together with the observational difference in underlying environmental factors affecting the habitat of these marine organisms.

2. Methodology

2.1. Study Area and Sampling Site

The study area comprised of the coastline of Brgy. Talao-talao, located in Lucena, Quezon (13° 55' North, 121° 39' East). The intertidal region along the coastline covering approximately 3000 m was included as the collection site. The sampling sites consisted of sandy beaches that are populated, slightly populated, and unpopulated. While selecting the sampling sites, their proximity to the port and human habitations were considered. This was done to ensure equal inclusiveness of macromolluscs in various habitats.

Figure 1. Sampling sites at Brgy. Talao-talao, Lucena, Quezon.

2.2. Field Sampling, Processing, and Identification of Specimens

Extensive sampling of live and dead macromolluscs was conducted in the entire intertidal region of Brgy. Talao-talao. Search surveys for live and dead molluscs of more than 10 mm in size were undertaken during the low tide at the intertidal zone of the sampling site in December 2022. The authors

collected intertidal molluscan species through purposive handpicking at various habitats. Particular attention was given to the undersides of rock, hollowed sands, coral rubbles, and other rocky surfaces for an exhaustive search of molluscan fauna present in the area. Live and dead mollusc specimens were manually handpicked and collected during times of low tide for subsequent recording and identification. Total efforts were estimated at a 24-hour collection, which 12 hours were conducted at the first low tide and another 12-hour collection during the lowest tide period of each sampling day. The presence of live molluscs in each sampling area was recorded for subsequent observational analysis of factors affecting the habitat of the intertidal molluscan assemblage.

After the collection, individual macromollusc specimens were placed in individual plastic bags sequentially numbered with a field code specific to the collection site. In the laboratory, shells were soaked in water mixed with detergent and gently brushed to remove debris and odour. After cleaning, macromollusc shells were rinsed several times with water and air-dried for a week. After almost the entire water content of the shell evaporated, shells were sorted and stored in individual plastic sealable bags. Finally, all the live specimens were placed in 95% ethanol and transported into the laboratory for photography and identification.

Collected shelled macromolluscs were identified through Springsteen and Leobrera's (1986) "Seashells of the Philippines" [7] and Poppe's "Philippine Marine Mollusks" [8,9,10,11,12]. Where discrepancies in the species name between these two publications occurred, the nomenclature of Poppe [8,9,10,11,12] in molluscan taxonomy was used. World Register of Marine Species was used for the final verification of molluscan identification.

Diversity indices of macromolluscs for the entire intertidal region of Brgy. Talao-talao was calculated using Shannon-Weiner (H') index to characterise the diversity of molluscs:

$$H' = \sum_{i=1}^{S} (pi)(lnpi) \quad (1)$$

Where S = the total number of species collected, and pi = proportion of individuals in the sample belonging to species "I." In addition, Margalef's index was calculated:

$$D = \frac{S-1}{lnN} \quad (2)$$

Where S is the total number of species and N is the total number of all samples.Lastly, Pielou's evenness index were also assessed:

$$J = \frac{H'}{lnS} \quad (3)$$

Where H' is the Shannon-Weinner diversity and S is the total number of species in a samples.

2.3. Ethical Statement

Ethical approval and waiver of approval from an institutional review board were not sought, nor is it applicable to the current study, as no animal experimentation was conducted.

3. Results and Discussion

3.1. Species Composition

A total of 65 species, 49 genera, and 33 families were collected in all the sampling sites of the entire shore of Brgy. Talao-talao, Lucena, Quezon (Figure 4 and 5 and Table 1). The three most abundant species after the collection were *Oliva keeni* (13), *Hexaplex cichoreum* (6), and *Laevistrombus canarium* (6). Other commonly observed species with more than one observed specimen in total were *Lambis lambis* (4), *Pleuroploca trapezium* (3), *Oliva reticulata* (3), *Bulla ampulla* (3), *Rhinoclavis vergatus* (3), *Mactra grandis* (3), *Conus radiatus* (2), *Cymatium cingulatum* (3), *Architectonica perspectiva* (2), *Vexillum sp.* (2), *Murex aduncospinosus* (2), *Monetaria moneta* (2), *Erosaria erosa* (2), *Tectus*

fenestratus (2), *Bufonaria margaritula* (2), *Spondylus plurispinous* (2), *Antigona lacerta* (2), and *Spondylus squamosus* (2). A single specimen represented the remaining 43 species.

