Vol. 14 January 2023
Print ISSN 2094-5019 • Online ISSN 2244-0461
doi: http://dx.doi.org/10.7828/ajob.v14i1.1547

Asian Journal of Biodiversity
This Journal is in the Science
Master Journal List of Clarivate
Zoological Record

Assessment of the Diversity of Macrofauna of Govantes River in Vigan City, Ilocos Sur, Philippines

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ABSTRACT

Macrofauna play a key role in the functioning of riverine ecosystems. However, knowledge about the diversity and functional structure of freshwater macrofauna is limited. This study assessed the macrofauna of Govantes River in Vigan City, to identify the observed species using morphological evidences, and to investigate its abundance and composition, and species diversity. A total of 20 species of macrofauna were found and identified within the Fish Aggregating Device (FAD) in the different stations. These species belong to Ichthyo Fauna (13 species), Crustacea (6 species), and Gastropods (1 species). All the diversity indices H', J' and exp (H') and Ho corresponding to diversity, evenness and richness respectively, are all statistically the same. This result implies that all the sampling stations have the same diversity, evenness and richness, based on the observed number of individuals of the species found. The dominant species found was *Karalla daura* in Station 1.

Keywords: abundance, evenness, dominance, ichthyo fauna, crustacea, gastropods

INTRODUCTION

Biodiversity plays a crucial role in people's lives all across the world. It provides a variety of other necessities for human survival, like food and medicines. Millions of people rely heavily on these resources to survive and support themselves. Biodiversity interventions could be done at various levels, such as genes, species, populations, natural communities, ecosystems, or a mixture of these levels (Dantis et al., 2021).

The country is a globally significant hotspot for biological diversity and a center for endemism (Paller et al., 2010). However, many of the studies are centered on terrestrial and marine biodiversity. Little is known about the diversity and status of endemic freshwater invertebrates and fishes, equally valuable as bioindicators of ecosystem health and an integral part of the country's natural heritage (Tauli, 2022).

However, the freshwater ecosystem is currently under stress because of the country's rapidly expanding human population, settlements, urbanization, pollution, and habitat destruction. According to observations, the nation's inland and coastal fisheries are dealing with significant issues, including the careless usage of the so-called riverine culture. Many years ago, the numerous types of fish in the rivers could be seen moving gracefully and transparently. Due to siltation, erosion, and quarrying, the formerly clear and transparent water has become a green and murky structure (Hakeem et. al., 2020).

Govantes River of Vigan City is not an exemption. The City of Vigan, the capital of Ilocos Sur, is situated along the western coast of Northern Luzon, about 408 kilometers north of Manila and 80 kilometers south of Laoag City. It is bounded on the North by the Municipality of Bantay, on the east by Abra River (also known as Banaoang River), on the south by the Municipality of Caoayan, on the west by the South China Sea, and the northwest by the Municipality of Sta. Catalina.(Concepcion, 2010).

Govantes River still converges at the western ends of South China Sea, but it already has blocked estuaries outside the rainy season. It has played a significant role in the economic and cultural life of the Biguenos over the centuries. Ancient trade and other social exchanges between the lowland and upland peoples, and also between the native and foreign (mostly Southeast Asian) peoples, were facilitated because of these once-navigable river systems and the sea. Albeit sparingly, Vigan's 2.5-kilometer castline and various rivers continue to sustain a sizeable number of the new city's population and support agricultural activities (Concepcion, 2010).

Macrofaunal organisms play several critical functional roles in aquatic ecosystems. Macrofauna is essential for secondary production (i.e., converting plant material to meat) both as direct food sources for human populations (e.g., clams) and as a significant food source. Biological monitoring of rivers using macrofauna is accepted as a valuable tool for assessing water quality (Fishar et al., 2005).

Biomonitoring based on macrofauna have been widely used as an integral part of water quality monitoring in many countries. As macrofauna are constantly exposed to their ambient environment, they provide more accurate conditions of their habitat. Their composition, abundance and distribution can be influenced by water quality (Flora, 2021).

Thus, evaluating and understanding biodiversity is both important and challenging. It enables one to summarize what is known and what needs to be known about the biodiversity of macrofauna found in rivers Abundance, community composition, diversity and distribution of macrofauna are important which are frequently used as bioindicator to evaluate the status of aquatic ecosystem.

This study is important and meaningful because basic information on the macrofauna in the river would help local fishermen and consumers know where to tap particular resources. Data gathered from this study will also serve as reference materials for further studies. Furthermore, the presence and access to such baseline data would provide resource managers and decision resources for protection when the resource is in danger of depletion or extinction.

It is, therefore, the primary purpose of this study to make an assessment of macrofauna in the Govantes River.

