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Rapid Water Quality Assessment of Bongoy River in Odiongan, Romblon Using Macro Invertebrates and Fecal Coliform Presence as Bioindicators

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Abstract

This study was conducted to assess the water quality of Bongoy River in Odiongan, Romblon using macroinvertebrates and fecal coliform as bioindicators. The collection of water samples and macroinvertebrates were done in five collection sites of the river with 500 meters interval every site. Macroinvertebrate samples were collected using D-frame and kick nets in upstream, midstream, and downstream stations of the river. The collected samples were counted and identified according to their taxa. A total of 164 macroinvertebrates were found in five sites of the river belonging to 11 species. Biotic Index Card as reference was used to categorize the macroinverbrates collected based on its tolerance to water pollution. The data were analyzed using Biological Monitoring Working Party (BMWP) Scoring System and based on this method, the category of the dominant macroinvertebrates found are Moderately-Tolerant Taxa with a score of 57 points. Comparing the results of the Biotic Index Card and BMWP Scoring System, it was found out that both of these methods used, Bongoy River is categorized as Moderately-Polluted River. Bacterial coliform kit was used in evaluating the presence of Total and fecal coliform and it was found out that all five collection sites have the presence of total coliform which indicates the presence of human or animal wastes and the potential for a serious bacterial contamination problem. It is thus concluded that in assessing of water quality of river, macroinvertebrates and coliform presence can be a good indicators of water pollution.

Keywords: Water quality; Macroinvertebrates; Coliform; Bioindicators.

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1. Introduction

As the world population increased, humans have started producing a lot of domestic wastes. The lack of garbage management being implemented in a community would resort humans to throw these wastes on rivers or the along riverbanks. The wastes being thrown in the river not only affect the organisms living in the water but also the health of the settlers near the rivers or streams. Through our approach to modernization and industrialization, humans have also started generating a lot of toxic waste products from the industrial processes. Since factories and other large establishments produce huge amount of waste, they use rivers as their drainage system. These waste products are toxic and kill numerous species of organisms living in the river and streams thus, disturbing the ecological balance [1]. Rivers and streams are considered one of the sources of life on Earth. During prehistoric times, humans have already utilized rivers by settling along riverbanks for their source of freshwater and food. These early settlers have also used these streams for their hygienic purposes. Since rivers form networks of waterways around the Earth, they have been useful in transporting people, livestock, and cargos, specifically in Asia. In Indo-China region, most specially, rivers were also used to transport harvested fruits and vegetables, and even their marketplaces are located on rivers. Some places have been famous for having rivers as their tourist attraction site such as the Nile River in Africa and the Loboc River in Bohol, Philippines. For farmers, rivers have been of great help on their crops by supplying water for their irrigation system. Aquatic macro invertebrates are an integral part of the food chain in lotic environments and they are sensitive to changes in the environment though degrees of sensitivity differ among various groups. Communities of organisms integrate the impact of different stressors and thus provide a broad measure of their aggregate impact. Macro invertebrates have limited migration and their assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances and thus are particularly suited for assessing site specific impacts. They are most frequently used in bio monitoring since many of them are sensitive to pollution and integrate short term and long term effects of environmental stressors [19, 20]. Different taxa have different habitat preferences and pollution tolerances. Absence of sensitive species and presence of tolerant ones indicate water quality deterioration. Various indices based on these criteria such as Hilsenhoff's Biotic Index (HBI), Biotic Index Card (Center for Watershed Stewardship, Pennsylvania State University), Invertebrate Community Index (ICI), Biological Monitoring Working Party Score (BMWP), Macro invertebrate Water Quality Index (MWQI), Average score per taxon, percent model affinity and EPT richness index have been used to evaluate water quality. An assessment of the microorganisms (i.e. coli forms) can provide an indication of water quality in the rivers. Fecal coli forms (FC) are normally associated with the fecal matter from warm bloodied animals while total coli forms (TC) are naturally occurring. Their presence in the rivers indicates fecal contamination, thereby posing a health risk. Further, high inputs of waste water into the waterways can magnify their numbers which can disrupt natural processes leading to water quality impairment [17]. In 1891, the Franklands came up with the concept that organisms characteristic of sewage must be identified to provide evidence of potentially dangerous pollution [13]. By 1893, the 'Wurtz method' of enumerating B. coli by direct plating of water samples on litmus lactose agar was being used by sanitary bacteriologists, using the concept of acid from lactose as a diagnostic feature. This was followed by gas production, with the introduction of the Durham tube. The concept of 'coliform' bacteria, those bacteria resembling B. coli, was in use in Britain. The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with fecal material of man or animals. At the time this occurred, the source water may have been contaminated by pathogens or disease-producing bacteria or viruses which can also exist in fecal material. Some water-borne pathogenic diseases include typhoid-fever, viral and bacterial gastroenteritis and hepatitis A. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal wastes [34]. Stream and lake monitoring for educational, as well as regulatory, purposes sometimes involves assessing the microbial quality of water and the risk of possible transmission of waterborne infectious diseases. Pathogenic organisms are generally present in water in very low numbers, and analytical tests to detect them are expensive and difficult. Levels of fecal coliform bacteria in streams and lakes are often used as indicators of microbial water quality instead of specific monitoring for disease-causing organisms. The primary reference for stream monitoring programs in schools, the Field Manual for Water Quality Monitoring [2], lists fecal coliform analysis as one of nine water quality tests whose results make up a water quality index. The presence of fecal coliform bacteria in water has both public health and policy implications. Fecal coliform bacteria in water samples are regarded as an indicator of potential contamination by human waste. The presence of this waste increases the risk of finding human pathogens. However, fecal coliform bacteria are also naturally present in the intestines and feces of many warm-blooded animals [1]. Assessment and monitoring of the water quality in rivers and streams are important to help prevent further introduction of pollutants in the river. This would also help create and implement environmental policies. Monitoring management together with strict environmental policies help lessen further future human impact on bodies of waters and natural ecosystems. Assessing the quality of water in Bongoy river is very important considering the fact that these rivers are the sources of water that provide the domestic, commercial and agricultural needs to many residents of Odiongan, Romblon. Some portions of the rivers might be under pressure of human-related activities that have altered physico-chemical status and threatened the aquatic organisms affecting the local residents in the area. In developing provinces like Romblon, water problems exist. This may be due to untreated waste waters from domestic, agricultural and industrial sources which are discharge into rivers and waterways, leading to severe water pollution and spreading of infectious diseases. These water resources are susceptible to pollution, and so, Bongoy River in Odiongan might be facing the same problem. The river is a source of water for domestic, industrial and agricultural activities of Odiongan municipality and its environs but; due to poor waste management proliferation of hotels, hospitals, schools and industrial setups, its water quality could have got compromised. Through this study, the community living along the Bongoy River in Odiongan, Romblon had been given the knowledge of how their activities affected the health of the river ecosystem and the water quality in the said stream. With this, their local government could implement strict laws and regulations regarding their household and pigpens drainage systems, and proper dumping sites for their garbage wastes.

