**Journal of Natural and Allied Sciences**
Vol. IV No. 1, pp. 57-72, January – December 2020

# Bivalve Resources in the Coastal Barangays of Infanta, Pangasinan, Philippines

**Dante M. Mendoza[1], Gerondina C. Mendoza[1] and Geronimo R. Rosario[2]**

[1]Department of Fisheries Science, College of Agriculture Systems and Technology
Pampanga State Agricultural University
dante_mendoza@psau.edu.ph

[2]College of Fisheries and Aquatic Sciences
Pangasinan State University – Binmaley Campus
Binmaley Pangasinan
geromerosario@gmail.com

**Abstract** - The bivalve resources in the coastal barangays of Infanta, Pangasinan were assessed using a descriptive survey method. A total of 30 species of bivalves belonging to 17 families were identified across study sites. *Corbicula fluminea* is the most abundant species of bivalves found in the coastal barangays with Family Veneridae dominating the community with a total of 8 representative species. Of the 6 coastal barangays, Bayambang harbors the highest number of species (28) while Barangay Cato recorded the highest relative abundance (28.88%). Relative abundance of species varied by study sites; *G. tumidium* (Bayambang – 13.8%), *G. pectinatum* (Cato - 13.56%), *C. fluminea* (Batang – 14.55%; Poblacion – 39.4%), *P. exilis* (Patima – 30.66%) and *Delillia* sp. (Nayom – 25.76%). Margalef's index was found highest in Bayambang (4.32). Computed Shannon-Weiner index indicates moderate diversity across sites with Bayambang and Cato recorded the highest value (H'=2.83). Simpson's dominance index indicates high dominance of a single or few species with values ranging from 0.72 (Poblacion) to 0.93 (Bayambang). Computation of evenness index revealed high values (0.85-0.93) indicating a more equitable distribution of individual bivalve. Lastly, Batang and Cato manifested the highest similarity and shared species indices of 0.92 and 0.48, respectively.

**Keywords:** bivalve, composition, distribution, diversity, similarity

## INTRODUCTION

Infanta is a coastal town located at the western portion of Pangasinan, Philippines [1]. The town is known for its small-scale commercial fishing fleets targeting tuna and other *payao*-associated species in the West Philippine Sea. The coastal waters of the town constitute a small portion of Dasol Bay, a major municipal fishing ground in Western Pangasinan. Its coastal waters are considered rich in macrobenthic fauna due to the presence of mangroves, seagrass beds and coralline rubbles that serve as refuge and breeding grounds. Like in other coastal towns, these faunas could be an important source of food and income. Apart from this, the town has also some inland bodies of water that provide some sort of livelihood for its populace.

Among the macrobenthic resources in communal bodies of water, bivalves are commonly harvested. Bivalves can be found in most tropical bodies of water such as lakes, rivers, mangrove swamps and bays. These organisms are often seen attached to such materials and burrowed in sandy or muddy

substrates. Bivalves are playing significant role in the ecosystem. Also, bivalves provide cheap and high-quality protein [2]. Numerous studies have indicated the nutritive value of bivalves [3, 4]. In the field of medicine, some species have shown potential in treating illnesses [5].

Gleaning in the coastal zones and harvesting in river beds, mangrove areas swamps and ponds are important activities that reduce bivalve populations in a certain area. Some commercially exploited bivalves are already well-documented but many remain unassessed. In particular, very few studies had focused on the composition and distribution of bivalves in the province of Pangasinan. Hence, assessment in the town of Infanta is still lacking. Such information is vital for conservation standpoint. Hence, this undertaking was made in order to provide information related to the diversity and abundance of bivalve resources in different aquatic ecosystems of the town.

## MATERIALS AND METHODS

### Location of the Study

The study employed the descriptive method of research. Field sample collection was made in the coastal barangays of Infanta, Pangasinan which include Bayambang, Batang, Cato, Patima, Poblacion and Nayom (Figure 1).

### Collection of Samples

Specifically, the samples were taken from freshwater swamps, brackishwater channels and intertidal zones of these barangays by 6 commissioned gleaners.

The gleaners were instructed to collect samples of bivalves within a 500 $m^2$ area established in each identified location in freshwater, brackishwater and coastal waters of each barangay for a period of 3 hours.

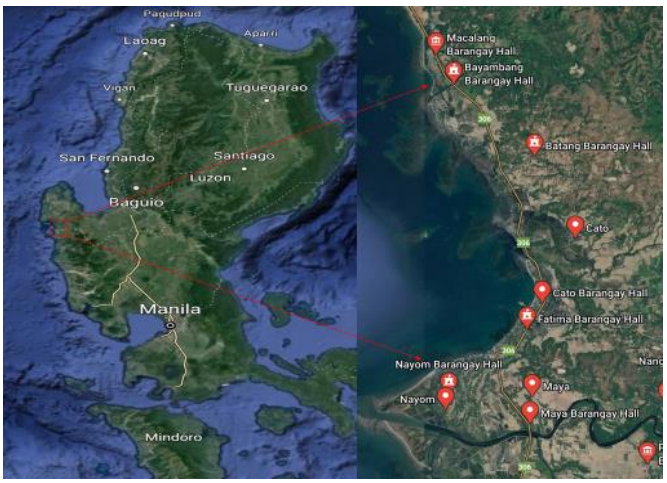


Figure 1. Location of the Study (Google Earth).

### Identification of Samples

Photographs of representative samples were taken for identification and classification [6-8]. The local name and economic value of the bivalves were determined by asking the local residents. The conservation of status of the bivalves was determined using the online resources published by SeaLifeBase (Palomares and Pauly, 2020) [9].

Figure 2. Some bivalve samples collected from the study sites.

### Data Analysis

The collected individuals (Figure 2) from each bivalve species were counted. The recorded number was used to determine the relative abundance and diversity of the species in each costal barangay. Diversity evaluation of bivalves

was made using the Margalef's Species Richness, Shannon Diversity Index, Simpson's Dominance Index and Evenness Index (Magurran, 1998). The similarity of species and shared species between coastal barangays were computed using Sorensen's Similarity Index and Chao et al (2000) shared species index.

## RESULTS

### Composition, Habitat Type, Economic Value and Conservation Status of Bivalves

Result of the assessment revealed 30 species of bivalve resources belonging to 17 families inhabiting the waters of coastal barangays of Infanta, Pangasinan (Table 1).

These species include *Placuna sella, Anadara antiquata, Anadara maculosa, Barbatia foliata, Trachycardium flavum, Corbicula fluminea, Polymesoda erosa, Donax cuneatus, Isognomon ephippium, Mactra achatina, Modiolus metcafei, Perna viridis, Crassostrea irredalei, Atrina pectinata, Pinna bicolor, Asaphis violascens, Gari togata, Azorinus acutidens, Spondylus squamosus, Tridacna squamosa, Pilsbryoconcha exilis, Anomalocardia squamosal, Anomalocardia flexuosa, Gafrarium tumidium, Gafrarium pectinatum, Lioconcha castrensis, Meretrix meretrix, Placamen calophylla, Periglypta chemnitzi and Delillia sp.* Among the identified families of bivalves, Veneridae has the highest number of representative species. It is surprising that *Delillia* sp. or locally known as unnok is present and harvested in the area. This bivalve is endemic in Cagayan River and commonly harvested for making various clam recipes [12]. However, there is still paucity of information on its biology and ecology including its taxonomic classification.