OBJECTIVES OF THE STUDY

This study aimed to identify the macrofaunal species along designated collecting stations based on morphological evidences, and assess the macrofaunal species in terms of species abundance and composition, and species diversity among stations.

MATERIALS AND METHODS

A preliminary survey was conducted regarding the entire length and geographical area of Govantes River (17 34'22.8" N, 120 22' 7.32" E). The Govantes River, located in Ilocos Sur, has a length of 6.2 km. Three stations were set along the Govantes River for the duration of the study based on observed ecological variables. The following were the study sites: Station I in Pantay Laud (17o 34 ' 17" N, 120o 22' 0" E), Station II in Pantay Daya (17o 34' 22" N, 120o 22' 3" E), and Station III is in Barangay IV (17o 34' 56" N, 120o 23' 11" E). Three replicates of fish aggregating devices (FAD) were established at each sampling station. Sampling was done one month and two months after the FADs had been established.

All the gathered species were identified with the guide of references. Moreover, identification was also made through morphological evidences using the Fishbase, as noted in other systematic reviews and taxonomic references (Larson, 2005; Chen & Tan, 2005; Colllete, 1999, as cited by Paller et al., 2011). Taxonomic nomenclature mainly follows the current system status presented in the FishBase as cited by Froese & Pauly, 2014.

The following diversity indices were used to describe Faunal Diversity: Species Richness, Shannon's diversity index, Simpson's index of diversity, and index of dominance. The computer software program for Biodiversity Pro was used in the calculations of the Shannon index, Simpson index, and index of dominance.

RESULTS AND DISCUSSIONS

Taxonomic Accounts

The macrofauna identified in this study are shown in table 1. Twenty species from 20 genera belonging to 17 families were collected from the three stations of the Govantes River in Vigan City; 13 are Ichthyofauna, 6 are crustaceans, and 1 is gastropod. Taxonomic nomenclature mainly follows the current system status presented in FishBase (Froese & Pauly, 2014).

Table 1

List of Macrofauna Collected from the Three Stations of Govantes River

Family	Scientific Name	Common Name
Leiognathidae	*Leiognathus equulus*	Sapsap
	Karalla daura	Bagsang
Osphronemidae	*Trichopodus trichopterus*	Lupog
	Osphronemus goramy	Bidangan
Cichlidae	*Oreochromis niloticus*	Tilapia
Gecarcinidae	*Cardisoma guanhumi*	Dakumo
Penaeidae	*Penaeus sp.*	Padaw
	Metapenaeus ensis	Pasayan/Hipon
Eleotridae	*Eleotris melanosoma*	Virot
Engraulidae	*Lycothrissa crocodillus*	Purong/Banak
Terapontidae	*Terapon jarbua*	Baraongan
Grapsidae	*Varuna litterata*	Kappi/Talangka
Palaemonidae	*Macrobrachium lamarrei*	Lagdaw
Haemulidae	*Plectorhinchus diagrammus*	Sidingan
Channidae	*Channa striata*	Dalag
Ampullariidae	*Pomacea canaliculata*	Golden kuhol
Megalopidae	*Megalops cyprinoides*	Bulan-bulan
Clariidae	*Clarias batrachus*	Paltat
Siganidae	*Siganus fuscescens*	Malaga
Portunidae	*Scylla serrata*	Arimbukeng

The identified freshwater macrofaunal species collected from the three sampling stations along the Govantes River are shown in figure 1, and their morphological descriptions.