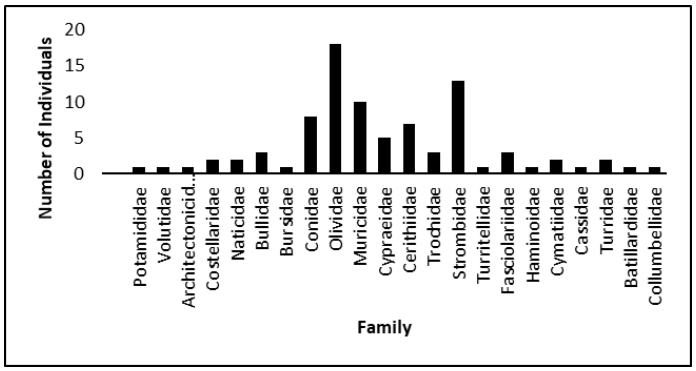

Figure 2. Total number of gastropod species collected in Brgy. Talao-talao, Lucena, Quezon.

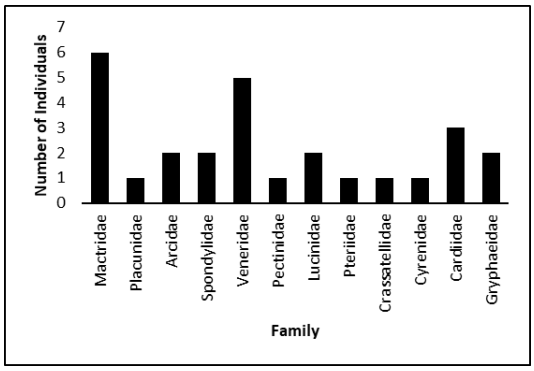

Figure 3. Total number of bivalve species in Brgy. Talao-talao, Lucena, Quezon.

3.2. Mollusk Diversity

The Shannon-Weiner diversity index (H') value in Brgy. Talao-talao, Lucena, Quezon were recorded at 3.036, suggesting a high diversity of specimens in the area. While species richness (d) was recorded at 0.669, Pielou's index for species evenness (J) was observed at 0.730. The survey conducted on the macromollusk composition of the intertidal zone revealed 45 species of gastropods and 17 species of bivalves inhabiting the area, recording high species diversity (H' = 3.036) and evenness (J = 0.730). Additionally, site 3, with a sand bar and coral rubbles, recorded the highest species composition of live mollusks. This may be due to favorable environmental conditions and lower anthropogenic interferences. On the other hand, sites 1 and 2 have the lowest number of live specimens collected since these two lie near the port and the tourist beaches, which have been reported as a source of contamination in the natural waters [13,14].

Table 1. Taxonomic list of gastropod and bivalve species sampled from the intertidal zones of Brgy. Talao-talao, Lucena, Quezon, Philippines.