In terms of habitat type, most of the identified bivalves inhabit the intertidal zone (seagrass beds) or locally known as *kapallippaan*. Hence, most are marine species. However, some of these species were also observed in mangrove areas and sandy to muddy river beds. Meanwhile, only few were collected from freshwater ponds and swamps. When it comes to their economic value, all bivalves are used as food by the locals with the exception of *T. squamosa*, which is already protected by the law. Some of these species were also identified as important material for shellcraft-making. As to conservation status, all bivalves were not yet evaluated according to the International Union for the Conservation of Nature except again for the *T. squamosa*, which was considered already as conservation dependent.

Table 1. Composition, habitat type, economic value and conservation status of bivalve resources.

| Family | Species | Local Name | Habitat Type | Economic Value | Conservation Status (IUCN) |
|---|---|---|---|---|---|
| Anomiidae | *Placuna sella* | *Tirem* | Mangrove area | Used as food and raw material for shell craft-making | Not Evaluated |
| Arcidae | *Anadara antiquata* | *Bangkalang* | Seagrass beds | Used as food | Not Evaluated |
| | *Anadara maculosa* | *Bangkalang* | Seagrass beds | Used as food | Not Evaluated |
| | *Barbatia foliata* | *Bangkalang* | Seagrass beds | Used as food | Not Evaluated |
| Cardiidae | *Trachycardium flavum* | *Wasay-wasay* | Seagrass beds | Used as food and raw material for shell craft-making | Not Evaluated |
| Corbiculidae | *Corbicula fluminea* | *Bennek* | Freshwater ponds and streams | Used as food | Not Evaluated |
| | *Polymesoda erosa* | *Lukan* | Mangrove area | Used as food | Not evaluated |

| | | | | | |
|---|---|---|---|---|---|
| Donacidae | *Donax cuneatus* | *Aniit* | Beach slope | Used as food and aqua feed | Not Evaluated |
| Isognomonidae | *Isognomon ephippium* | *Kampis* | Brackishwater river and ponds | Used as food | Not evaluated |
| Mactridae | *Mactra achatina* | - | Intertidal zone | Used as food | Not evaluated |
| Mytilidae | *Modiolus metcafei* | *Tahong* | Seagrass beds | Used as food | Not evaluated |
| | *Perna viridis* | *Tahong* | Mangrove areas | Used as food raw material for shell craft-making | Not evaluated |
| Ostreidae | *Crassostrea irredalei* | *Tirem* | Mangrove areas and hard substrate of brackishwater river | Used as food | Not evaluated |
| Pectinidae | *Atrina pectinata* | *Badung-badung* | Seagrass beds | Used as food | Not evaluated |
| | *Pinna bicolor* | *Badung-badung* | Seagrass beds | Used as food | Not evaluated |
| Psammobiidae | *Asaphis violascens* | - | Intertidal zone | Used as food | Not Evaluated |
| | *Gari togata* | *Balinggasa* | Sandy-muddy mangrove areas, substrate of brackishwater river | Used as food | Not Evaluated |
| Solecurtidae | *Azorinus acutidens* | - | Sandy-muddy Brackishwater river | Used as food | Not Evaluated |
| Spondylidae | *Spondylus squamosus* | - | Mangrove and coralline rubbles | Used as food | Not evaluated |
| Tridacnidae | *Tridacna squamosa* | *Mellet* | Subtidal zone | Exploitation is strictly prohibited | Lower risk; conservation dependent |
| Unionidae | *Pilsbryoconcha exilis* | *Beldat* | Freshwater ponds and swamps | Used as food | Not Evaluated |
| Veneridae | *Anomalocardia squamosa* | *Karabuyo* | Intertidal zone, seagrass beds | Used as food | Not Evaluated |
| | *Anomalocardia flexuosa* | *Karabuyo* | Intertidal zone, seagrass beds | Used as food | Not Evaluated |
| | *Gafrarium tumidium* | *Kupoy-kupoy* | Mangrove areas, intertidal zone, seagrass beds | Used as food | Not Evaluated |
| | *Gafrarium pectinatum* | *Kupoy-kupoy* | Mangrove areas, intertidal zone, seagrass beds | Used as food | Not Evaluated |
| | *Lioconcha castrensis* | - | Seagrass beds | Used as food | Not Evaluated |
| | *Meretrix meretrix* | *Kappo-kappo* | Intertidal zone, seagrass beds | Used as food | Not Evaluated |
| | *Placamen calophylla* | - | Intertidal zone | Used as food and raw material for shell craft-making | Not Evaluated |
| | *Periglypta chemnitzi* | - | Seagrass beds | Used as food | Not Evaluated |
| ? | *Delillia sp.* | *Unnok* | Sandy river beds | Used as food | No record |

**Distribution in Coastal Barangays**

Table 2 presents the distribution of bivalve resources in the coastal barangays. It can be gleaned from the tabulated result that Barangay Bayambang harbors the highest number of species followed by Barangay Batang and Cato with both recorded a number of 25 species. Only 4 species of bivalves were observed in Barangay Poblacion and recorded the least among the study sites.

Table 2. Distribution of bivalve resources in the coastal barangays.

| Species | Barangay | | | | | |
|---|---|---|---|---|---|---|
| | **Bayambang** | **Batang** | **Cato** | **Patima** | **Poblacion** | **Nayom** |
| Placuna sella | + | + | - | - | - | - |
| *Anadara antiquata* | + | + | + | - | - | - |
| *Anadara maculosa* | + | + | + | - | - | + |
| *Barnatia foliata* | + | + | + | - | - | - |
| *Trachycardium flavum* | + | + | + | - | - | - |
| *Corbicula fluminea* | + | + | + | + | + | + |
| *Polymesoda erosa* | + | + | + | + | - | + |
| *Donax cuneatus* | + | + | + | + | + | + |
| *Isognomon ephippium* | + | + | + | + | - | + |
| *Mactra achatina* | + | + | + | - | - | - |
| *Modiolus metcafei* | + | + | + | - | - | + |
| *Perna viridis* | - | + | + | - | - | - |
| *Crassostrea irredalei* | + | + | + | + | + | + |
| *Atrina pectinata* | + | + | + | - | - | - |
| *Pinna bicolor* | + | + | + | - | - | - |
| *Asaphis violascens* | + | - | - | - | - | - |
| *Gari togata* | + | + | + | + | - | + |
| *Azorinus acutidens* | + | + | + | + | - | + |
| *Spondylus squamosus* | + | - | - | - | - | - |
| *Tridacna squamosa* | + | - | - | - | - | - |
| *Pilsbryoconcha exilis* | + | + | + | + | + | + |
| *Anomalocardia squamosal* | + | + | + | - | - | - |
| *Anomalocardia flexuosa* | + | + | + | - | - | - |
| *Gafrarium tumidium* | + | + | + | - | - | + |
| *Gafrarium pectinatum* | + | + | + | - | - | + |
| *Lioconcha castrensis* | + | - | - | - | - | - |
| *Meretrix meretrix* | + | + | + | - | - | + |
| *Placamen calophylla* | + | + | + | - | - | - |
| *Periglypta* | - | - | + | - | - | - |
| *Delillia sp.* | + | + | + | + | - | + |
| **Total Species Observed** | **28** | **25** | **25** | **9** | **4** | **14** |