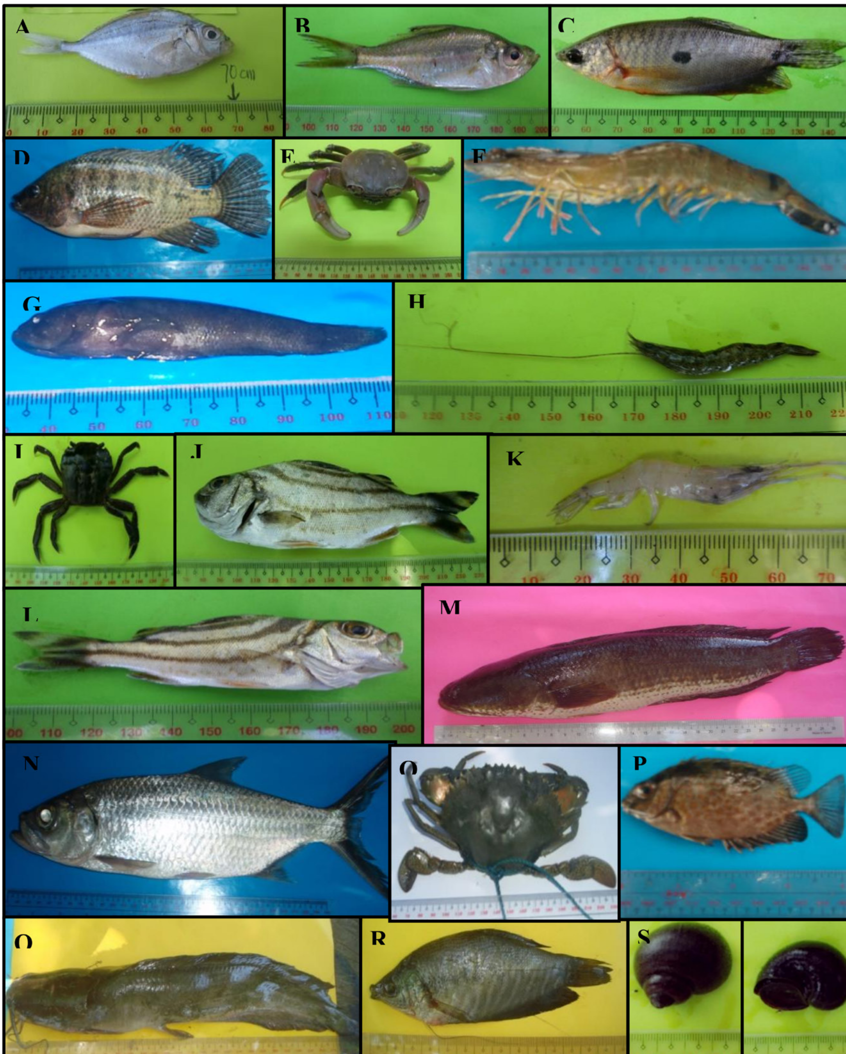

Figure 1. Macrofauna identified in this study. A. *Leiognathus equulus;* B. *Karalla daura;* C. *Trichopodus trichopterus;* D. *Oreochromis niloticus;* E. *Cardisoma guanhumi;* F. *Penaeus sp.;* G. *Eleotris melanosoma;* H. *Varuna litterata;* I. *Terapon jarbua;* J. *Metapenaeus ensis;* K. *Macrobrachium lamarrei;* L. *Plectorhinchus diagrammus;* M. *Channa striata;* N. *Megalops cyprinoides;* O. *Scylla serrata;* P. *Siganus fuscescens;* Q. *Clarias batrachus;* R. *Osphronemus goramy;* S. *Pomacea canaliculata..*

Leiognathus equulus (Fig. 1.A). There are eight dorsal spines in all. Dorsal soft rays have three anal spines and can have a range of 15 to 16. Its soft anal rays range in wavelength from 14 to 15. It has a long, rounded nose, huge eyes, and a deep body. The body is silvery in color, and the caudal peduncle has a tiny brown saddle on it. The dorsal fin is transparent, whereas the anal fins are yellow. The back is sharply arched, the body is compressed and deep, and the breasts are scaleless. Unclothed head with nuchal spine (Kuhlmorgen- Hille,, 1974 as cited by Froese & Pauly, 2014 in Fishbase).

Karalla daura (Fig. 1. B). Maximum length of male/unsex 14.0 cm; average length of male/unisex 9.0 cm. Anal spines: 3, anal soft rays: 14–15, dorsal spines: 8, dorsal soft rays: 16. Body is silvery; dorsally it is greenish grey with faint vermiculations; the lateral line stripe is broad yellow; the second to sixth spines of the dorsal fin have a spot blotch. bare head with a nuchal spine. Body elliptical and compressed; maximum depth 2.0–2.5 in SL. Black pectoral axil, scalless breasts, and a long, downward-facing mouth (Kuhlmorgen – Hille, G., 1974 as cited by Froese & Pauly , 2014 in Fishbase).

Trichopodus trichopterus daura (Fig. 1. C). Male/unsexed, maximum length 15.0 cm; male/unsexed, average length 10.0 cm. Total dorsal spines: 6–8, total dorsal soft rays: 7–10, total anal spines: 9–12, total anal soft rays: 30–38. Color in life is brown; shoulders have sporadic black lines; opercles and thorax are yellowish; median fins and pectorals are brown; ventrals are yellow. Very narrow and obliquely shaped mouth, vertical and moderately protractile top jaw, and prominent lower jaw. The mouth is at a superior posture. Moderately sized, haphazardly placed scales. uneven, curving lateral line. Caudal fin that is somewhat shorter or emarginated (Herre, 1924 as cited by Froese & Pauly , 2014 in Fishbase).

Oreochromis niloticus daura (Fig. 1. D). The body's maximum size is 50.8 cm, and it is deep and compressed. Vertebrae: 30-32; Anal spines: 3; Anal soft rays: 9-11; Dorsal spines (total): 15–18; Dorsal soft rays (total): 11–13. The mouth is in an oblique position. Breeding males' genital papillae are not tasellated, and their lower jaws are only slightly expanded (between 29 and 37 percent of their head length). The appearance of uniform vertical stripes across the depth of the caudal fin is its most distinctive feature (Fishbase by Froese & Pauly, 2014).