Gastropods		Bivalves	
Family	Species	Family	Species
Architectonicidae	*Architectonica perspectiva* Linnaeus, 1758	Arcidae	*Anadara oceanica* Lesson, 1831
Batillardidae	*Pirenella cingulata* Gmelin, 1791	Cardiidae	*Vasticardium angulatum* Lamarck, 1819
Bullidae	*Bulla ampulla* Linnaeus, 1758		*Trachycardium alternatum*
Bursidae	*Tutufa bubo* Linnaeus, 1758		*Vasticardium flavum* Linnaeus, 1758
	Bufonaria margaritula Deshayes, 1833	Cyrenidae	*Geloina coaxans* Gmelin, 1791
Cassidae	*Phalium glaucum* Linnaeus, 1758	Crassatellidae	*Crassinella martinicensis* d'Orbigny, 1853
Cerithiidae	*Cerithium interstriatum* G. B. Sowerby II, 1855	Gryphaeidae	*Hyotissa hyotis* Linnaeus, 1758
	Cerithium zonatum W. Wood, 1828	Lucinidae	*Antigona lacerta* Hanley, 1845
	Rhinoclavis sordidula A. Gould, 1849	Mactridae	*Mactra grandis* Gmelin, 1791
	Rhinoclavis vertagus Linnaeus, 1767	Pectinidae	*Decatopacten radula* Linnaeus, 1758
Conidae	*Conus virgo* Linnaeus, 1758	Placunidae	*Placuna placenta* Linnaeus, 1758
	Conus radiatus Gmelin, 1791	Pteriidae	*Pteria avicular* Holten, 1802
	Conus flavidus Lamarck, *1810*	Spondylidae	*Spondylus versicolor* Schreibers, 1793
	Conus magus Linnaeus, 1758		*Spondylus squamosus* Schreibers, *1793*
	Conus lividus Hwass, 1792	Veneridae	*Marcia hiantina* Lamarck, 1818
Costellaridae	*Vexillum sp.*		*Paphia declivis* G. B. Sowerby II, 1852
	Vexillum sp.		*Tapes literatus* Linnaeus, 1758
Collumbellidae	*Parametaria epamella* Duclos, 1840		
Cymatiidae	*Linatella caudata* Gmelin, *1791*		
Cypraeidae	*Erosaria erosa* Linnaeus, 1758		
	Erronea onyx Linnaeus, 1758		

	Monetaria moneta Linnaeus, 1758
Fasciolariidae	*Pleuroploca trapezium* Linnaeus 1758
Haminoidae	*Atys naucum* Linnaeus, 1758
Muricidae	*Chicoreus ramosus* Linnaeus, 1758
	Hexaplex cichoreum Gemli, 1791
	Murex aduncospinosus G. B. Sowerby II, 1841
	Murex tribulus Linnaeus, 1758
	Murex ternispina Lamarck, 1822
Naticidae	*Natica fasciata* Röding, 1798
	Polinices flemingianus Récluz, 1844
Olividae	*Oliva keeni* Marrat, 1870
	Oliva reticulata Röding, 1798
	Oliva sericea Röding, 1798
Potamididae	*Telescopium telescopium* Linnaeus, 1958
Strombidae	*Canarium labiatum* Röding, 1798
	Canarium urceus Linnaeus, 1758
	Conomurex luhuanus Linnaeus, 1758
	Laevistrombus canarium Linnaeus, 1758
	Lambis lambis Linnaeus, 1758
Trochidae	*Tectus fenestratus* Gmelin, 1791
	Trochus maculatus Linnaeus, 1758
Turitellidae	*Turritella terebra* Linnaeus, 1758
Turridae	*Lophiotoma polytropa* Helbling, 1779
	Lophiotoma acuta Perry, 1811
Volutidae	*Cymbiola vespertilio* Linnaeus, 1758