1.1. Objectives

This study aimed to assess the water quality of the Bongoy River in Odiongan, Romblon through evaluation of the richness of macroinvertebrate populations. This study also aimed to serve as the baseline information for the long term assessment of water quality in other rivers of Odiongan, Romblon.

1.2 Study Area

Figure 6

Bongoy River is 12’23.533’N, 121’59.116’E, 95 feet above sea level located in Municipality of Odiongan comprising barangays Tulay, Liwanag, Budiong (Cota) and Tabing-Dagat.

1.3 Scope and limitations of the Study

The study utilizes experimental method which only focuses on the stretch of Bongoy River in Odiongan, Romblon. The assessment of water quality only uses macroinvertebrates and fecal colifirm presence as bioindicators. Upstream, midstream and downstream level of the River were also considered for the population density of the macroinvertebrates present. For sampling of the macro invertebrates, a length of 100m stream reach was considered as a unit and the macro invertebrates sampled using D-frame net as also kicks net both of which were of 500µm mesh size. Rapid Bio assessment Protocol developed by Center for Watershed Stewardship, Pennsylvania State University (USA) was followed for estimating the Biotic Index (BI) and Biological Monitoring Working Party (BMWP) Scoring System were also used assigning specific tolerance values for different families of macro invertebrates in the river. And finally, in determining the presence of total coliform, a bacterial test kit (LaMotte brand) was used.