**Relative Abundance**

As to the overall abundance of bivalves, Barangay Cato recorded the highest relative abundance among coastal barangays (Figure 3). This accounts for the 28% of the total individuals collected during the period of the study. This was followed by Bayambang and Batang which recorded 23.10% and 19.27%, respectively.

In terms of relative abundance by species, the result for each coastal barangay is shown in the following graphs (Figures 4 to 9). *G. tumidium* dominates the bivalve community of Bayambang (Figure 4). Meanwhile, *G. pectinatum* was observed as dominant species in Cato (Figure 5). For the community in Batang and Poblacion, *C. fluminea* recorded the highest relative abundance (Figures 6 and 7). In Patima, *P. exilis* dominates (Figure 8) while *Delillia* sp. was found to be the most abundant bivalve in Nayom (Figure 9).

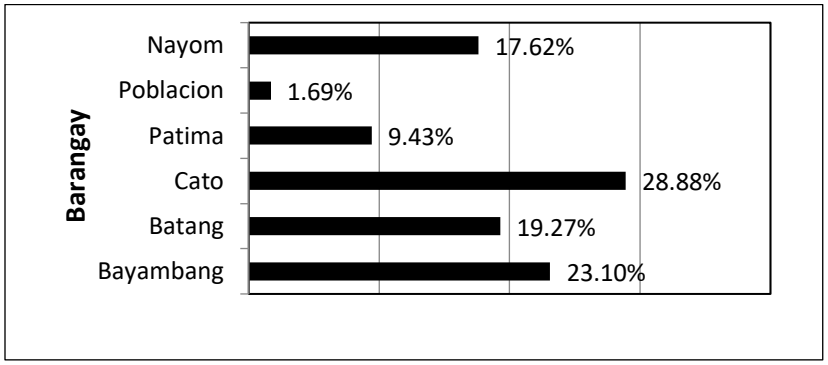


Figure 3. Overall Relative Abundance.

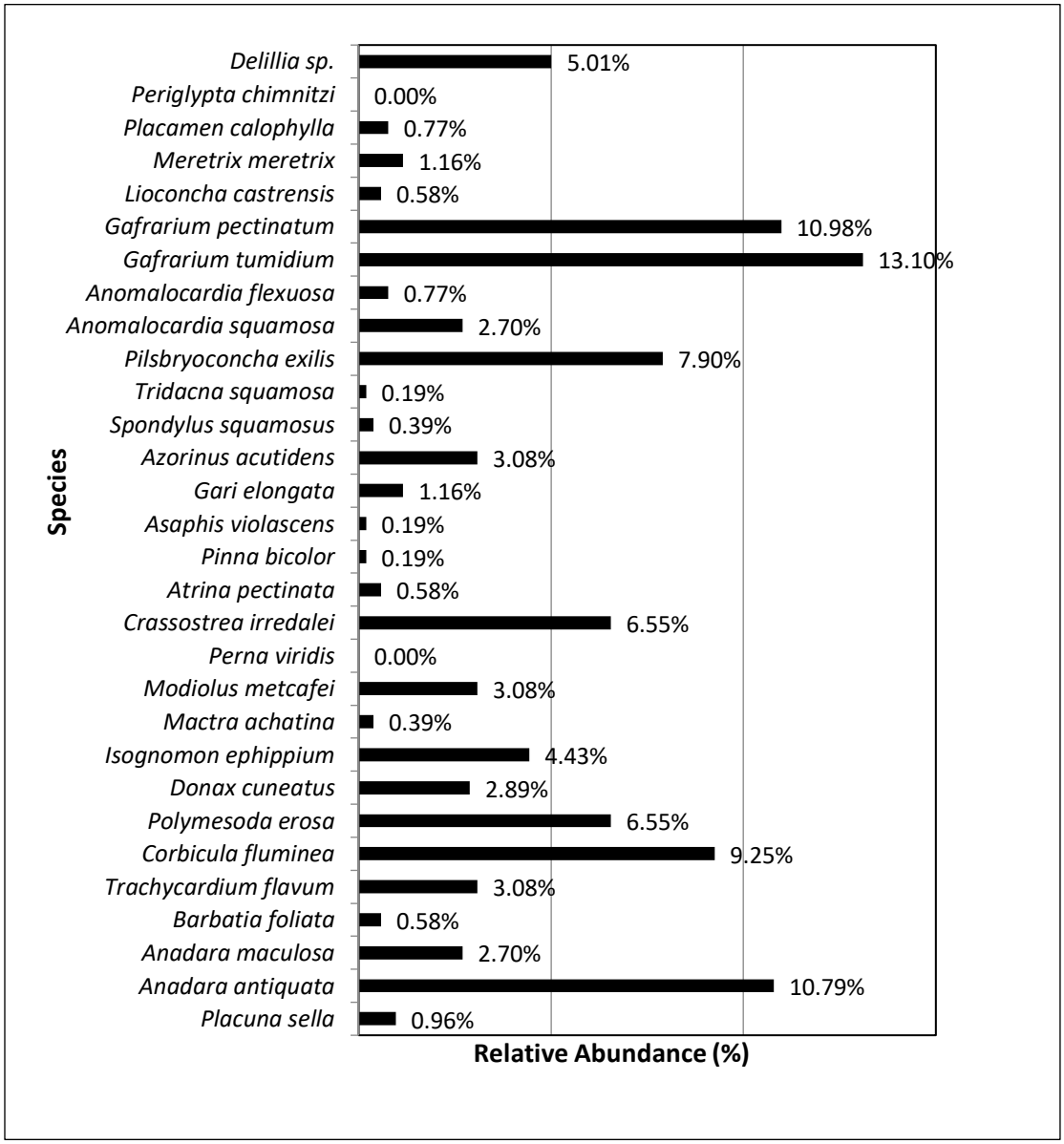


Figure 4. Relative abundance of bivalves in Barangay Bayambang.