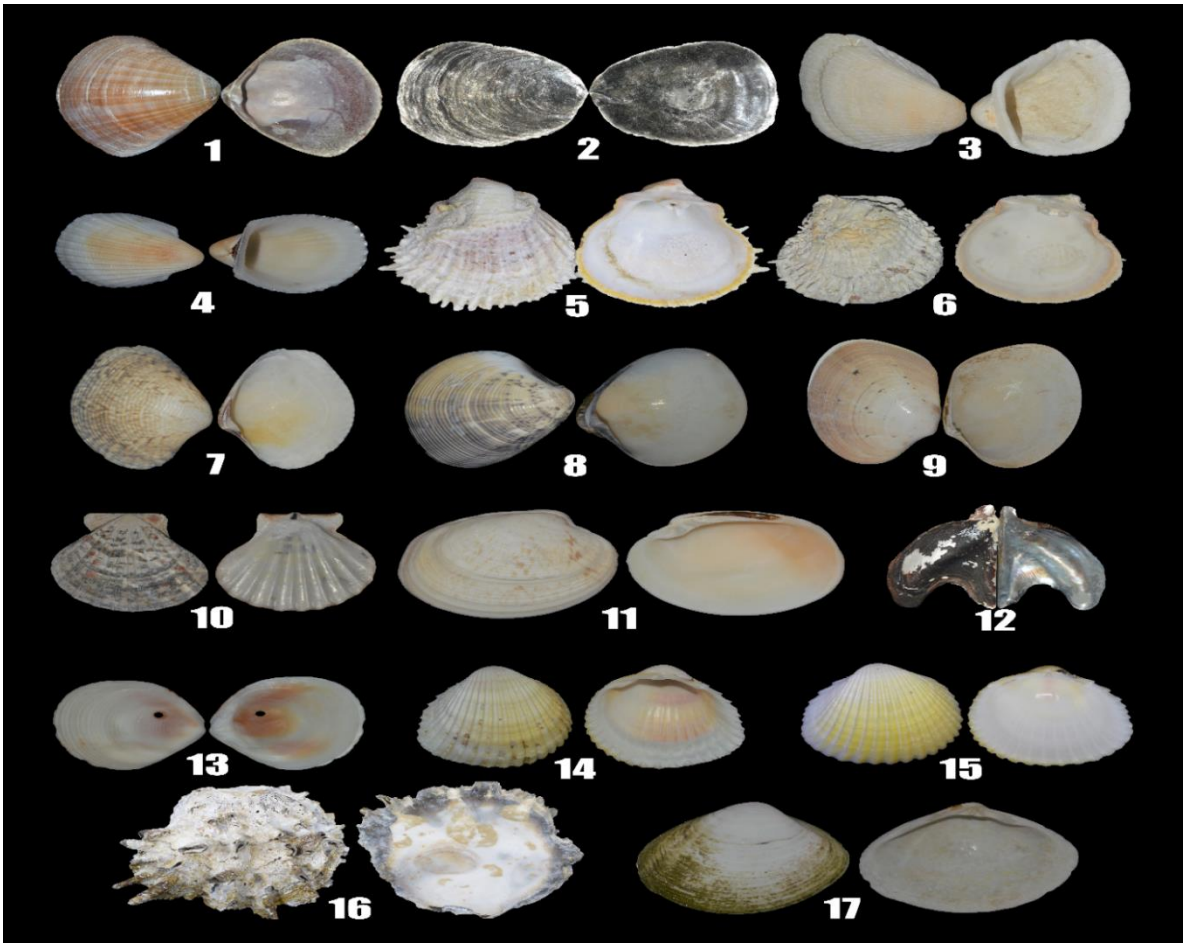

Figure 4. Shells of collected bivalve species in Brgy. Talao-talao, Lucena, Quezon. 1. *Mactra grandis*;

2. *Placuna placenta*; 3. *Anadara pilule*; 4. *A. glubosa*; 5. *Spondylus squamosus*; 6. *S. versicolor*; 7. *Paphia declivis*; 8. *Marttha hiantina*; 9. *Paphia semirugata;* 10. *Decatopacten radula*; 11. *Antigona lacerta*; 12. *Pteria avicular*; 13. *Crassinella matinicensis*; 14. *Trachycardium alternatum*; 15. *T. flavum*; 16. *Hyotissa hyotis*; 17. *Polymesoda coaxans.*