1.4 Materials and Methods

Rapid Bio assessment Protocol developed by Center for Watershed Stewardship, Pennsylvania State University (USA) was followed for estimating the Biotic Index (BI) and Biological Monitoring Working Party (BMWP) Scoring System by assigning specific tolerance values for different families of macro invertebrates in the river. For sampling these macro invertebrates, a length of 100m stream reach was considered as a unit and the macro invertebrates sampled using D-frame net as also kicks net both of which were of 500µm mesh size. The kick net was placed downstream and the stream bottom substrates 1m above kicked to dislodge invertebrates clinging to debris and stones into the kick net. The contents in the net were emptied into bucket and invertebrates collected. The D frame net was employed to trap specimens clinging to vegetation, root mats etc., along the boundary. Each site was sampled twice and samples were collected one week apart. Samples were sorted within one day of collection, and sorted and then sifted through. Any observable macroinvertebrates were identified, and species presences were recorded. The collected specimens were preserved in jars containing either 70% ethanol. They were identified using the standard keys. In determining the presence of total coliform, a bacterial test kit (LaMotte) was used and following procedures were used; 1) Determine the sample source (e.g. river, streams), 2) Collect water from the water source using a sterile container, 3) Place the collected water sample in the sampling bag slowly without splashing. Tear off the top of the bag at the scored line and pull the tabs outward to open the bag, 5) Fill the bag to the 4 oz fill line. Pull the wire ends to close and whirl the bag for three complete revolutions. Shake the bag to dissolve the tablet, 6) Remove all five tubes from the display package and remove the caps, 7) Unwhirl the bag and pull the tabs outward to open the bag. Fold one tape wire inward to form a spout. Carefully fill all 5 tubes to the 10 ml line with the water sample. Replace the caps tightly. Do not mix or shake the tubes, 8) Stand the carton upright and place all 5 tubes into the display package. All tubes should now be standing vertically with the tablet at the bottom of each tube and 9) Store the tubes at room temperature, out of direct sunlight, for 44-48 hours. The air temperature should be fairly constant and between 21-29 degree Celsius. While the tubes can be incubated at room temperature, incubation at 44.5 degree Celsius will accelerate growth and result in a more rapid test result.

1.5 Data Analysis

In analyzing the data gathered, standard metrics from the Center for Watershed Stewardship, Pennsylvania State University (USA) were used. The metrics were categorized according to the richness and composition measures, the tolerance measures and trophic/habit measures of the benthic macroinvertebrates. The Biological Monitoring Working Party (BMWP) (Armitage and his colleagues 1990) score and Average Score Per Taxon of macroinvertebrates were also calculated. Each group or family in the Biological Monitoring Working Party (BMWP) corresponded to a score between 1 and 10, according to the sensitivity level to the environmental disturbance. The most sensitive organisms, such as the stoneflies, were given the score of 10 and the least sensitive, such as oligochaeta worms, was allotted to have the score of 1. The scores for each family represented in the sample were then summed to give the BMWP score. In observing the total coliform presence, a positive result in any one of the five tubes should be regarded as a potential coliform bacterial contamination but if a positive result is found in two or more tubes, there is a potential for a serious bacterial contamination problem.

1.6 Results and Discussions

Based on this results, the Bongoy River could not be considered as having “very clean” water (score >150), having a BMWP score of 57 points which categorizes Bongoy River as Moderately Impacted/Polluted. This is due to the nearby residential areas, slaughter house, hotel, old market building, and commercial buildings. Moreover, it is also considered as the catch basin water system in the municipality of Odiongan. Our results suggest that the Environmental Protection Areas policies must be implemented to ensure the conservation of the river. Nevertheless, given the increase in the number of urban settlements in Bongoy River in the recent years as well as new residential areas near to environmental conservation and protection areas, other watercourses located in these areas should also be monitored to assess their environmental health.

Table 1: Macroinvertebrate Samples Collected in 5 Sampling Sites

	SAMPLING SITES					BMWP TAXA SCORE
Invertebrates	**1**	**2**	**3**	**4**	**5**	
Odonata: Dragonfly	+	+	-	+	-	8
Plecoptera: Stonefly	+	+	+	-	-	10
Psephinedae:Water Penny	+	-	+	-	+	10
Trichoptera: Caddisfly	+	+	-	-	-	10
Hemiptera: Water Strider	+	+	+	+	+	10
Annelida: Oligochaeta	-	+	-	-	-	1
Crustacea: Shrimps	+	+	+	+	+	6
Mollusca: Pouched Snails	+	-	+	+	-	3
Pelecypoda: Clams	+	+	-	+	-	6
TOTAL						**57**

