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RESEARCH ARTICLE

MACROINVERTEBRATES AS BIOLOGICAL INDICATORS OF WATER QUALITY IN KITABOG RIVER, TITAY, ZAMBOANGA SIBUGAY,WESTERN MINDANAO, PHILIPPINES

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ABSTRACT

The water quality of Kitabog River at Kitabog Titay, Zamboanga Sibugay was assessed using macroinvertebrates. A total of 11 species of macroinvertebrates were identified in the study area. Phylum arthropoda has the number of 6 species and Gerris marginatus was the most abundant (32). One-Way ANOVA revealed that there were highly significant between species abundance and station ($p=0.00 < .05$). The Biological Monitoring Working Party (BMWP) Score System revealed that Kitabog River was under questionable category. The catergory interprets that the river is moderately impacted. The quality of water in the study site is brought by the waste matter being deposited into the river from the rubber plantation.

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INTRODUCTION

The last few decades has witnessed increasing concerns about environmental problems produced by the anthropogenic degradation and misapplication of natural resources. Policies regarding the correct usage of water are extremely important because the availability of clean freshwater resources is essential for themaintenance of life throughout the world (Uherek C.B. *et al*., 2014). Aquatic macroinvertebrates species are animals without backbone and can be seen with the naked eye. Aside from that, they were also involved in nutrient cycles, primary productivity, translocation of materials and decomposition of organic material within aquatic environment. Monitoring macro invertebrates could be a powerful tool in the assessment of habitat quality because aquatic macro invertebrates can indicate changes in environment the reason why they were utilized as bioindicators (Fajardo *et al*., 2015).Study of identification of macro invertebrates in freshwater provides basis on the current quality of freshwater. The presence or absence of certain species in ecosystems has proven to be very effective tool for detecting the level of disturbance, especially because of the anthropogenic processes. Some species are tolerant to these environmental change and pollution while some others cannot (Clesceri, Greenberg, & Eaton, 1999; Mafla, 2005; Bustamante, Monsalve, & García, 2008; Tione, Bedano, & Blarasin, 2011; Riley, Gerba, & Elimelech, 2011). Benthic macroinvertebrates such as annelids, mollusks, crustaceans have biological ecological functions in determining the quality of the water.Rubber processing done by plantations can effectively increase contamination of freshwater systems and may result to habitat disruption of freshwater organisms. Battery solution containing formic and acetic acids is used as coagulant to solidify the suspended natural raw rubber contained within the latex. During the rubber processing, the formic acid used as coagulant is extracted and thus directly disposed as liquid wastes. Some of these wastes are drained into the river leading to contamination. Zamboanga Sibugay is blessed with large hectares of rubber farms among neighboring provinces in Region IX. As recorded, Zamboanga Sibugay ranks the second next to North Cotabato with 143.08 metric tons of rubber production in entire Philippines archipelago (PSA, 2014). This commodity has brought economic elevation of the municipal and provincial economy. Along with the high productivity of rubber, river systems are directly affected due to waste materials being drained unto it. Riverbank has become the main source of water in households nationwide. Natural stresses subject freshwater to degradation. In addition, anthropogenic processes provide the highest impact in disruption, destruction and alteration of the freshwater. This study aims to assess the status of the water quality of the Kitabog River in which became the