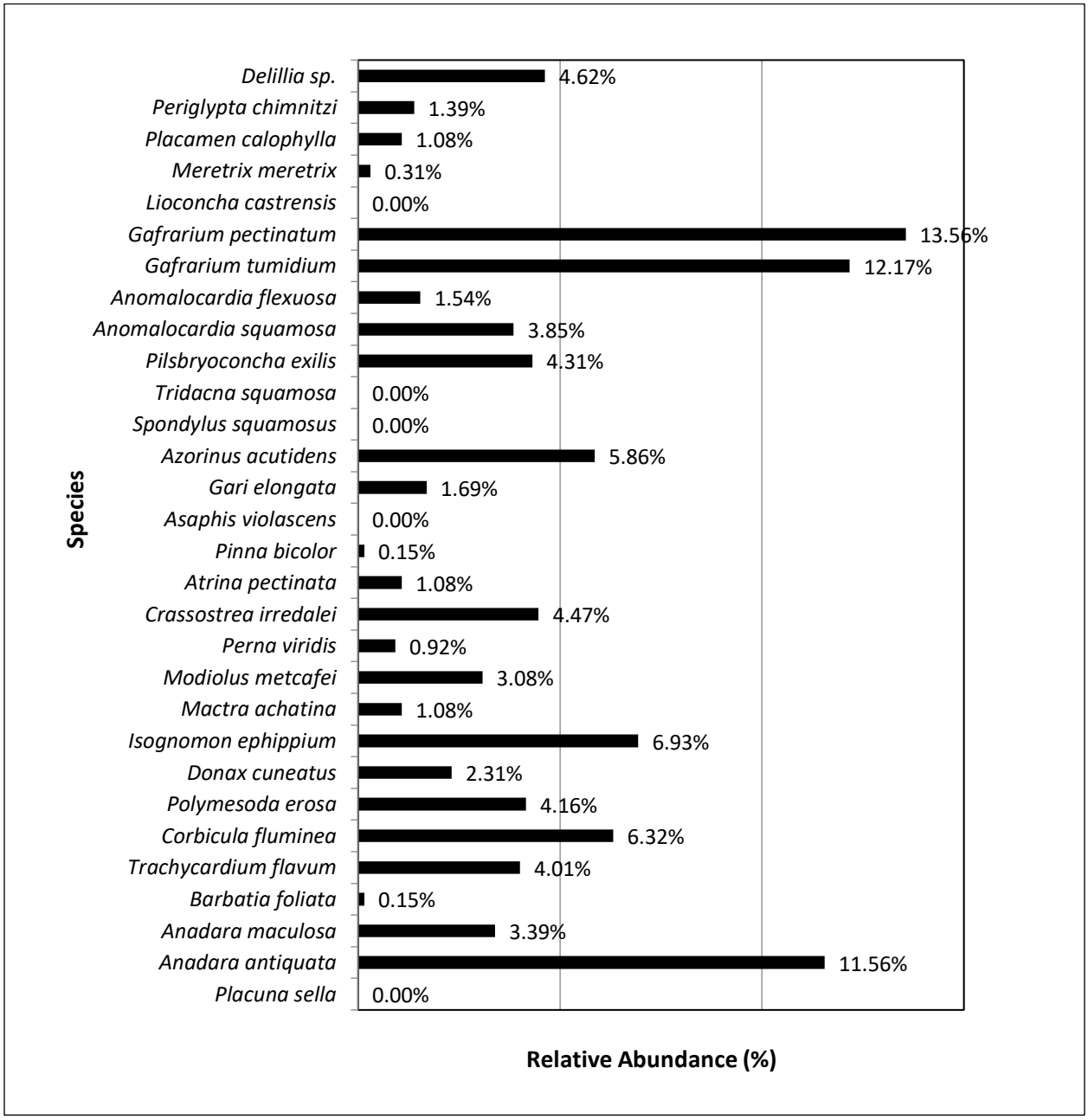


Figure 5. Relative abundance of bivalves in Barangay Cato.

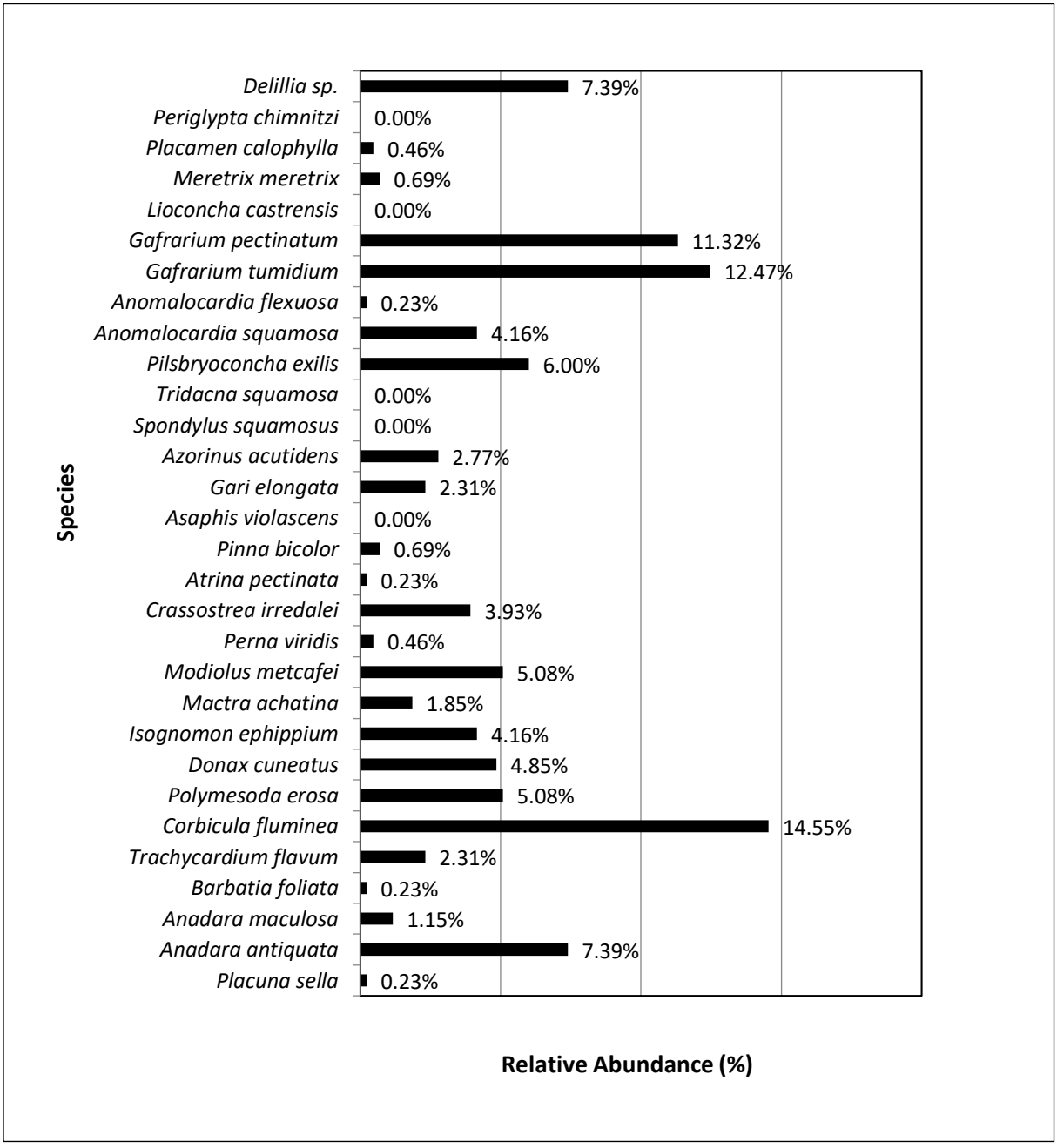


Figure 6. Relative abundance of bivalves in Barangay Batang.

