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Species composition and abundance of benthic species along Cagayan river: Conservation purposes

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Abstract

This study generally aimed to provide an update on the benthic community along the Cagayan River. Specifically, this study sought to determine the species composition, economic value, conservation status, and relative abundance of microbenthic invertebrates in the waters of Cagayan River, specifically in Lal-lo (Site 1) and Alcala (Site 2). Sampling stations were established at each site and a modified transect-quadrat approach was used in the collection of samples. Samples were identified using online published resources and relative abundance was also computed. The results of the study identified seven Mollusk species, with four species under the class Bivalvia and three under Gastropoda. *Corbicula* sp., *Delillia* sp., and *Batissa violacea* were found to be of high economic value, serving as important sources of income for local communities. However, *Delillia* sp., endemic to the Cagayan River particularly at Lal-lo, is becoming increasingly rare. In terms of conservation status, most species were categorized as "Not Evaluated" on the IUCN Red List, except for one economically important bivalve species, which was classified as "threatened." In terms of the relative abundance of benthic Mollusk species in the Cagayan River at Lal-lo and Alcala. *Corbicula* sp. dominated both sites, representing 63.67% of the total catch at Lal-lo (N=14,673) and 72.18% at Alcala (N=205). *Delillia* sp. was the second most abundant species at Lal-lo, accounting for 35.74% of the catch, while *Melanoides tuberculata* was the second most abundant at Alcala with 27.82%. The least abundant species was *Batissa violacea*, with only 60 individuals recorded (0.26%), highlighting its decline and classification as a threatened species. The abundance of benthic species varied significantly across stations, with Fabrica in Lal-lo being the most abundant collection site (N=7,704). Moreover, *Corbicula* sp. demonstrated resilience to environmental disturbances, maintaining its economic importance as a consistent source of livelihood for local communities. Thus, the findings of this research study highlight the need for further research on genetic barcoding to provide accurate identification of the samples and conservation efforts to protect these valuable Mollusk species and ensure their sustainable use.

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Introduction

Cagayan River, also called Río Grande De Cagayan, longest stream in Luzon, Philippines. It begins its 220-mile (350-kilometre) course in a twisting pattern in the Sierra Madre in Northeastern Luzon. It then flows north into a 50-mile- (80-kilometer) wide fertile valley that is important for the cultivation of rice and tobacco. Ilagan, Isabela, Tuguegarao, and Cagayan are major riverine towns. At Aparri, the Cagayan enters the ocean at the Babuyan Channel of the Luzon Strait. The Chico, Magat, and Ilagan rivers are its main tributaries The Cagayan River has a rich biodiversity that contains a diverse assemblage of fish, shellfish, shrimps, crabs, and other organisms.

The Cagayan River serves as the major fishing ground for the region's farmers and fisher folk. It plays a vital role as potential fisheries and aquatic resources in the region. It provides a wide range of services to the residents of Lal-lo and Alcala. As an open water ecosystem, the river is strongly influenced by the surrounding environment water quality of the river is influenced by several parameters like land use, settlement patterns, farming, and industrial activities around the river. The water quality of rivers consequently leads to a certain change in the benthic community structure.

To date, however, limited studies have been conducted on benthic habitat and resource assessment along the stretch of Lal-lo and Alcala that could serve as additional data in the formulation of management measures for proper utilization, conservation, and protection of the resources. A better understanding of the benthic ecosystem is needed for conservation and management measures, along with sustainable development shortly. Many factors influence the benthic ecosystem such as climate change, tides, sediment perturbation, species interaction, and human interaction. The exploration of scientific research, monitoring, and conservation measures are essential to ensure that the exploitation of resources does not lead to massive destruction of benthic ecosystems. Many macrobenthic species have sedentary behavior and relatively long lifespans, they can serve as indicators of the benthic ecosystem status to assess the influence of these factors (Dreujou, 2020). Biological monitoring is an essential element needed to assess the environmental health of aquatic benthic ecosystems.

Thus, establishing a baseline of macrobenthic invertebrate diversity and abundance provides essential information for conservation efforts. It allows policymakers to track changes and implement measures to protect and preserve the Cagayan River's biodiversity. Hence, this study is conceived to provide an update on the benthic community along the Cagayan River, particularly in the municipality of Lal-lo and Alcala, Cagayan where a majority of macrobenthic gatherers live. Specifically, this study sought to determine the benthic species composition, economic value, conservation status, and relative abundance of macrobenthic invertebrates collected along the Cagayan River.

Materials and methods

Study area

The study was carried out along the Cagayan River, particularly at Alcala and Lal-lo, Cagayan (Fig. 1). These are identified sites with natural occurrence of benthic aquatic species according to the interviewed gatherers. In the municipality of Lal-lo, seven (7) sampling stations were established, and five (5) sampling stations in the municipality of Alcala, Cagayan were also established using Global Positioning System (GPS) as shown in Fig. 2&3.