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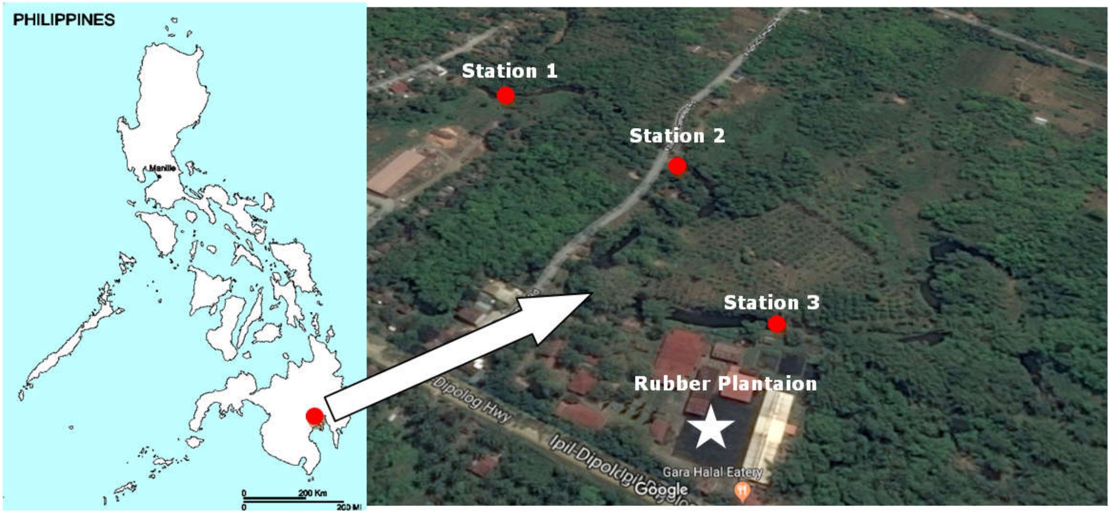

Figure 1. Map of the Philippines showing the study area

Table 1. Inventory of aquatic macroinvertebrates found in the 3 stations

Phylum	Order	Family	Scientific Name	Common Name	Count			TOTAL
					Station 1	Station 2	Station 3	
Arthropoda		*Gerridae*	*Gerris marginatus*	Water Striders	11	16	5	32
		Nepidae	*Ranatra linearis*	Water stick	3	9	0	12
		Gerridae	*Metrobates* sp.	Short bodied strider	5	11	2	18
	Hemiptera	*Notonectidae*	*Notonecta* sp.	Back swimmer	8	13	1	22
	Odonata	*Coenagrionidae*	*Ischnura* sp.	Damselfly nymph	2	12	1	15
			Dolomedes facetus	Water *spider*	0	3	0	3
		Lacordaire	*Psephenidae* sp.	Water penny	1	4	0	5
Annelida			*Lumbricina* sp.	Earthworm	5	2	1	8
Mollusca			*Bithynia tentaculata*	Faucet snail	14	9	4	27
	Gastropoda	*Thiaridae*	*Melanoides tuberculate*	Red rimmed melania	13	7	4	24
	Venroida	*Corbicula*	*Sphaerium corneum*	Fingernail clam	9	3	0	12
TOTAL					71	89	18	178

drainage of waste in a rubber plantation at Titay, Zamboanga Sibugay, specifically; Identify macroinvertebrates that are found on the river; determine the density of macroinvertebrates; determine the biodiversity index of the selected sites of the river; and determine the significant difference of the communities in selected sites of the river. The study is sought to determine status of quality of water in the Kitabog River. The study further addresses the community on the status of water quality in the Kitabog River, Titay, Zamboanga Sibugay. The study only covers to determine the quality of the water in Kitabog River through identification of macroinvertebrates. It is assumed that the higher the biodiversity and density of macro invertebrates, the higher will be the water quality.

MATERIALS AND METHODS

Description of the study site: The study was conducted in Kitabog River, Kitabog, Titay, Zamboanga Sibugay Province. The geographic location of the study site is 7.8355° N, 122.5853° E. The barangay is found along the Ipil-Dipolog Road. The barangay has a river and is said to be disturbed by an adjacent rubber plantation industry that drains its liquid and solid wastes into the river basin. The research site was divided into 3 stations for sampling of macroinvertebrates. Each station has a distant of 1 km away from each other and are strictly measured with 25 m x 10 m of dimension in gathering the samples.

Data Gathering. A permit was secured from the Barangay Chairman of the Barangay Kitabog, Tiay, Zambonga Sibugay. Macroinverterbrates were collected from three different stations of the river. Station 1, an undisturbed station; Station 2, anundisturbed,1 km from the Station 1; Station 3 a disturbed station, 2 kms from station 1. Data were collected on May 2018 at the 3 stations. Samples of macro invertebrates were collected using net. The collected samples were placed white plastic container and properly labeled.