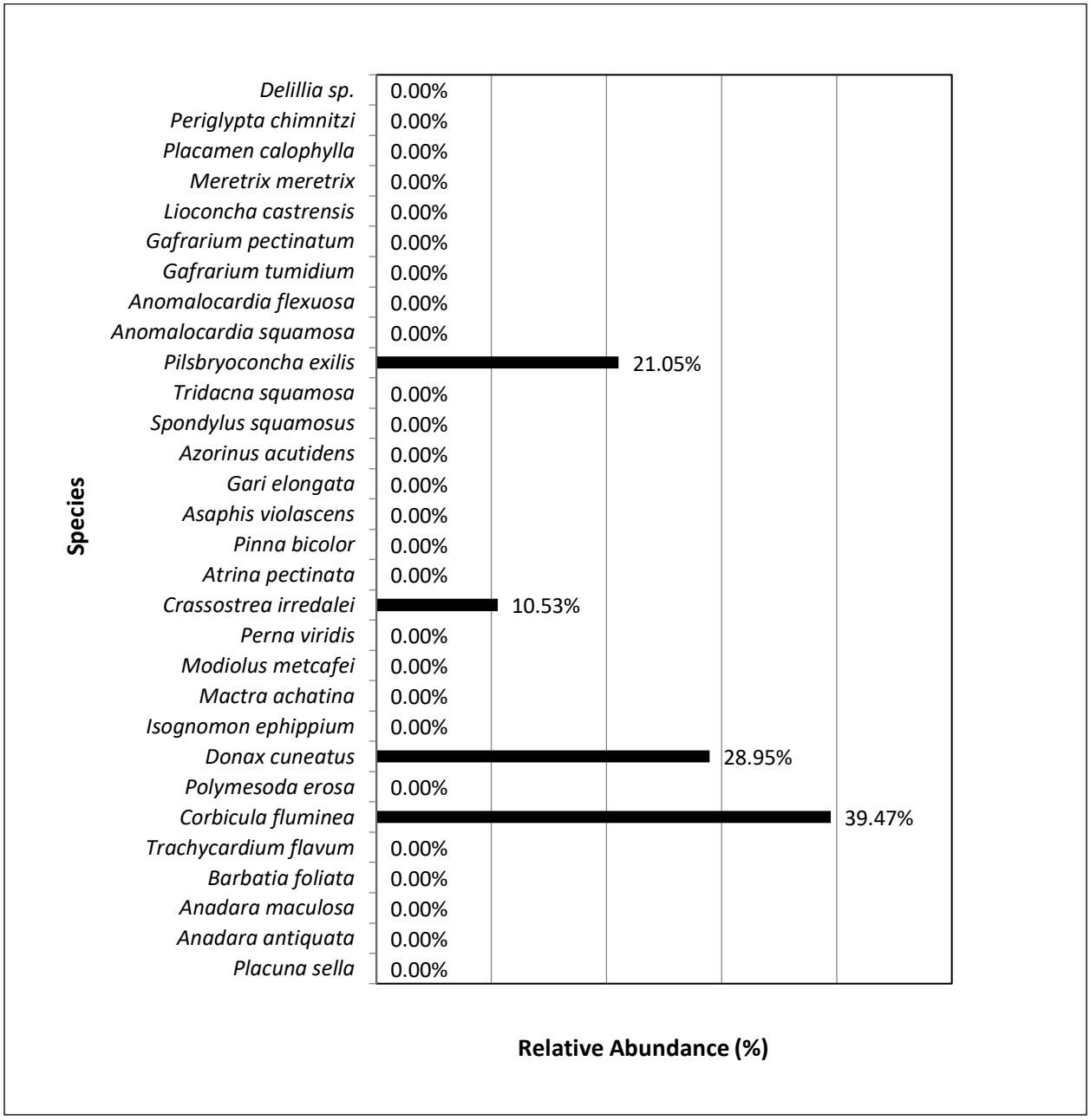


Figure 7. Relative abundance of bivalves in Barangay Poblacion.