Establishment of study area

The study used a modified transect-quadrat approach, as Fig. 2 illustrates. The research area's shoreline is split by two (2) fixed transect lines in each municipality, spanning about 50 meters each. The distance between each transect line is approximately 5 meters. Away from each transect. Depending on the local topography, the transect line's length changed.

Figure 1. Location maps municipalities as study sites.

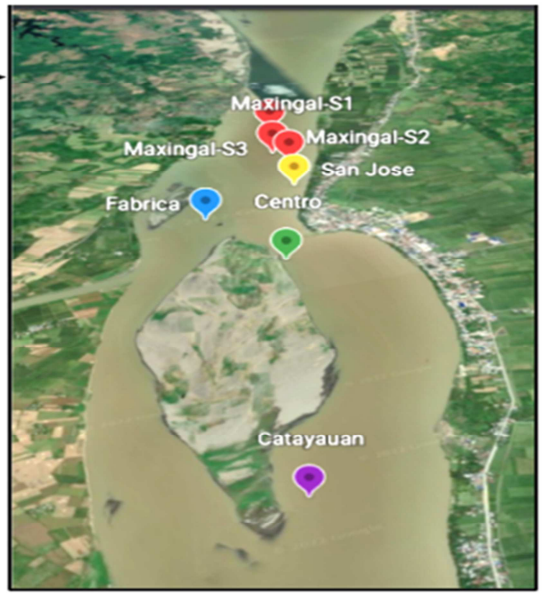

Figure 2. Sampling stations along Lal-lo

Figure 3. Sampling stations along Alcala

Collection of samples

The samples were taken from the established sampling stations at the two municipalities by the commissioned gatherers. The commissioned gatherers were instructed to collect samples of macrobenthic within the transect line established using a scoop net locally known as "Karwas" (Fig. 4).

Fig. 4. Collecting tool "Karwas" in gathering benthic species

Samples were collected biweekly and sometimes based on weather conditions affecting all collection sites. In each of the stations, three (3) fifty-meter (50-meter) transect line was laid for the collection of benthic species. The scoop net was dragged down with the mouth positioned against the current with the gatherer's foot pushing the substrates inside the "Karwas" while continuously dragging forward during collecting. Based on observation, approximately, it would take approximately 10-15 minutes to cover the collection site of 50 meters (Fig. 5).

Identification of samples

After the collection and weight determination, samples from scoop nets were taken to the laboratory at Cagayan State University at Aparri for

subsequent sorting. Samples were sorted, measured, and documented through photographs for further identification and classification. The local name and the economic value of each species identified were determined by asking the residents while the conservation status of the species identified was determined using the online resources published in the SeaLife Base (Palomares and Pauly, 2020) and available references and taxonomy for freshwater clams (Mollusca Base eds., 2022), Freshwater Clam, *B. violacea* (Poutieres, 1999).

Fig. 5. Photos of microbenthic invertebrates encountered in the surveyed sites along Cagayan River: Asian Clam *Corbicula* sp. (A), Charru mussel *Mytulis edulis* (B), Freshwater Mollusk *Delillia* sp. (C), Red-rimmed melania *Melanoides tuberculate*a (D), Trumpet snail *Stenomelania torulosa* (E), Nerite snail *Theodoxux* sp. (F) and Freshwater clam *Batissa violacea* (G)

Data analysis

Abundance of species (RA) was computed based on the monthly total number of individuals caught per station as follows: (G.W. Snedecor, 1980).

RA=Ni/N x 100%

Where RA is Relative abundance, Ni is the number of individuals in species and N is the total number of individuals in the community.

Results and discussion

Species composition, economic value, and conservation status

As presented in Table 1, seven (7) species of shelled mollusk resources were recorded belonging to four families inhabiting the waters of Cagayan River-Lal-lo (Site-1) and Alcala (Site-2). Observations revealed that six (6) species were found at Site 1-Lallo, as compared to two (2)species collected from Site 2-Alcala.

These species include *Corbicula* sp., *Batissa violacea*, *Delillia* sp., *Mytulis edulis*, *Stenomelania torulosa*, *Melanoides tuberculate*, and *Theodoxux* sp. Among the identified families, Corbiculidae has the highest number of species collected particularly the species of *B. violacea* and *Corbicula* sp. which is considered an economically important species of bivalve that is similar in Indonesia wherein *B. violacea* are valuable economic resources (Bathiar *et al.*, 2022). There are

still a few *Delillia* sp. locally known as "Unnok" which are endemic to the Cagayan River and becoming rare in its natural habitat which is also considered economically important since it also sold in the market as an additional income to gatherers. However, *Delillia* sp., and *Corbicula* sp. taxonomic classification is still a scarcity of information.