Cardisoma guanhumi (Fig. 1. E). The carapace of *C. guanhumi* can grow up to a height of about 11 cm (4.3 in) and a length of up to 35 cm (14 in). Like many crabs, males have dimorphic claws; the longer claw can reach a maximum length of 15 cm (5.9 in) in males and eventually outgrows the carapace. The color ranges from a dark blue to a light grey, and the eyes are stalked. Typically, juveniles have legs that are orange in hue and a brown carapace. Females typically appear white or light gray. The presence of adult colors ranges from 80 g (2.8 oz) to 180 g (6.3 oz). It can weigh more than 500 g (Silva et al., 2014).

Penaeus sp. (Fig. 1. F). Males are slightly smaller than females, measuring 20-25 cm (8-10 in) long and weighing 100-170 g (3.5-6.0 oz). Females can grow to be over 33 cm (13 in) long, but are usually 25-30 cm (10-12 in) long and 200-320 grams (7-11 oz). The body structure of these species is that of a prawn, with a head, tail, five pairs of walking legs (pleopods) and five pairs of walking legs (pereopods), as well as multiple head appendages. The cephalothorax is enclosed by a carapace, or hard exoskeleton. The telson towards the rear of the prawn is unarmed and lacks spines, while the first three pairs of its pereopods contain claws (Khafage et al., 2019).

Eleotris melanosoma (Fig. 1. G). Fins are speckled in young animals and black in larger ones. Body is dark brown to black with longitudinal lines. Male/unsexed maximum length is 26.0 cm. Anal spines: 1, Anal soft rays: 8, total dorsal spines: 7, total dorsal soft rays: 8. D VI + I, 8. Scales 46–56 in the lateral series. Large mouth that extends below the back portion of the eye and a drooping head. Dark brown to black, with occasional body lines of this color (Hoese, 1986 as cited by Froese & Pauly, 2014 in Fishbase).

Varuna litterata (Fig. 1. H). The dorsal surface of the carapace is somewhat depressed, and the typical groove between the gastric and cardiac areas is clearly defined. The carapace is quadrangular in shape. The external orbital tooth is one of three anterior-lateral teeth that are all rounded and not overly acuminate, and the lateral margins are freely convergent backwards (Hoese, 1986 as cited by Froese & Pauly, 2014 in Fishbase).

Terapon jarbua (Fig. 1. I). The body is fusiform in shape. The longest possible length is 36.0 cm TL male/unisex. There are 11–12 dorsal spines, 9–11 dorsal soft rays, and 7–10 anal soft rays in total. The opercula flap is much beyond the lower opercula spine. The posteriorly exposed and serrated post-temporal bone. Fawn above, cream below, and dark at the nape; head, body, and fins have an iridescent sheen. (Myers, 1991 as cited by Froese & Pauly , 2014 in Fishbase).

Metapenaeus ensis (Fig. 1.J). Maximum length: 18.9 cm BL (female); 15.4 cm BL for males and unsexed. Maximum carapace lengths are 3.5 cm for men and 4.2 cm for women. Body length ranges from 7.0 to 14.0 cm. Hepatic, orbital, and antennal spines on the carapace. Longer than the hepatic groove, the branchio-cardiac groove. The first peripod has tiny spines. First to six abdominal somites have a dorsal carina (Muhammadar et al., 2019).

Macrobrachium lamarrei (Fig. 1. K). A medium-sized freshwater prawn is called *Macrobrachium lamarrei.*. From the tip of the rostrum to the tip of the telson, males can grow to a maximum length of 80 mm, whereas females can grow to a maximum length of 75 mm. The cephalothorax is typically covered with greenish brown pigmentation, while the body is typically creamy white to light brownish white. Cephalothorax and abdomen are the two distinctly separate regions of the body. The cephalothorax, which is smooth and rigid, is covered by the carapace. This species' rostrum extends far beyond the antennal scale. (Ismael and New, 2000 as cited by Sharma and Subba, 2005).

Plectorhinchus diagrammus (Fig. 1. L). Male/unsexed maximum length: 40.0 cm. Anal spines: 3, Anal soft rays: 7–8, total dorsal spines: 12–13, total dorsal soft rays: 19–20. Scales in the lateral lines are between 53 and 56. The mouth is in a terminal position. (Randall,et al., 1990 as cited by Froese & Pauly , 2014 in Fishbase).