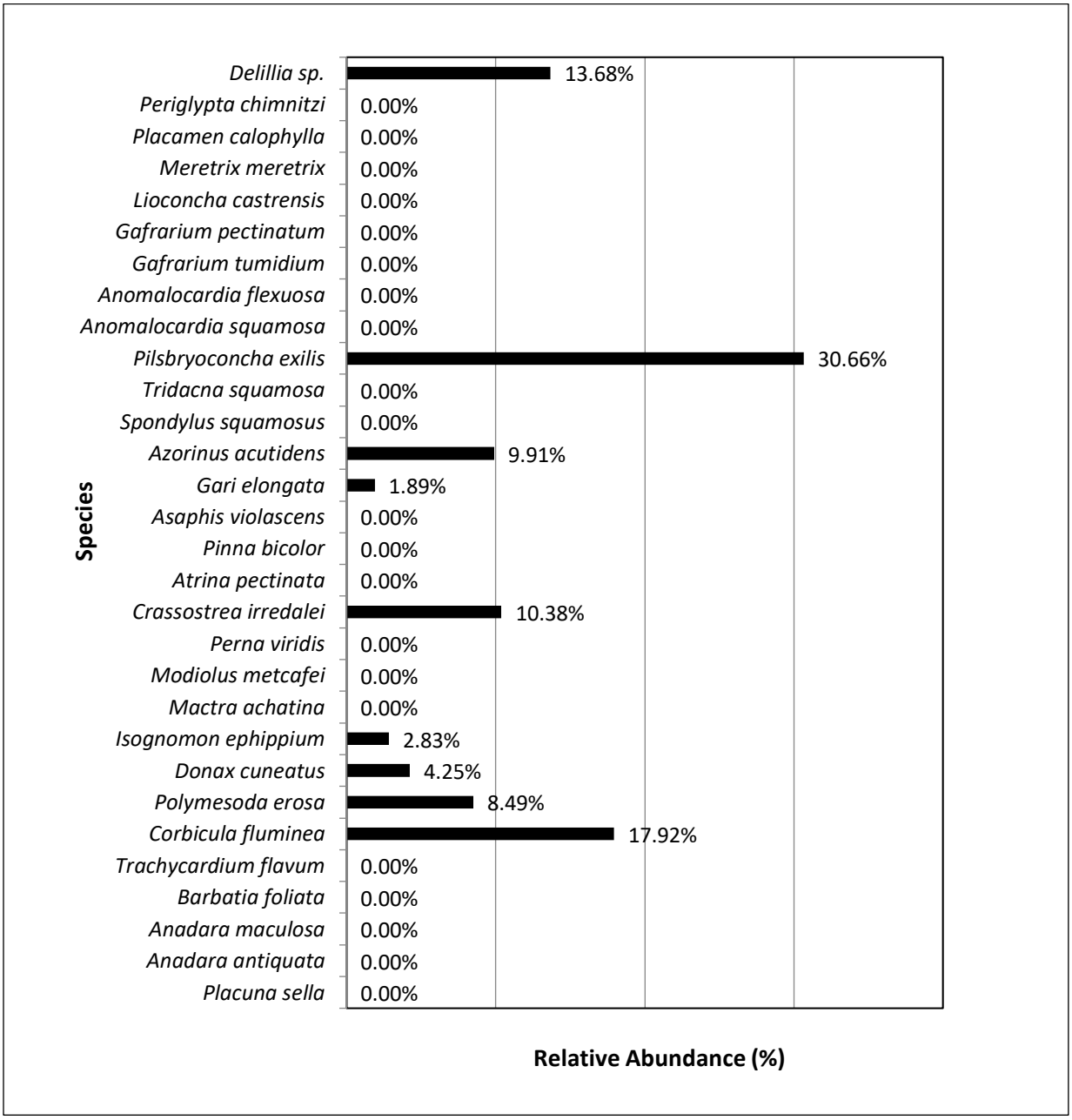


Figure 8. Relative abundance of bivalves in Barangay Patima.

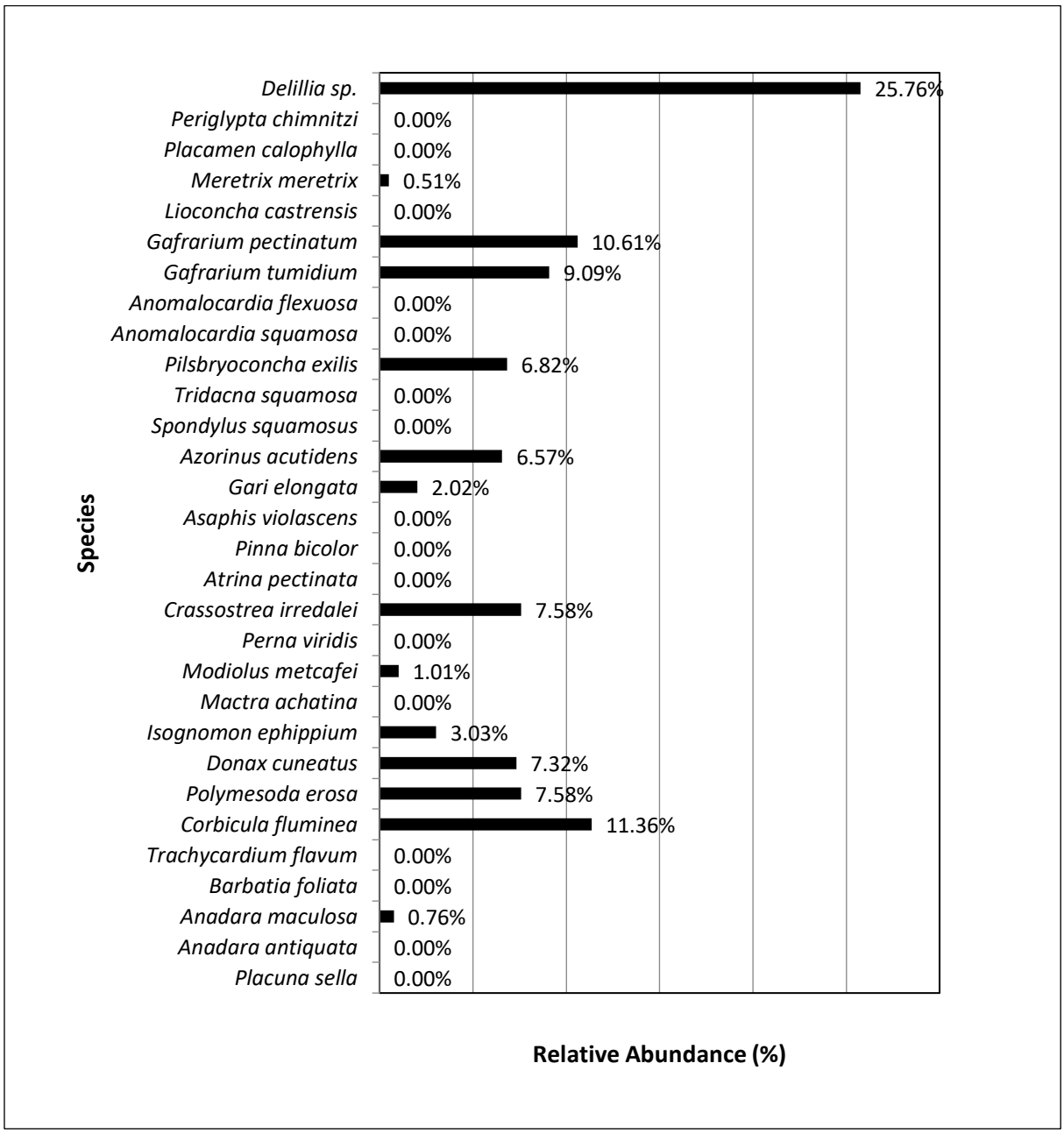


Figure 9. Relative abundance of bivalves in Barangay Nayom.

**Computed Diversity Indices**

Investigation of diversity in this study was based on the number of collected samples during the course of the study. The computed diversity indices are presented in Table 3. Margalef index was found highest in Bayambang. In terms of Shannon-Weiner Index, Bayambang and Cato recorded the highest value. As to Simpson's Index of Dominance, highest value was obtained in Poblacion. For Evenness Index, highest value was recorded in Cato and Patima. Meanhwile, overall computed values showed 3.76 for Ma, 2.20 for H', 0.87 for D and 0.65 for E.

**Species Similarity**

As indicated in Table 4, highest similarity index was obtained between Batang and Cato (0.48) while lowest was recorded between Bayambang and Poblacion (0.13).

