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Aquatic Macrofauna Assessment Along Agno River in the Province of Pangasinan, Philippines

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***Abstract** - The study assessed the aquatic macrofauna diversity along Agno River in Pangasinan. It classified biodiversity in terms of macrofauna diversity, dominance, richness, and evenness. There were 32 macrofauna species found which included 23 fishes, five crustaceans, and four mollusks. In terms of the month of sampling, results revealed no significant differences in macrofauna diversity, dominance, richness, and evenness. The macrofauna species were assessed to be very low (H'=1.60). However, there were significant differences in macrofauna diversity, richness, dominance, and evenness among the five sampling stations. The dominant species found along Agno River was Oreochromis niloticus.*

***Keywords** – diversity, dominance, evenness, richness*

INTRODUCTION

Biodiversity is tremendously important in the lives of people all throughout the planet. It offers food, medicine, and a range of other resources that humans require to survive. Countless millions of people rely largely on these resources for their survival and livelihood. Overexploitation and the recent natural phenomenon known as climate change, on the other hand, appear to be the primary threats to the ecosystem's survival. According to Alcala (2016), biodiversity interventions can be done at various levels, such as gene, species, population, natural community, and the ecosystem, or a mixture of these levels.

The remaining biodiversity of the Philippines, as well as the ecosystems that support it, are in grave danger. Overexploitation, deforestation, land degradation, climate change, and pollution, are all contributing to the rapid depletion of these essential resources, making the country a biodiversity hotspot. The bulk of the world's forests have been devastated by extractive industries like logging and mining. In addition, as the world's population expands, rainforests are being converted to agriculture and plantations to help alleviate land scarcity. Coral reefs and mangroves are also harmed by cyanide and dynamite fishing, as well as rapid coastal development.

The Philippines has experienced significant environmental degradation in recent years, according to the Philippine Biodiversity Conservation Priorities. Environmental problems such as the introduction of invasive species, threats to economic growth, and worldwide population bloom have resulted in a loss of 93 percent of our natural forest cover during the 1900s, according to PBCP's research (Amante, 2016).

Biodiversity and economic services are vitally crucial to human well-being because the majority of the hundred million Filipinos rely largely on these natural resources for their livelihood. These biodiversity mechanisms serve as a foundation for development, which has a significant impact on ecological use. In the country, there are 421 important rivers, with about 50 of them classified naturally dead. The demand for these rich resources is enormous. More research and careful implementation of conservation plans for the region's flora and fauna are still needed (DENR-BMB, 2014).

The provincial government agenda basically focused on the protection, rehabilitation, and conservation of natural resources, as well as strengthening the agricultural and fishery sectors. This provided information on the diversity composition of faunal and floral species in the Agno River. The local fishermen likewise were enlightened on the status of the Agno River and assessed their involvement in the conservation of the river for community development.

According to De Jesus (2015), the Agno River provides several ecological services to local communities in the provinces of Benguet and Pangasinan. Among the provisioning services are clean water, aquatic resources for food and medicine and the non-consumptive use for power generation and transport navigation. Other support services such as regulatory and cultural include flood control, maintenance of water quality, and tourism. However, these services depend on the fluvial process or the movement of water and sediments in the river channels that are important in the distribution of nutrients, gases and small organisms. Altering the features of a river would have impacts on its functions.

Further, the study of De Jesus (2015) focused only on the physico-chemical characterization of Agno River within the San Roque Dam Watershed. Results showed that the San Roque Dam Watershed is still suitable for the water usage under DENR Class C standards. However, the study was conducted only within the San Roque Dam Watershed and there are no baseline data for the impact of the heavy metals for comparison. Similarly, there have been few research on the Agno River's health effects, and the river's biodiversity has yet to be assessed.

By assessing and monitoring the diversity of macrofauna species, this provided food and livelihood for the local people living near freshwater ecosystems. Through commercial commodities, recreation, and tourism, this also contributed to economic well-being. The diversity of fishes, for instance, can be reliable indicators of biological and ecological integrity due to their continuous exposure to water conditions. Freshwater fishes display biotic reactions such as changes in growth and distribution related to water pollution and chemical toxicity.

Biodiversity studies had some significant inputs in science education specifically in the increasing concern for environmental conservation and the management of our ecosystems. This likewise led to the globalization of the Philippine economy and maintained food security for the country's growing population. Science Education continued to have vital influence especially in the K to 12 transition of our educational system and its positive impact in the environment.

Biodiversity is under threat primarily as a result of excessive resource use and substantial habitat modification. Other emerging countries are unable to handle their resources in a sustainable manner. As a result, development plans must be implemented to manage our existing biodiversity and to generate more attractive alternatives. Development plans could be made to help us maintain our economic stability while also increasing our national capability to safeguard fauna diversity.