Channa striata (Fig. 1. M). Male/unsexed specimen grows to a maximum length of 100.0 cm, and its average length is 61.0 cm TL. Anal spines: 0; anal soft rays: 23–27; total dorsal spines: 0; total dorsal soft rays: 38–43. Subcylindrical body, depressed head, and rounded caudal fin. With a huge head that resembles a snake's head, the dorsal surface and sides are dark and mottled with a mixture of black and ochre, while the belly is white. It has enormous scales. (Allen, 1991 as cited by Froese & Pauly, 2014 in Fishbase).

Megalops cyprinoides (Fig. 1. N). Male/unsexed specimens can grow to a maximum length of 150 cm, whereas females typically grow to a maximum length of 45.5 cm. Tarpons can reach a length of 5-8 feet and weigh 80-280 pounds. They have bluish or greenish backs with delicate dorsal and anal rays. The majority of a tarpon's body, excluding the head, is covered in shiny, silvery scales that have prominent lateral lines. They have big mouths with robust lower jaws that stick out farther than the rest of their faces, large eyes with adipose eyelids, and no anal spines or soft rays. Dorsal spines (total): 0; Dorsal soft rays (total): 13-16. Midway down the body is a dorsal fin with a short base (Myers, 1991 as cited by Froese &Pauly, 2014 in Fishbase).

Scylla serrata (Fig. 1. O). The hue of the shell can range from a dark, mottled green to a very dark brown. The claws' contribution causes the weight of males to rise with each stage of ontogenesis. However, the gross anatomy of male and female animals is largely the similar up to a CW of about 10 cm. Males of 15 cm and 20 cm CW and above weigh 55 and 80 percent, respectively, more than females of the same CWs, making gender differences in weight most noticeable in giant crabs. The carapace bears four blunt frontal teeth and nine broad teeth of a comparable size on each anterolateral border. The chilipeds (claws) are substantial, have numerous well-developed spines, and range in color from gray to purple brown (Fazhan et al.,2017).

Siganus fuscescens (Fig. 1. P). Male/unsexed maximum length is 40.0 cm; male/unisex average length is 25.0 cm. There are 13 vertebrae in all, 10 soft rays on the dorsal side, 7 on the anal side, and 10 soft rays on the dorsal side. Body silvery below, olive green or brown above; fish frequently have a dark patch below the lateral line's origin. When adults are scared, they develop mottling. slender, pungent, and poisonous spines (Woodland, 1990 as cited by Froese & Pauly, 2014 in Fishbase).

Clarias batrachus (Fig. 1. Q). The average specimen measured 47.0 cm TL male/unsexed; the average length was 26.3 cm TL male/unsexed; the maximum weight reported was 1.2 kg. Anal spines: 0; anal soft rays: 47–58; total dorsal spines: 0; total dorsal ray soft rays: 60–76. posteriorly compressed body. The upper jaw is slightly protruding. Pectoral fins' spine, which is serrated on its inner edge and has a rough outer edge (Allen, 1991 as cited by Froese & Pauly, 2014 in Fishbase).

Osphronemus goramy (Fig. 1. R). With 8-10 complete dark vertical bars in juvenile color phase; adults without vertical bars or sexual dichromatism, both sexes drab; transverse scale rows usually 6.11.12; dorsal fin spines usually 12-13 (rarely 11 or 14); soft-rayed portion of anal fin greatly enlarged, its distal margin parallel to distal margin of caudal fin; caudal fin rounded or obtusely rounded, not truncate or emarginated. The first soft ray of the pelvic fins extends into a tentacle that extends behind the caudal fin or beyond it. (Roberts, 1992 as cited by Froese & Pauly 2014 in Fishbase).

Pomacea canaliculata (Fig. 1. S). Normal coloration. The flesh is often creamy white to golden pinkish or orange, with bands of brown, black, and yellowish-tan color. Albino and gold color variations also exist. The length of the shell can reach 15 cm. Size is influenced by the accessibility of food. The most destructive stage occurs when the shell's length is between 10 mm and 40 mm. Male golden apple snails have convex opercula, whereas females have concave opercula (Yang et al., 2018).

Distribution of the Macrofaunal Species

Table 2 and Table 3 show the distribution of the identified macrofaunal species and their relative abundance.