**Table 3. Computed values of diversity indices.**

| Diversity Index | Barangay | | | | | | Overall |
|---|---|---|---|---|---|---|---|
| | Bayambang | Batang | Cato | Patima | Poblacion | Nayom | |
| Ma | 4.32 | 3.95 | 3.71 | 1.49 | 0.82 | 2.17 | 3.76 |
| H' | 2.83 | 2.73 | 2.83 | 1.93 | 1.29 | 2.29 | 2.20 |
| D | 0.93 | 0.92 | 0.93 | 0.83 | 0.72 | 0.88 | 0.87 |
| E | 0.85 | 0.85 | 0.88 | 0.88 | 0.93 | 0.87 | 0.65 |

**Table 4. Similarity and shared species indices of bivalves between coastal barangays**

| Barangay | Bayambang | Batang | Cato | Patima | Poblacion | Nayom |
|---|---|---|---|---|---|---|
| **Bayambang** | 0 | 0.83 (0.45) | 0.77 (0.43) | 0.32 (0.24) | 0.14 (0.13) | 0.50 (0.33) |
| **Batang** | | 0 | 0.92 (0.48) | 0.36 (0.26) | 0.16 (0.14) | 0.56 (0.36) |
| **Cato** | | | 0 | 0.36 (0.26) | 0.16 (0.14) | 0.56 (0.36) |
| **Patima** | | | | 0 | 0.44 (0.31) | 0.64 (0.39) |
| **Poblacion** | | | | | 0 | 0.29 (0.22) |
| **Nayom** | | | | | | 0 |

## DISCUSSION

Bivalve fishery played a preponderant role on the economic well-being of the town's local fishers. Although the harvesting of bivalves is still considered as subsistence activity, it provides food and some sorts of income for fishing families. The coastal waters of Infanta, Panagsinan are part of Dasol Bay, a municipal fishing ground that is connected to the South China Sea. According to Liu (2013), the South China Sea harbors the most diverse bivalve resources in the world with about 802 species [13]. Similarity and variation observed in the composition of bivalve resources in the coastal barangays of the town can be linked to the presence and absence of important habitats such as seagrass beds, mangroves and sandy to muddy substrates. It was observed in this study that the Barangays of Bayambang, Batang and Cato

recorded higher number of species compared to the Barangays of Patima, Poblacion and Nayom. These barangays have vast seagrass and mangrove areas which are important factor in the survival of bivalves. Looking deeper at the details, most of the identified species were found in the marine ecosystems, particularly in the seagrass beds. According to Asadi et al. (2018), seagrass areas provide more favorable ecological setting for bivalves compared to other areas with relatively harsh environmental conditions [14]. Meanwhile, Poblacion only occupied a small land portion of town with limited channels, water impoundments and coastal zone that could support diverse bivalve populations.

The abundance of bivalves from the family Veneridae in Bayambang, Batang and Cato can also be linked to the presence of vast seagrass beds of these areas. The family is considered the largest among bivalve groups comprising 765 representative species [15]. The most abundant bivalve belonging to this family are *G. tumidium* and *G. pectinatum*. These species were also reported dominating the bivalve resources of seagrass ecosystem in Labakkang coastal water, South Sulawesi, Indonesia [16]. Also, Asadi et al. (2018) reported that *G. tumidium* has a relative abundance of 24%, the highest in 5 of 6 sampling sites of their study in Gili Ketapang Island, East Java, Indonesia. Meanwhile, it was observed that freshwater species of bivalves are abundant in Batang, Patima, Poblacion and Nayom. These species include *P. exilis, C. fluminea* and *Delillia sp*. which are found in freshwater ponds, swamps and sandy rivers. The abundance of *Delillia* sp. in Nayom could be attributed to the presence of the largest river system in the town, the Nayom River. This is also a common bivalve sold in the market of the town.

The values of Margalef index (Ma) in the present study varied from 0.82 (Poblacion) to 4.32 (Bayambang) and an overall value of 3.76. This index indicates the richness of species in an area but highly sensitive to sample size [17]. Also, this index has no limit. However, Jorgensen et al. (2005) stated that richness index ranging from 2.5 to 4.0 was moderate [18]. Therefore, the findings implied that the status of bivalve species richness in Infanta is in moderate condition. The Shannon-Weiner index (H') ranges from 1.29 to 2.83. Highest computed values were obtained in Bayambang and Cato. Meanwhile, lowest value was obtained in Poblacion. Overall computed value is 2.20. Similar to Ma, this index is sensitive to sample size. As observed, highest and lowest richness were observed in the same sites. Hence, it can be said that that there is direct relationship between richness and the value of this index. The usual values of Shannon-Weiner index are within the range of 0-5, of which higher values indicate minimal pressure on the resource [19]. Mason (1981) categorized Shannon-Weiner index as low (H'<1), moderate (1≤H≤3) and high (H'>3) [20]. Looking again at the result, values implied a moderate bivalve diversity in the coastal barangays and in Infanta as a whole. Also, the result for H' is in similarity with the study of Monolisha and Edward (2015) carried out in Andhra Pradesh coast [21]. As to Simpson's Dominance index (D), values obtained are high having a mean overall value of 0.87 across all sites. Highest computed D was obtained from Bayambang and Cato both with 0.93 and lowest was observed in Poblacion (0.72). This index ranges from 0 to 1. Legendre and Legendre (1983) stated that the dominance index can be categorized as low (D<0.4), moderate (0.4<D>0.6) and high (D>0.6) [22]. Based from this categorization, the computed values of D across coastal barangays are generally high. This result indicates the dominance of a single or few species. According to Lowe and McConnell (1999), when there is high dominance of a given species, it may be due to the aggregation in a certain area or due to human activities [23]. This result could be linked to the seasonal collection of bivalves in the coastal waters of Infanta. Although not directly studied, fishers claimed that they only opted to collect bivalves during lean periods. With respect to Evenness index (E),

values range from 0.85 (Bayambang and Batang) to 0.93 (Poblacion). Magurran (1998) claimed that evenness index may vary between 0 and 1 [24]. According to Odum (1975), the community can be said in steady state if E≥0.6 [25]. Surprisingly, computed values for E were all higher than 0.6 implying that bivalve resources in the area are in steady state. Almost similar findings were reported by Vito (2018) on the evenness of economically important bivalves in north-west Bohol [26].

Based from the result, the Sorensen's similarity and shared species indices ranges from 0.14 (between Bayambang and Poblacion) to 0.92 (Batang and Cato). The index represents the percentage of shared species between communities or area with a range of 0 to 1. The higher value obtained between the three barangays (Bayambang, Batang and Cato) could be attributed to their vicinity to each other. These barangays shared almost the same types of aquatic habitats such as seagrass beds, intertidal zone, mangrove areas and river systems. Hence, movements of identified bivalves are not restricted between these areas.

Management activities are indispensable to maintain the diversity and abundance of exploited resources in a certain area [27]. Aban et al. (2017) studied the sustainability of municipal fisheries resources of Infanta, Pangasinan [28]. Based from the findings of their study, the fisheries resources of the town were managed through enactment of fishery ordinances. These ordinances aimed to regulate fishing activities and stop illegal activities that threatened the resource. Mangrove reforestation and clean-up drives were also carried out in the coastal and riverine areas of the town according to local fishers.