Identification of samples: All samples were identified using a taxonomic key adapted from *Aquatic macroinvertebrates diversity and physico-chemical characteristics of freshwater bodies in Tubay, Agusan Del Norte, Philippines*by Fajardo, D.M. *et al*. (2015).

Statistical Analysis: Water quality assessment was determined by the BMWP Score System adapted from Armitage *et al*., 1983 [30], and Alba-Tercedor, 1996.Species diversity indeces were determined using Shannon and Simpson's Index of biodiversity. One Way ANOVA was used to determine if there were significant difference of the samples collected at 3 sites. Tukey's Post hoc analysis was used if the data were significant. Species density was used to determine the population size.

Where, $d = \frac{\text{number of individuals.}}{\text{area of the site}}$

RESULTS

Table 1 revealed a total of 11 speciesof macroinvertebrates were collected in the 3 stations. Phylum arthropoda has the number of species (6).

Table 2. Species density in the 3 stations

Scientific Name	Common Name	Station 1	Density (m^2)	Station 2	Density (m^2)	Station 3	Density (m^2)	Total
Gerris marginatus	Water Striders	11	0.044	16	0.064	5	0.02	0.128
Bithynia tentaculata	Faucet snail	14	0.056	9	0.036	4	0.016	0.108
Melanoides tuberculate	Red rimmed melania	13	0.052	7	0.028	4	0.016	0.096
Ranatra linearis	Water stick	3	0.012	9	0.036	0	0	0.048
Metrobates sp.	Short bodied strider	5	0.02	11	0.044	2	0.008	0.072
Sphaerium corneum	Fingernail clam	9	0.036	3	0.012	0	0	0.048
Notonecta sp.	Back swimmer	8	0.032	13	0.052	1	0.004	0.088
Ischnura sp.	Damselfly nymph	2	0.008	12	0.048	1	0.004	0.06
Lumbricina sp.	Earthworm	5	0.02	2	0.008	1	0.004	0.032
Dolomedes facetus	Water spider	0	0	3	0.012	0	0	0.012
Psephenidae sp.	Water penny	1	0.004	4	0.016	0	0	0.02
Total		71	0.284	89	0.356	18	0.072	0.712

Table 3. Diversity indeces of the three study stations

Indeces	Station 1	Station 2	Station 3
Simpson_ 1-D	0.8621	0.8815	0.8025
Shannon_H	2.096	2.235	1.224

Table 4. Difference of three stations in Kitabog River

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	247.697	2	123.8485	7.579748	0.002166	3.31583
Within Groups	490.1818	30	16.33939			
Total	737.8788	32				

Table 5. Scheffe Post hoc Analysis of three stations

	(I) Stations	(J) Stations	Mean Difference (I-J)	Std. Error	Sig.
Scheffe	Station 1	Station 2	-1.63636	1.72360	.641
		Station 3	4.81818*	1.72360	.031
	Station 2	Station 1	1.63636	1.72360	.641
		Station 3	6.45455*	1.72360	.003
	Station 3	Station 1	-4.81818*	1.72360	.031
		Station 2	-6.45455*	1.72360	.003

Table 6. BMWP classes, scores, categories and interpretation

Class	BWMP Score	Category	Interpretation
I	>150	Good	Very clean water
	101 – 150		Clean or not significantly altered
II	61 – 100	Acceptable	Clean but slightly impacted
III	36 – 60	Questionable	Moderately impacted
IV	15 – 35	Critical	Polluted or impacted
V	<15	Very Critical	Heavily polluted

Phylum Annelida has the lowest number of species (1). *Gerris marginatus* was the most abundant (32) and *Dolomedes facetus* was the least abundant (3).

Density of Macroinvertebrates: Table 2 showed thatStation 2 has the highest density (0.36 m^2.) over Station 1 (0.28m^2) and Station 3 (0.07m^2). This implies that more species are found in Station 2 than Station 1 and Station 3.*Gerris marginatus* in Station 2 has the highest density (0.06 m^2).

Species diversity Indeces: Station 2 has the highest diversity index of 0.88 of Simpson_1-D and 2.24 Shannon_H. Station 3 has lowest diversity index of Simpson_1-D 0.80 and Shannon_H 1.22. This means that more species are found in Station 2 than stations 1 and 3 (Table 3).