It could be noted that, from the seven (7) species, four (4) species fall under class Bivalvia: *Corbicula* spp. locally known as "Bennek", *Delillia* sp., known as "Unnok", *Batissa violacea* well known as Cabibi and *Mytulis edulis* "Tahong". On the other hand, the other three (3) species belonging to class Gastropoda comprised of *Stenomelania torulosa*, known as "Susu", *Theodoxux*, sp., locally called "Shek" and the last is *Melanoides tuberculata*, known as "Duriken". Species composition shows that only three were of high economic value, which served as a major source of income: *Corbicula sp., Delillia sp., and Batissa violacea.* All other benthic species found were not edible and unfamiliar in the community as edible food. In terms of economic uses, five species are utilized as food while two of these species were not consumed as food. When comparing these findings in the assessment of benthic marine gastropods and bivalves in Butuan Bay, Philippines, it is apparent that the species diversity is relatively lower and all identified bivalve species in this region are deemed edible, as reported by Jamodiong *et al.* (2018). Moreover, the shells of *B. violacea* are used in making souvenir items and it has also been documented that Mollusk serve as raw materials for button manufacturing and shell craft industries, as noted by Floren (2003) and Laureta (2008) and cited by Garcia and Anticamara (2023).

Table 1. Composition, occurrence, economic value, and conservation status of benthic species in Cagayan river at Lallo and Alcala

Family	Species	Local name	Substrate	Economic value	Conservation status (IUCN)
Corbiculidae	*Corbicula* sp.	"Bennek"	Lal-lo & Alcala	Uses as food	Not Evaluated
	Batissa violacea	"Cabibi"	Lal-lo	Uses as food	Threatened
	Delillia sp.	"Unnok"	Lal-lo	Uses as food	Not evaluated
Mytillidae	*Mytulis edulis*	"Tahong"	Lal-lo	Not edible	Not evaluated
Thiaridae	*Stenomelania torulosa*	"Susu"	Lal-lo	Used as food	Not evaluated
	Melanoides tuberculata	"Duriken/Agurung"	Alcala	Used as food	Not evaluated
Neritidae	*Theodoxux* sp.	"Shek"	Lal-lo	Not edible	Not evaluated

Studies dealing with the macrozoobenthic species distribution in freshwater tidal estuarine areas are insufficient (Bruyndoncx *et al.*, 2002). Specifically in the Cagayan River, to date, the macrobenthic community has never been thoroughly explored knowing that this plays a crucial role in the material cycle by participating in the breakdown and recycling of organic matter since majority of these species are filter feeders.

Based on the IUCN Red List, majority of the samples identified were "Not Evaluated" status and only 1 species encountered was "threatened" in status and this species of bivalve is also categorized as an economically important species within the locality.

Relative abundance

Tables 2A and 2B present the data on the relative abundance of benthic species along the Cagayan River at Lal-lo and Alcala. Estimation of benthic species abundance was made by the contribution of the monthly catch (number of pieces) in each sampling site, Table 2A and 2B. Benthic abundance at two (2) Sites (S1-Lal-lo and Alcala-S2) shows that at both sites, *Corbicula sp.* dominated other species. Site (1*)* has the highest (N= 14,673) with a total percentage of 63.67%., similarly at Site (2- Alcala,) where the same *Corbicula sp.* appeared as the most abundant species with a total individual count of (N= 205) representing 72.18 % of the total catch, throughout the study.

Table 2A. Abundance of benthic species at Cagayan river-Lal-lo and Alcala, Cagayan

A) Lallo	Sampling station							Total (N)	SA %
Species	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7		
Corbicula sp.	991	4,678	4,053	4,005	14	34	898	14,673	63.67
Delillia sp.	666	1,733	1,391	3,641	4	12	791	8,238	35.74
Batissa violacea	17	12	10	21	0	0	0	60	0.26
Stenomelania torulosa	0	33	0	36	0	5	0	74	0.32
Mytulis edulis	0	1	0	0	0	0	0	1	0.00
Theodoxux sp.	0	0	0	1	0	0	0	1	0.00
Melanoides tuberculata	0	0	0	0	0	0	0	0	0.00
Total	1,674	6,457	5,454	7,704	18	51	1,689	23,047	100

Table 2B. Abundance of benthic species at Cagayan river-Lal-lo and Alcala, Cagayan

B) Alcala	Sampling station				Total (N)	SA %
Species	Maraburab	Carallanagan	Tupang	Pinopoc		
Corbicula sp.	197	2	6	0	205	72.18
Delillia sp.	0	0	0	0	0	0
Batissa violacea	0	0	0	0	0	0
Stenomelania torulosa	0	0	0	0	0	0
Mytulis edulis	0	0	0	0	0	0
Theodoxux sp.	0	0	0	0	0	0
Melanoides tuberculata	2	77	0	0	79	27.82
Total	199	79	6	0	284	100

The second most abundant species at Lal-lo was *Delillia* sp. with a total count of 8,238 individuals' equivalent to 35.74% followed by *S. torulosa* with 74 pcs (0.32%). The least abundant was *B. violacea* with a total count of 60 individuals (0.26%) which implies that *B. violacea* is continuously declining and is categorized as a threatened species in the Cagayan River.