## CONCLUSIONS

1. There are 30 species of bivalves belonging to 17 families present in the coastal barangays of Infanta, Pangasinan.
2. *Corbicula fluminea* is the most abundant species of bivalves in the coastal barangays of Infanta, Pangasinan.
3. The family Veneridae has the highest representative species among the families of bivalves identified in the area.
4. Most bivalves inhabit seagrass beds, intertidal and mangrove areas.
5. All identified bivalves are used as food and some are also utilized in shellcraft-making with exception of *T. squamosa* that is now protected by the law.
6. The conservation status of all identified bivalve species except *T. squamosa* was not evaluated at present.
7. Overall relative abundance was found highest in Barangay Cato and lowest was observed in Barangay Poblacion.
8. Relative abundance by species per barangay showed the dominance of *G. tumidium, G. pectinatum, C. fluminea, P. exilis* and *Delillia* sp.
9. The diversity of bivalve resources in the coastal barangays of the town is categorized as moderate.
10. Barangay Batang and Cato showed higher similarity index implying the constant movement of most bivalve species in each heterogeneous habitat that can be found in these areas.

## RECOMMENDATIONS

1. A study must be carried out in relation to the factors that influence the diversity and abundance of bivalves in the coastal areas of Infanta.
2. Another study in coordination with the local government must be conducted to determine what particular management strategy is appropriate to maintain the richness of bivalve resources in the area.

## REFERENCES

[1] PhilAtlas. 2019. Infanta, Province of Pangasinan. https://www.philatlas.com

[2] Venugopal, V. and K. Gopakumar. 2017. Shellfish: Nutritive value, health benefits, and consumer safety. *Comprehensive Reviews in Food Science and Food Safety* 16(6): 1219-1242.

[3] Wright, A.C., Fan, Y. and G.L. Baker. 2018. Nutritional value and food safety of bivalve molluscan shellfish. *Journal of Shellfish Research* 37 (4): 695-708.

[4] Biandolino, F., Di Leo, A., Parlapiano, I., Papa, L., Giandomenico, S., Spada, L. and Prato and E. 2019. Nutritional quality of edible marine bivalves from the Southern Coast of Italy, Mediterranean Sea. *Polish Journal of Food and Nutrition Sciences* 69(1): 71-81.

[5] Boominathan, M., Subash Chandran, M.D. and T.V. Ramachandra, T.V. 2008. Economic valuation of bivalves in the Aghanashini Estuary, West Coast, Karnataka. *ENVIS Technical Report* No. 30. 33 pp.

[6] Abbott, R.T. 1991. Seashells of Southeast Asia. General Printing Services Pte. Ltd., Singapore: 145 pp.

[7] Oliver, O.P.H. 2004. Guide to seashells of the World. Octopus Publishing Group Ltd., London: 320 pp.

[8] Laureta, L. 2008. Compendium of the economically important seashells in Panay, Philippines. The University of the Philippines Press. 147 pp.

[9] Palomares, M.L.D. and D. Pauly (Editors). 2020. SeaLifeBase. World Wide Web electronic publication. www.sealifebase.org

[10] Magurran, A.E. 1998. Ecological diversity and its measurement. Princeton, New Jersey: Princeton University Press.

[11] Chao, A., Hwang, W., Chen, Y. and C.Y. Kuo. 2000. Estimating the number of shared species in two communities. *Statistica Sinica* 10(1): 227-246.

[12] Pinakbet Republic. 2012. Unnok/ginukan, freshwater shellfish. https://pinakbetrepublic.blogspot.com/2012/02/unnokginukan-freshwater-shellfish.html?m=0

[13] Liu, J.Y. 2013. Status of marine biodiversity of the China Seas. *PloS ONE* 8(1): e50719.

[14] Asadi, M.A., Iranawati, F. and A.W. Andini. 2018. Ecology of bivalves in the intertidal area of Gili Ketapang Island, East Java, Indonesia. *AACL Bioflux* 11(1): 55-65.

[15] Huber, M. 2015. Compendium of bivalves 2. A full-color guide to the remaining seven families. A systematic listing of 8,500 bivalve species and 10,500 synonyms. ConchBooks, Hackenhaeim, Germany: 907 p.

[16] Hamsiah, Herawati, E.Y., Mahmudi, M. and Sartimbul, A. 2016. Seasonal variation of bivalve diversity in seagrass ecosystem of Labakkang coastal water, Pangkep, South Sulawesi, Indonesia. *ACCL Bioflux* 9(4): 775-784.

[17] Gamito, S. 2010. Caution is needed when applying Margalef diversity index. *Ecological indicators* 10(2): 550-551.

[18] Jørgensen, S. E., F. Xu, J. Marques, and F. Salas. 2011. Application of indicators for the assessment of ecosystem health, pp. 9-76. *In:* S. Jørgensen (Editor), Handbook of ecological indicators for assessment of ecosystem health. Second edition. CRC Press, Boca Raton, Florida, USA.

[19] Catibog-Sinha, C.S. and L.R. Heaney. 2006. Philippine Biodiversity: Principles and Practice, Haribon Foundation for the Conservation of Natural Resources, Inc. Quezon City. 495 p.

[20] Mason, C.F. 1981. Biology of Freshwater Pollution. Longman, Inc. New York. 250 p.

[21] Monolisha, S. and J.K.P. Edward. 2015. Biodiversity of marine mollusk from selected locations of Andhra Pradesh Coast, Southeastern India. *Indian Journal of Geo-Marine Sciences* 44(6): 842-855.

[22] Legendre, L. and P. Legendre. 1983. Numerical ecology. Elsevier Amsterdam. 419 p.

[23] Lowe-McConnell, R.H. 1999. Estudos ecológicos de comunidades de peixes tropicais. EDUSP, São Paulo, SP, 524p.

[24] Magurran, A.E. 1998. Ecological diversity and its measurement. Princeton, New Jersey. Princeton University Press.

[25] Odum, E.P. 1975. Ecology: the link between the natural and the social science. Second Edition. Holt, Rinehart and Winston. 244 p.

[26] Vito, M.P. 2018. Diversity and abundance of economically important bivalves in north-western Bohol, Philippines. *International Journal of Fisheries and Aquatic Studies* 6(3): 44-48.

[27] Bautista, L.M., Capinpin, E.C. Jr. and F.A.T. Argente. 2017. Assessment of Commercially Important Marine Invertebrates in Selected Areas of Anda, Pangasinan, Northern Philippines. *PSU Journal of Natural and Allied Sciences* 1(1): 12-16.

[28] Aban, S.M., Garcia, A.C., Ibarra, C.E., Raguindin, R.S., De Vera, R.B. and D.M. Mendoza. 2017. Fisheries Resources of Dasol Bay in Western Pangasinan, Philippines. *PSU Journal of Natural and Allied Sciences* 1(1): 7-11.