Difference of the stations: One-Way ANOVA revealed that there were highly significant between species abundance and station (p=0.00 < .05).

Post-hoc analysis revealed that Station 1 and Station 2 are not significant (0.64). Station 1 is and Station 3 are significant (0.03). Station 3 is significant both Station 1 (0.31) and Station 3 (0.003). Table 6 shows that the water quality can be determine based from the inhabiting species of macroinvertebrates in the water. Macroinvertebrates are scored based on sensitivity to pollutants. Macroinvertebrates that are highly intolerant are scored 10 and the highly tolerant are scored 1. The sums of the scores are then based from the score system.

Water quality

The Biological Monitoring Working Party (BMWP) Score System discovered that the water in Kitabog River is at "Questionable" category. The category interprets that the river is "Moderately impacted". (Source: Armitage *et al.*, 1983[30], and Alba-Tercedor,1996 [29]).

Table 7. BMWP Taxa scoring

Scientific Name	Common Name	Score
Gerris marginatus	Water Striders	5
Bithynia tentaculata	Faucet snail	3
Melanoides tuberculate	Red rimmed melania	6
Ranatra linearis	Water stick	5
Metrobates sp.	Short bodied strider	5
Sphaerium corneum	Fingernail clam	3
Notonecta sp.	Back swimmer	5
Ischnura sp.	Damselfly nymph	6
Lumbricina sp.	Earthworm	1
Dolomedes facetus	Water spider	5
Psephenidae sp.	Water penny	1
Total Score		45

DISCUSSIONS

Among 11 identified macroinvertebrates, the results shown that *Gerris marginatus* is most dominant between 3 stations, specifically in Station 2 and Station 3. *Bithynia tentaculata* in Station 1 is mostly found over *Ranatra linearis*. Therer were no *R. linearis,Sphaerium corneum, Psephenidae* sp., *Dolomedes facetus* collected in Station 3 because some of these organisms are sensitive to water pollutant (Fajardo, *et al*., 2015). Species scored with 6 are moderately intolerant to water pollutants and the system continues downward.Species density refers to the number of organisms per unit area. In the study, *Gerris marginatus* has the highest density (0.13 per m^2) over *Dolomedes facetus*(0.01 per m^2) between the 3 stations of the study site. The stations' diversity index was also computed to identify which station is most diverse. The Simpson (.88) and Shannon (2.24) indeces value provided evidence that Station 2 is most diverse than Station 1 (Simpson: 0.86, Shannon: 2.10); Station 3 has the lowest diversity among (Simpson: 0.80, Shannon: 1.22). Three different stations were assessed by One-Way ANOVA and was found out that Station 3 significantlydiffers with Station 1 and Station 2. This implies that macro invertebrates identified in Station 3 were highly tolerant in water pollutants brought by rubber plantation. Thus, the water quality in Kitabog river is falls under "Questionable" (BMWP: 45) which means the water is moderately impacted. This quality of water is the product of the waste materials of the rubber plantation deposited into the river. Different effluents generated from rubber processing are coagulation serum, carbonaceous organic materials, nitrogen & sulphate compounds, sulphuric acid, hydrogen sulphide, ammonia and different amines (Das *et al*., 2016). According to the study of Pandey *et al*. (1990) effluent from latex rubber processing industries is basically acidic in nature. Usage of different acids attribute to pH variation of different effluent. Due to the use of acid in latex coagulation, preservation and creaming process, the effluent discharged from rubber processing plant is acidic in nature.The effluents coming out from rubber processing is a serious concern because of the presence of high biological oxygendemand and ammonia. Without proper treatment, discharge of wastewater from rubber processing industry to the environment may cause serious and long lasting consequences (Das *et al*., 2016).

Conclusions

It is therefore concluded that the water quality in the river is less suitable for aquatic life inhabitants. The problem may extend into terrestrial area when water is used for wildlife drinking and thus the effect may magnify.Considering the health of the people and the aquatic life, this research suggests that drainage system of the rubber plantation should be altered and should not target the river. In addition, there should be a continuous monitoring of the water quality over period of time.

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