Table 2

Individual-based (Abundance) Distribution of Organisms in the Different Stations

Common Name	Species Scientific Name	Station I R1	R2	R3	Total	Station II R1	R2	R3	Total	Station III R1	R2	R3	Total	Grand Total
Tilapia	*Oreochromis niloticus*	5	2	19	26	5	46	71	122	20	25	43	88	236
Sidingan	*Plectorhinchus diagrammus*	1		1	2	93	7		100					102
Birut	*Eleotris melanosoma*	7	233	2	242	1	1		2					244
Bagsang	*Karalla daura*	9	49	223	281									281
Baraongan	*Terapon jarbua*	2	14	4	20									20
Sapsap	*Leiognathus equulus*	2			2									2
Dakumo	*Cardisoma guanhumi*	1			1									1
Padaw	*Penaeus sp.*	1			1									1
Purong	*Lycothrissa crocodillus*		8		8									8
Kappi	*Varuna litterata*		12		12									12
Pasayan	*Metapenaeus ensis*	2	3		5									5
Lagdaw	*Macrobrachium lamarrei*		16		16		56	40	96					112
Malaga	*Siganus fuscescens*	2			2									2
Arimbukeng	*Scylla serrata*		2		2									2
Dalag	*Channa striata*		1		1	2	3	1	6	1	4	5	10	17
Bisukol	*Pomacea canaliculata*						13	40	53	206	241	345	792	845
Gurami (Bidangan)	*Osphronemus goramy*					25	3	100	128	22	18	18	58	186
Bulan-Bulan	*Megalops cyprinoides*							2	2	4	2		6	8
Guramin (Lupog)	*Trichopodus trichopterus*					254	367	6	627	40	41	63	144	771
Paltat	*Clarias batrachus*									4	3	1	8	8
Total Individuals		32	340	249	621	380	496	260	1136	297	334	475	1106	2863
Observed Number of Species		10	10	5	15	6	8	7	9	7	7	6	7	20

Table 3

Relative Abundance of Organisms in the Different Stations, in Percent

Common Name	Species Scientific Name	Station I R1	R2	R3	Total	Station II R1	R2	R3	Total	Station III R1	R2	R3	Total	Grand Total
Tilapia	*Oreochromis niloticus*	15.63	0.59	7.63	4.19	1.32	9.27	27.31	10.74	6.73	7.49	9.05	7.96	8.24
Sidingan	*Plectorhinchus diagrammus*	3.13	0.00	0.40	0.32	24.47	1.41	0.00	8.80	0.00	0.00	0.00	0.00	3.56
Birut	*Eleotris melanosoma*	21.88	68.53	0.80	38.97	0.26	0.20	0.00	0.18	0.00	0.00	0.00	0.00	8.52
Bagsang	*Karalla daura*	28.13	14.41	89.56	45.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.81
Baraongan	*Terapon jarbua*	6.25	4.12	1.61	3.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70
Sapsap	*Leiognathus equulus*	6.25	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Dakumo	*Cardisoma guanhumi*	3.13	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Padaw	*Penaeus sp.*	3.13	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Purong	*Lycothrissa crocodillus*	0.00	2.35	0.00	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28
Kappi	*Varuna litterata*	0.00	3.53	0.00	1.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42
Pasayan	*Metapenaeus ensis*	6.25	0.88	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
Lagdaw	*Macrobrachium lamarrei*	0.00	4.71	0.00	2.58	0.00	11.29	15.38	8.45	0.00	0.00	0.00	0.00	3.91
Malaga	*Siganus fuscescens*	6.25	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Arimbukeng	*Scylla serrata*	0.00	0.59	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Dalag	*Channa striata*	0.00	0.29	0.00	0.16	0.53	0.60	0.38	0.53	0.34	1.20	1.05	0.90	0.59
Bisukol	*Pomacea canaliculata*	0.00	0.00	0.00	0.00	0.00	2.62	15.38	4.67	69.36	72.16	72.63	71.61	29.51
Gurami (Bidangan)	*Osphronemus goramy*	0.00	0.00	0.00	0.00	6.58	0.60	38.46	11.27	7.41	5.39	3.79	5.24	6.50
Bulan-Bulan	*Megalops cyprinoides*	0.00	0.00	0.00	0.00	0.00	0.00	0.77	0.18	1.35	0.60	0.00	0.54	0.28
Guramin (Lupog)	*Trichopodus trichopterus*	0.00	0.00	0.00	0.00	66.84	73.99	2.31	55.19	13.47	12.28	13.26	13.02	26.93
Paltat	*Clarias batrachus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.35	0.90	0.21	0.72	0.28

As shown in the tables, the three most abundant in the different sampling stations are as follows: Station I; *Karalla daura* (45.25%), *Eleotris melanosoma* (38.97%), *Oreochromis niloticus* (4.19%); Station II; *Trichopodus trichopterus* (55.19%), *Osphronemus goramy* (11.27%), *Oreochromis niloticus* (10.74%); Station III; *Pomacea* *canaliculata* (71.61%), *Trichopodus trichopterus* (13.02%), *Oreochromis niloticus* (7.96%). Taken as a whole, the most abundant is *Pomacea canaliculata* (29.51%), followed by *Trichopodus trichopterus* (26.93%), *Karalla daura* (9.81%), *Eleotris melanosoma* (8.52%) and *Oreochromis niloticus* (8.24%). On the other hand, only one individual was observed each for *Cardisoma guanhumi* and *Penaeus sp*.