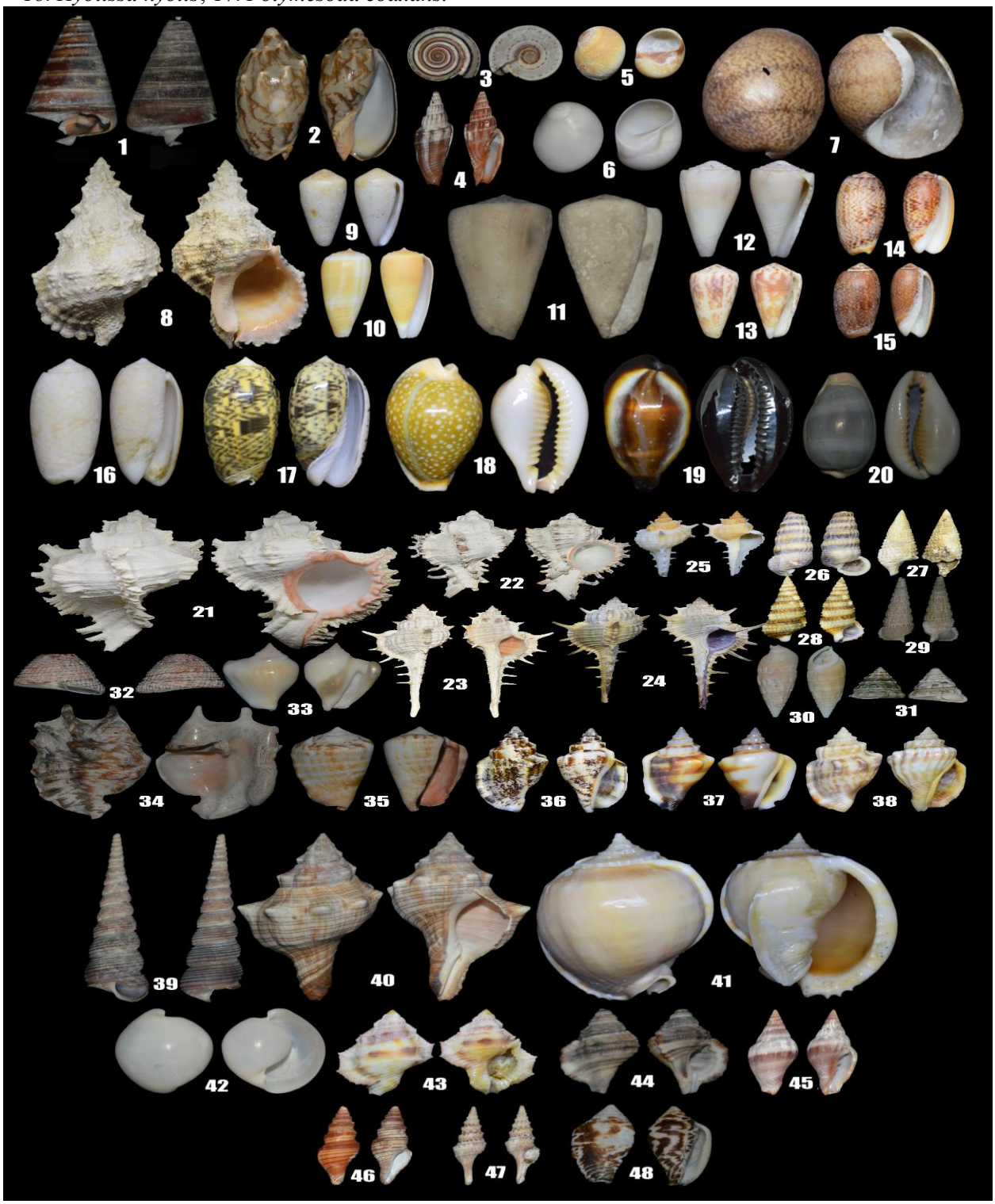

Figure 5. Shells of the gastropod species collected at Brgy. Talao-talao, Lucena, Quezon. 1. *Telescopium telescopium*; 2. *Cymbiola vespertilio*; 3. *Architectonica perspectiva*; 4. *Vexillum sp.*; 5. *Natica fasciata*;