It is on these premises that the researchers conducted this study to assess and monitor the aquatic macrofauna existing in Agno River in the province of Pangasinan. The findings of the study were also collaborated to other government agencies such as local government units (LGUs), the Department of Environment and Natural Resources (DENR), and the Bureau of Fisheries and Aquatic Resources (BFAR).

OBJECTIVES OF THE STUDY

This study assessed the aquatic macrofauna diversity along Agno River in Pangasinan during the months of June, August-September, and November, 2018.

Specifically, the study had the following objectives:

1. To identify aquatic macrofauna species found along Agno River;
2. To compare aquatic macrofauna biodiversity along Agno River by months and sampling stations and determine if there are significant differences in terms of the following biodiversity indices:
   - 2.1 Macrofauna Diversity
   - 2.2 Macrofauna Richness
   - 2.3 Macrofauna Dominance
   - 2.4 Macrofauna Evenness

MATERIALS AND METHODS

The descriptive research design, specifically the sampling survey, was utilized in this study. During the months of June, August-September, and November of 2018, the research was undertaken in five sampling stations in Pangasinan. The sampling stations were determined using Google Earth 2016 and the Global Positioning System (GPS).

The morphological appraisal of the macrofauna species was based on taxonomic references, and the species were subsequently authenticated by approved agencies. Furthermore, the Paleontological Statistics (PAST) software was used to calculate the biodiversity indices.

The study employed the use of standard laboratory procedures to evaluate fauna species. The following procedures were utilized for the field investigation:

1. The actual locations of the stations were determined by means of the Global Positioning System (GPS). Then, coordinates were mapped using Google Earth 2016. There were three sampling sites per station.
2. For the macrofauna sampling, the steps were modified from the methods of De Vera, et al. (2015). Ten percent sampling of the designated stations using the belt transect quadrat method was employed. Within the 10m x 10m quadrat, three 1m x 1m quadrats equally distributed were established as faunal plots.
3. Counting of each macrofauna species in the transect site was done for identification of species diversity, richness, dominance and evenness. Species present in the area were counted and pictures were taken using digital camera.
4. After counting the faunal species in the transect area, data were recorded and later transcribed on data sheets for better organization.

Determination of Aquatic Macrofauna Diversity

a. The fauna species diversity was described using Shannon-Weiner Index of Diversity formula which is as follows:

$$H' = -\sum_{i=1}^{s} Pi \ln Pi$$

where: H' = diversity index

Pi = fraction of the whole population made up of species i

s = numbers of species counted

$\sum$ = sum counted from species 1 to species S

b. Fauna species richness is the number of species (s) as the simplest determination of species diversity in relation to total abundance (*N*).
Margalef's index (SR)

$$SR = (s - 1) / \ln (N)$$

c. To describe the dominance of fauna species, the Simpson index of dominance was utilized based on the following formula:

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

$$= \sum Pi^2$$

where: D = dominance index
n = number of organisms in a species
N = final number of organisms among all species

d. To get the coefficient of species evenness

$$J = \frac{H}{H_{max}}$$

where: J = species evenness
H = species diversity index
$H_{max} = \log_n S$

The data gathered were evaluated and analyzed using the following statistical tools. Kruskal-Wallis H test was used to determine the significant differences among the different sampling months and stations in terms of macrofauna species diversity, richness, dominance, and evenness. All P values lower than 0.05 were declared significant. The indices of biodiversity were computed using PAST® software (version 2.17) from Hammer, et al. (2001).

RESULTS AND DISCUSSION

Aquatic Macrofauna Species Found Along Agno River

A total of 32 aquatic macrofauna species were identified as shown in Table 1. There were 23 fishes, four crustaceans, and five mollusks. These species were *Ambassis gymnocephalus* (glass fish), *Arius manillensis* (kanduli), *Channa striata* (dalag), *Oreochromis niloticus* (Nile tilapia), *Sarotherdon melanotheron* (blackchin tilapia), *Clarias batrachus* (hito), *Trichopodus pectoralis* (snakeskin gourami), *Trichogaster* sp. (blue gourami) *Ambassis gymnocephalus* (glass fish), *Leiopotherapon plumbeus* (ayungin), *Channa striata* (dalag), *Oreochromis niloticus* (Nile tilapia), *Sarotherodon melanotheron* (blackchin tilapia), *Clarias batrachus* (hito), *Anodontostoma chacunda* (kabasi), *Sardinella* *fimbriata* (tamban), *Cyprinus carpio* (common carp), *Labeo rohita* (karpa), *Stolephorus indicus* (dilis), *Gerres filamentosus* (malakapas), *Glossogobius giuris* (biya), *Eubleekeria jonesi* (sapsap), *Gazza achlamys* (sapsap), *Lutjanus russellii* (bambangin), *Megalops cyprinoides* (bulan-bulan), *Moolgarda pedaraki* (bulasi), *Trichopodus pectoralis* (gourami), *Scatophagus argus* (pingaw), *Sillago sihama* (asohos), *Leiopotherapon plumbeus* (ayungin), *Zenarchopterus dispar* (siwi-siwi), *Macrobrachium rosenbergii* (ulang), *Penaeus vannamei* (sugpo), *Portunus pelagicus* (alimasag), *Scylla serrate* (alimango), *Corbicula fluminea* (tulya), *Geloina expansa* (halaan), *Vittina coromandeliana* (kosiling), *Brotia herculea* (susong pilipit), and *Tarebia granifera* (agurong).