In terms of their presence/absence in the sampling areas, the most widespread species is *Oreochromis niloticus*, which was found in all the nine sampling areas, followed by *Channa striata*, which was found in seven areas; *Trichopodus trichopterus* and *Osphronemus goramy*, found in six areas; *Eleotris melanosoma*, found in 5 areas; *Plectorhinchus diagrammus*, found in 4 areas; *Karalla daura*, *Terapon jarbua*, *Macrobrachium lamarrei*, *Megalops cyprinoides*, and *Clarias batrachus*, all were found in three areas, *Metapenaeus ensis* found in two areas; and found in only one area were *Leiognathus equulus*, *Cardisoma guanhumi*, *Penaeus sp.*, *Lycothrissa crocodillus*, *Varuna litterata*, *Siganus fuscescens*, and *Scylla serrata*.

Diversity Analyses of Data

This section presents and interprets the diversity indices computed from the abundance-based data.

Table 4

Summary of Diversity Indices

	Index	Station 1			Station 2			Station 3		
		R1	R2	R3	R1	R2	R3	R1	R2	R3
Shannon	H'	1.997	1.139	0.422	0.893	0.92	1.444	1.033	0.97	0.903
	Mean H'	1.186±0.283[a]			1.086±0.283[a]			0.969±0.283[a]		
	Hmax	2.303	2.303	1.609	1.792	2.079	1.946	1.946	1.946	1.792
	J'	0.867	0.495	0.262	0.498	0.442	0.742	0.531	0.499	0.504
	Mean, J'	0.541±0.115[a]			0.561±0.115[a]			0.511±0.115[a]		
	exp(H')	7.367	3.124	1.525	2.442	2.509	4.238	2.809	2.638	2.467
	Mean exp(H')	4.005±1.064[a]			3.063±1.064[a]			2.638±1.064[a]		
Simpson	(D)	0.143	0.495	0.807	0.51	0.569	0.268	0.508	0.543	0.554
	(1/D)	6.986	2.021	1.238	1.961	1.758	3.737	1.969	1.841	1.805
	(1-D)	0.857	0.505	0.193	0.49	0.431	0.732	0.492	0.457	0.446
Hill	H^0	10	10	5	6	8	7	7	7	6
	Mean H^0	8.33±1.036[a]			7.000±1.036[a]			6.667±1.036[a]		
	H^1	25.74	7.46	2.653	5.232	5.437	11.581	6.407	5.85	5.305
	H^2	0.006	0	0	0	0	0	0	0	0

Means followed by the same letter are not significantly different (***p*>*0.05***).

The diversity indices summarized in Table 4 were computed using the software Biodiversity Pro. Shannon H' quantifies the uncertainty in the species identity of a randomly chosen individual in the assemblage (Gotelli & Chao, 2013). Since H' corresponds to uncertainty, it means that the higher the value of H,' the lesser the probability of correctly guessing the species of a random organism from the area, which also means the more diverse the area is. The table shows that R1 (H'=1.997) of Station 1 is the most diverse among the sampling areas. Interestingly, the least diverse area, R3 (H'=0.422), is also within the same station.

Shannon H' incorporates richness and evenness, making it difficult to compare areas with different richness and evenness. Evenness refers to the equality of distribution of the individuals of the sampling areas to the different species. To specify the evenness of an assemblage, Shannon J' (which is H'/Hmax and approximately equivalent to Simpson (1-D) is used in many diverse kinds of literature. On the other hand, Simpson D corresponds to dominance, and this number ranges from zero and one, where D approaches one in a sample consisting of one species. Table 4 shows that it is in R1 (J'=0.867, (1-D)=0.857) of Station 1, where species almost equally distribute the individual organisms. On the other hand, a species dominates (Karalla daura) on R3 (J'=0.262, (1-D)=0.193) of the same station.

The richness of an assemblage is usually quantified in terms of the number of species found. The exponential form of H' is the adequate number of species (ENS), approximately equivalent to the Hill number Ho. Specifically, the Hill number Ho refers to the number of species in the area. On the other hand, H1 can be interpreted as the number of "typical species" and H2 as the number of "very abundant species" in the assemblage (Gotelli & Chao, 2013). Again, it can be seen from Table R1 and R3 of Station I are the richest and least rich assemblages, respectively, in terms of the number of species found when the replications were considered individually.

The results of GLM Multivariate Analysis show that the significance values are all greater than 0.05. These mean that all the diversity indices, H', J' and exp (H') and Ho corresponding to diversity, evenness, and richness, respectively, are all statistically the same. This result implies that all the sampling stations have the same diversity, evenness, and richness based on the observed number of individuals of the species found.