6. *Polinices flemiangus*; 7. *Bulla ampulla*; 8. *Tutufa bubo*; 9. *Conus virgo*; 10. *Conus radiatus*; 11. *Conus flavidus*; 12. *Conus lividus*; 13. *Conus magus*; 14. *Oliva keeni*; 15. *Oliva sericea*; 16. *Oliva keeni*; 17. *Oliva reticulata*; 18. *Erosaria erosa*; 19. Erronea onyx; 20. Monetaria moneta; 21. *Chicoreus ramosus*; 22. *Hexaplex chicoreum*; 23. *Murex aduncospinosus*; 24. *Murex tribulus*; 25. *Murex ternispina*; 26. *Pirenella cingulata*; 27. *Cerithium interstratum*; 28. *Ceritherium zonatum*; 29. *Rhinoclavis sordidula*; 30. *Rhinoclavis vergatus*; 31. *Trectus fenestratum*; 32. *Trochus maculatus*; 33. *Laevistrombus canarium*; 34. *Lambis lambis*; 35. *Conomurex luhuanus*; 36. *Canarium labiatum*; 37. *Canarium urceus*; 38. *Canarium urceus*; 39. *Turritella terebra*; 40. *Pleuroplaca trapezium*; 41. . *Phalium glaucum*; 42. *Atys naucum;* 43. *Bufonaria margaritula;* 44. *Cymatium cingulatum;* 45. *Vexillum sp.;* 46. *Lophiotoma polytropa;* 47. *Lopiotoma acuta;* 48. *Parametaria epamella.*

3.1. Habitat Variations

During the sampling period, the highest species abundance and the number of live specimens were recorded in site 3 (2 *Conus* samples; data not presented), where little human habitation was observed. Additionally, the undisturbed sandbar with coral rubbles and rocks were the frequent sites of live gastropods compared to the sandy beaches in sampling sites 1 and 2, which lies near the port of Lucena and populated sandy beaches.

Observational differences of habitat in Brgy. Talao-talao, Lucena City, Quezon Province demonstrated various factors affecting molluscan habitat: proximity to port, human habitation, and resorts are the possible underlying factors affecting the diversity and abundance of the molluscan assemblage in the area. Analysis of the biodiversity indices illustrated high diversity and richness of the molluscan fauna in the intertidal region of Brgy. Talao-talao. However, continuous threats and environmental insults in and on the surrounding area poses threats to the immensely rich marine community, as environmental factors such as the proximity to port and human habitations, and the use of area as a tourism hotspot for various outdoor water activities may pose significant threat to the marine ecosystem functioning. As previous reports [14] have demonstrated the lethal effects of large number of ships carrying oils and ore materials that constantly sail through ports and harbours may often cause accidental oil spills, leading to serious ecotoxicological impact on marine diversity and biological functioning of the marine ecosystem. The coastal zone of the sampling area has been used for tourism and traditional fishing; the increase in urbanisation may also be an underlying factor that may affect the diversity and species composition of molluscs in this area. Various surveys conducted to assess the magnitude of molluscan diversity in the Philippines revealed that the phylum Mollusca contributes to 23 [3] to 51% [4] of the total marine biodiversity. This study highlights the possible factors affecting the habitat and the sustainable growth and development of the mollusc assemblage, thus requiring a more consolidated, scientific-based approach to the development of the marine coastal communities of Lucena City, Quezon Province. More especially, these marine organisms offer an alternative source of income due to their application for shell crafts and trade. Furthermore, marine molluscs are consumed as a culinary delicacy, either boiled or served in coconut milk in various localities in the Philippines, aiding the combat of food scarcity in the country's remote, secluded rural coastal communities.

4. Conclusion

This study is the first report on the species composition and diversity of macromolluscs in Lucena, Quezon, including the species occurrence in relation to differences molluscan habitat. A high magnitude of molluscan diversity was recorded in the intertidal region of Brgy. Talao-talao, with 65 different species (45 mollusc and 17 bivalves) originating from 33 families. Species originating from the family *Olividae* recorded the highest number of specimens collected among all sampled gastropod and bivalve species, while the family *Strombidae* recorded the highest species variation. Taken together; the observations demonstrated various factors affecting the diversity and habitat of molluscan fauna, such as proximity to beach, ports, and resorts and the use of the marine area for traditional fishing and tourist hotspot for water activities may be the main factors affecting the diversity and abundance of

macromolluscan assemblage in Brgy. Talao-talao, Lucena City, Quezon Province. In this direction, more comprehensive studies and extensive sampling should be conducted to assess the magnitude of the effects of various temporal factors at multiple spatial scales on the diversity and distribution of macro- and micro-molluscs.

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