Table 1. Aquatic Macrofauna Species in the Five Stations of Agno River in Pangasinan

Aquatic Fauna	Family	Scientific Name	Common Name
Fishes	Ambassidae	*Ambassis gymnocephalus* (Lacepede, 1802)	Glass fish
	Ariidae	*Arius manillensis* (Valenciennes, 1840)	Kanduli
	Channidae	*Channa striata* (Bloch, 1793)	Dalag
	Cichlidae	*Oreochromis niloticus* (Linnaeus, 1758)	Nile tilapia
	Cichlidae	*Sarotherodon melatheron* (Ruppell, 1852)	Blackchin tilapia
	Clariidae	*Clarias batrachus* (Linnaeus, 1758)	Hito
	Clupeidae	*Anodontostoma chacunda* (Hamilton, 1822)	Kabasi
	Clupeidae	*Sardinella fimbriata* (Valenciennes, 1847)	Tamban
	Cyprinidae	*Cyprinus carpio* (Linnaeus, 1858)	Comon carp
	Cyprinidae	*Labeo rohita* (Hamilton, 1822)	Karpa
	Engraulidae	*Stolephorus indicus* (van Hasselt, 1823)	Dilis
	Gerreidae	*Gerres filamentosus* (Cuvier, 1829)	Malakapas
	Gobiidae	*Glossogobius giuris* (Hamilton, 1822)	Biya
	Leiognathidae	*Eubleekeria jonesi* (James, 1971)	Sapsap
	Leiognathidae	*Gazza achlamys* (Jordan and Starks, 1917)	Sapsap
	Lutjanidae	*Lutjanus russellii* (Bleeker, 1849)	Bambangin
	Megalopidae	*Megalops cyprinoides* (Broussonet, 1782)	Bulan-bulan
	Mugilidae	*Moolgarda pedaraki* (Valenciennes, 1836)	Bulasi
	Osphronemidae	*Trichopodus pectoralis* (Regan, 1910)	Gourami
	Scatophagidae	*Scatophagus argus* (Linnaeus, 1766)	Pingaw
	Sillaginidae	*Sillago sihama* Forsskal, 1775)	Asohos
	Terapontidae	*Leiopotherapon plumbeus* (Kner, 1864)	Ayungin
	Zenarchopteridae	*Zenarchopterus dispar* (Valenciennes, 1847)	Siwi-siwi
Crustacean	Palaemonidae	*Macrobrachium rosenbergii* (De Man, 1879)	Ulang
	Penaeidae	*Penaeus vannamei* (Boone, 1931)	Sugpo
	Portunidae	*Portunus pelagicus* (Linnaeus, 1858)	Alimasag
	Portunidae	*Scylla serrata* (Forsskal, 1775)	Alimango
Mollusks	Cyrenidae	*Corbicula fluminea* (Muller, 1774)	Tulya
	Cyrenidae	*Geloina expansa* (Mousson, 1849)	Halaan
	Neritidae	*Vittina coromandeliana* (Sowerby, 1836)	Kosiling
	Pachychilidae	*Brotia herculean* (Gould, 1846)	Susong pilipit
	Thiaridae	*Tarebia granifera* Lamarck, 1816)	Agurong

Aquatic Macrofauna Biodiversity Along Agno River

Table 2 shows the Kruskall-Wallis H-Test in the faunal biodiversity by month. Species diversity is the number of different species that are represented in a given community. However, test showed no significant differences among the biodiversity indices for the faunal species studied. The diversity, richness, dominance, and evenness revealed comparable indices in the month of sampling. The variety of species belong to one riverine

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system. There are limited sampling gears and restricted time of sampling that somewhat limited the expression of their probable differences.