On the other hand, data shows that *M. tuberculata* in Alcala is the second and last species found with a count of 79 individuals (27.82%). It could be further observed that among the species with the highest economic value, *B. violacea* revealed the least abundant catch throughout the study.

Considering the abundance of the species in the different stations at two (2) Sites, Results show that across stations, Fabrica, obtained the most abundant benthic catch accounting for 7,704 individuals., which was followed by Maxingal 2- Lallo (N=6,457), compared to the other Maxingal stations 1(N=1,674) with (N=5,454) at Maxingal 3 station.

In Alcala (S-2) benthic abundance across stations indicated that Maraburab has the most abundant catch among stations accounting for (N= 199, followed by Carallangan with (N=79), N- individuals with *Corbicula* sp. as the most abundant species collected in the area.

Other stations, claimed to be collecting sites of abundant benthic species such as Tupang and Pinopoc are no longer producing abundant benthic species as indicated by their N=6 and O respectively. Findings show, across stations, the best collection site with diverse valuable species is Fabrica (Table 2). An ecosystem can become unproductive for benthos due to various factors, such as the degradation of water quality and the build-up of contaminants in the water column, sediments, and estuarine food chain (Cave *et al.*, 2005).

Observations in the study sites in relation to pollution pressures differed, which might have contributed presence of benthic species. Alcala site was observed to be more exposed with high organic loads transported from upstream, and the continuous widening of the shore brought about by erosion, as it is surrounded by agricultural farms, as compared to Lal-lo which is surrounded by farms too but has higher land locks of rocks benefiting shell formation for the benthos, besides preventing faster erosion which is not found in Alcala. As cited by (Tessena and Mohamed, 2016) the adverse

effects of human activities have resulted in the degradation of stream, and riverine ecosystems which alters the structure and function of stream biota, thus affecting species diversity.

Findings in the study, however, indicated the sustainability of *Corbicula* sp. amidst disturbed environmental conditions as reflected in its dominating presence in both sites. *Corbicula* sp. is noted for great economic importance being a year-round source of livelihood for the people of Lal-lo and Alcala. Asiatic clam *Corbicula* sp., is known to be an invasive species in other areas and may rapidly dominate aquatic environments around the world (Gomes *et al.*, 2015).

Conclusion

The study identified seven species of Mollusks belonging to two taxa across two study sites, with four species under the class Bivalvia (*Corbicula* sp., *Delillia* sp., *Batissa violacea*, and *Mytulis edulis*) and three under the class Gastropoda (*Stenomelania torulosa*, *Theodoxux* sp., and *Melanoides tuberculata*). *Corbicula* sp. dominated both sites. Of the seven species, three (*Corbicula* sp., *Delilia* sp., and *B. violacea*) were of high economic value, serving as key income sources, while the remaining species were not recognized as edible in the local community. The quality and quantity of benthic macro-invertebrates recorded were notably low compared to previous studies conducted at Cagayan River in Lallo, showing a reduction in species diversity. Additionally, the abundance of *Corbicula* species in Cagayan River at Alcala differed from previous findings. The disappearance of *Delilia* sp. and the unregulated harvesting of Corbiculidae and *B. violacea* have likely contributed to the low recruitment of these species. The study underscores the need for stricter policies on sewage discharge to ensure the release of safer effluents into the environment.

Recommendations

Based on the study's findings, several recommendations are proposed. Future research should be conducted across different seasons with an extended duration and more sampling sites, particularly in Alcala, Gattaran, and Camalaniugan, to provide a broader understanding of Mollusk diversity. Genetic barcoding should be employed to accurately identify *Corbicula* sp. and *Delillia* sp. Additionally, on-site larval monitoring and growth studies should be conducted for *Corbicula* sp. in both Alcala and Lal-lo, considering their adaptability to various environmental conditions. Regular water quality monitoring at the study sites is essential to assess the impact on Mollusk populations. Moreover, strict adherence to existing ordinances and policies regarding the protection of *B. violacea* is crucial to sustain its abundance and ensure its continued existence in Lal-lo.

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