CONCLUSIONS

The diversity of the Govantes River, corresponding to 13 observed Itchthyo Fauna, six crustaceans, and one gastropod, is typical of Philippine riverine ecosystems. The slight changes in the diversity index, increasing from upstream to downstream, are not statistically significant. The evenness is also the same for all the sampling stations. Station III is virtually the richest sampling station.

RECOMMENDATIONS

Systematics of macrofauna should be further done through various approaches such as DNA analyses and physiological, among others, to ascertain the various properties which may provide other information on the economic significance of individual taxon. On the management aspect, it is also recommended that since this study shows that the Govantes River is still viable for supporting a rich diversity of riverine macrofauna, the city government of Vigan should initiate restoration efforts to make the river more productive.

LITERATURE CITED

Concepcion, G. (2010). Sibibiag a karayan.

Dantis, M. and Lacap, M. (2021). Aquatic macrofauna assessment along Agno River in the province of Pangasinan, *Philippines. Southeast Asian Journal of Science and Technology, 6*(1), 88-97.

Fazhan, H., Waiho, K. and Ikhwanuddin, M. (2017). Non-indigenous giant mud crab, Scylla serrate (Forskal, 1775) (Crustacea: Brachyura: Portunidae) in Malaysian coastal waters: a call for caution. *Egyptian Journal of Biological Pest Control*, 29 September 2017.

Fishar, M.R. and Williams, W.P. (2005). A feasibility study to monitor the macroinvertebrate diversity of the River Nile using three sampling methods. *Hydrobiologia* (2006) 556: 137-147. Springer 2006.

Flora, S. (2021). Macrofauna as Bioindicators for Monitoring Pollution Status in Gulshan lake of Dhaka City Bangladesh. Department of Zoology, 2021.

Froese, D. and Pauly, R. (2007). FishBase. Retrieved on July 15, 2014, from http://www.fishbase.org.

Gotelli, N. and Chao, A. (2013). Measuring and Estimating Species Richness, Species Diversity, and Biotic Similarity from Sampling Data. In: Levin S.A. (ed.) *Encyclopedia of Biodiversity, second edition,5*, pp. 195- 211. Waltham, MA: Academic Press.

Hakeem, K., Bhat, R., Qadri, H. (2020). Concerns and threats of contamination on aquatic ecosystems. National Library of Medicine. National Center for Biotechnology Information. doi: 10.1007/978-3-030-35691-0_1

Khafage, A., Taha, S. and Attallah, M. (2019). Presence of tiger shrimp Penaeus monodon Fabricius, 1798 (Penaeidae) in the Egyptian commercial shrimp catch, Alexandria, Egypt. *The Egyptian Journal of Aquatic Research, 45*, Issue 2, pages 183-187, June 2019.

Muhammadar, A., Sarong, M., Ulfa, M., Putra, D. and Zulfahmi, Z. (2019). Length-weight relationship of Metapenaeus ensis in Aceh Utara waters, Ihokseumawe City, Indonesia.IOP Conf. Ser.: Earth Environ. Sci 348 012089

Paller, V., Labatos, B., Matalog, O. and Ocampo, P. (2010). Freshwater fish fauna in watersheds of Mt. Makiling forest reserve, Laguna, Philippines. *Philippine Journal of Science 140* (2): 195-206, December 2011.

Sharma, A. and Subba, B.R. (2005). General biology of freshwater prawn Macrobrachium lamarrei of Biratnagar, Nepal. Our Nature (2005) 3:31-41. Retrieved on August 11, 2013, from http//:www.nepjol.info/index.php/ON/ article;viewfile/332/324.

Silva, C.C., Schwamborn, R. and Lins Oliveira, J. E. (2014). Population biology and color patterns of the blue land crab, cardisoma guanhumi (Latreille 1828) (Crustacea: Gecarcinidae) in the Northeastern Brazil. *Brazilian Journal of Biology 74* (4), Novemeber 2014.

Tauli, M. P., Garcia, M. P., Podeque, J. R., Signey, L. L., Sarmiento, K., Santos, M. D. (2022). Fish Species Composition and Distribution from 2015 to 2019 in the Ibulao River, Ifugao, Cordillera, Philippines. *The Philippine Journal of Fisheries*. DOI: 10.31398/tpjf/29.1.2020C0016

Yang, Q., Liu,S, He, C. and Yu, X. (2018). Distribution and the origin of invasive apple snails, Pomacea canaliculata and P. maculate (Gastropoda: Ampollariidae) in China. *Journal Scientific Reports, Science Edition*, 19 January 2018.

ACKNOWLEDGMENTS

The author would like to thank the University of Northern Philippines administration headed by its President, Dr. Erwin F. Cadorna for its support and encouragement in the conduct of this research, and the Director of University Research and Development Office for her constant assistance and guidance to faculty researchers. I also thank reviewers for their constructive comments.