Table 2. Kruskall-Wallis H-Test for Significant Difference in the Faunal Biodiversity By Month

Faunal Biodiversity Indices	Chi-Square, df = 2	P-Value
Faunal Diversity	3.363	.186
Faunal Richness	1.414	.493
Faunal Dominance	3.434	.180
Faunal Evenness	.985	.611

*Significant at α = 0.05

Species richness is the most commonly used indicator of biodiversity where the more diverse an ecosystem the more resistant it is when environmental conditions change (Orourke, 2006) as cited by Dusaran and Pabulayan, 2010. The sampling sites are rich in species such as ‘tilapia’ (*Oreochromis niloticus*), ‘ulang’ ((*Macrobrachium rosenbergii*), and ‘bulasi’ (*Moolgarda pedaraka*). The ‘bulasi’ ‘ is a local delicacy in the province because of its palatable taste, and the ‘ulang’ on the other hand, is a commercially important species which can thrive entirely in freshwater.

In the case of the evenness of the species across months, results revealed very low classification level. Fishes are decreasing worldwide because of human-caused degradation of aquatic habitats (Moyle, et al. 2013).

It can be gleaned in Table 3 the Kruskall-Wallis H-test in the faunal biodiversity by sampling station. The biodiversity indices revealed significant findings. Overall, faunal diversity was computed to be very low with H’ = 1.60 based on the classification scheme presented by Fernando et al. (2000). The very low fauna diversity can be attributed to some physical and chemical factors such as the presence of total suspended solids and heavy metals. There are also observed anthropogenic acts like quarrying operations along river banks. Other factors could be the limited fishing gears utilized.

Table 3. Kruskall-Wallis H-Test for Significant Difference in the Faunal Biodiversity By Sampling Station

Faunal Biodiversity Indices	Chi-Square, df = 4	P-Value
Faunal Diversity	33.297*	.000
Faunal Richness	32.779*	.000
Faunal Dominance	33.196*	.000
Faunal Evenness	19.963*	.001

*Significant at α = 0.05

The highest diversity and richness was found in station 5 in Lingayen, Pangasinan. The collected species are already varied organisms of freshwater and marine species. On occurrences of high tides along the sites, some marine species are collected such as *Anodontostoma chacunda*, *Gerres filamentosus*, *Lutjanus russellii*, *Sardinella fimbriata*, *Scatophagus argus*, *Geloina expansa*, *Portunus pelagicus,* and *Scylla serrata*. De Jesus (2015) has cited that Agno River has lean diversity compared to other freshwater ecosystems in the country. Nevertheless, there is no available previous fauna diversity recorded for the Agno River systems which can be used to compare the present study.

Species dominance measures how certain number of species dominate a particular area. In this index, Kruskal Wallis H test for faunal dominance revealed a significant difference among the five stations (p-value=0.000).

Among the species, Nile tilapia (*Oreochromis niloticus*) dominates all the stations in the study. It appears to be most widely distributed among the sampling stations confirming other findings on the invasive nature of *O. niloticus.* The study of De Jesus (2016) also revealed the presence of fishes like tilapia (*Oreochromis niloticus*), common carp (*Cyprinus carpio*) and mudfish (*Channa striata*) in Agno River.

The Nile tilapia species (*O. niloticus*) are found to be the dominant species in lower Agno River. They are fast-growing and tolerant of a range of environmental conditions. These species adapt readily to changes in salinity levels and oxygen availability, can feed at different trophic levels, and under certain circumstances, can tolerate overcrowding. They occupy both freshwater and estuarine environments within their native ranges. The ecological impacts of invasive species vary significantly depending on the invading species, the extent of the invasion, and the vulnerability of the ecosystem being invaded.

The presence of introduced species is noteworthy because invasion of freshwater areas by non-native species is reported to threaten local fish populations through competition with and predation on native species, habitat alteration, and water quality deterioration among others (Linaugo, et al. 2010). *O. niloticus* was an introduced species in lower Agno River which is a voracious feeder and known to compete with native species for food and habitat.

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CONCLUSIONS

The following conclusions were formed based on the study's findings:

1. There were 32 identified aquatic macrofauna species found along Agno River belonging to different families and genera.
2. The Shannon index showed very low to low classification across sampling months in terms of macrofauna diversity, richness, dominance, and evenness. In terms of the month of sampling, the indices are not significantly different. However, the parameters of macrofauna biodiversity are significantly different across all sampling stations. The faunal species were assessed to be very low.

RECOMMENDATION

The following recommendations are made based on the study's findings:

1. A more extensive biodiversity evaluation of other areas of the Agno River, particularly in the upstream portion is suggested.
2. Surveys are required to establish the distribution of other species as well as the economic potential of these species.
3. There should be plans or programs in place to disseminate information on conservation and protection of the Agno River to local residents and inhabitants of the barangays traverse by the river.

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