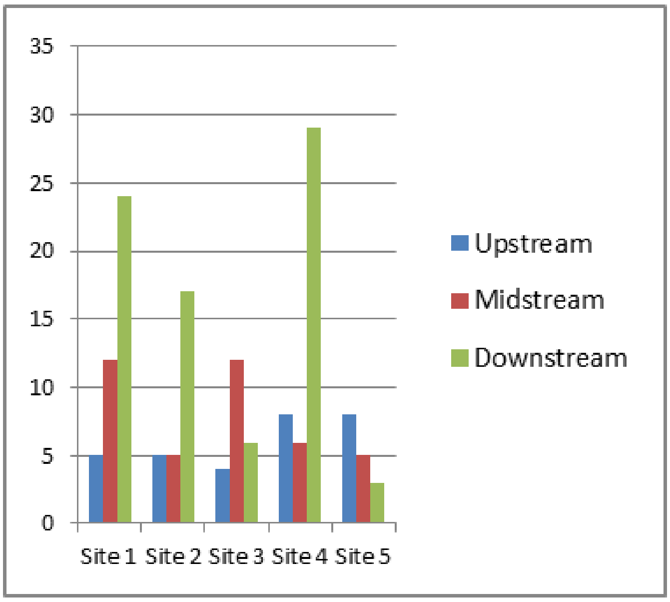

Figure 1: Shows that macroinvertebrates in downstream stations in five sampling sites have the highest richness of taxa followed by midstream stations and upstream stations.

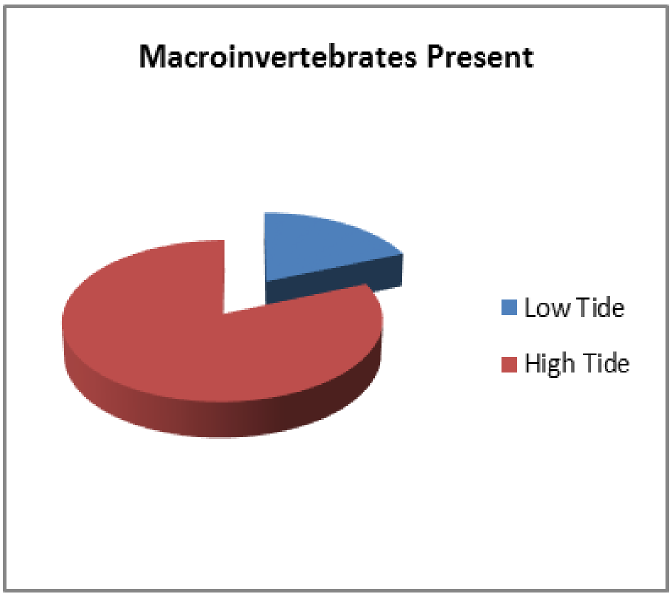

Figure 2: Shows that more macroinvertebrates are present during high tide.

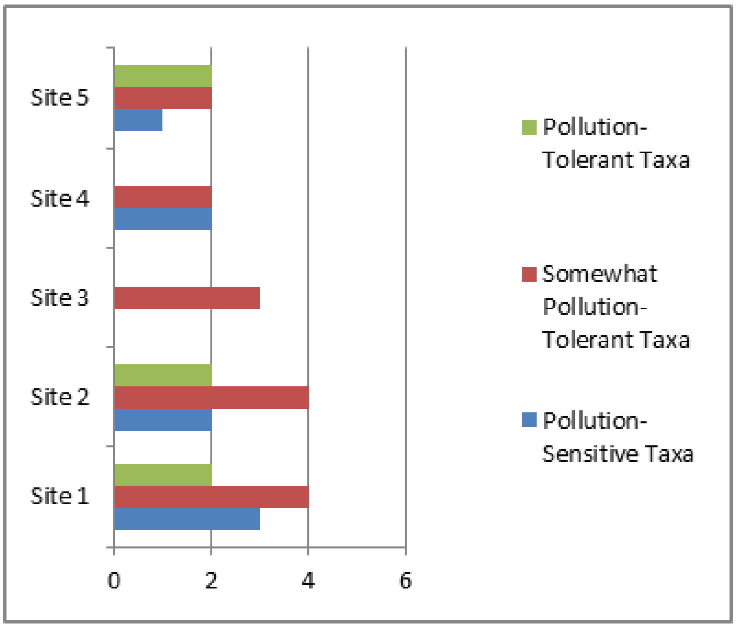

Figure 3: Shows that the Taxa belonging to Somewhat Tolerant to pollution is the most dominant macroinvertebrates found in 5 sampling sites of Bongoy River, followed by Pollution-Sensitive and Pollution-Tolerant Taxa

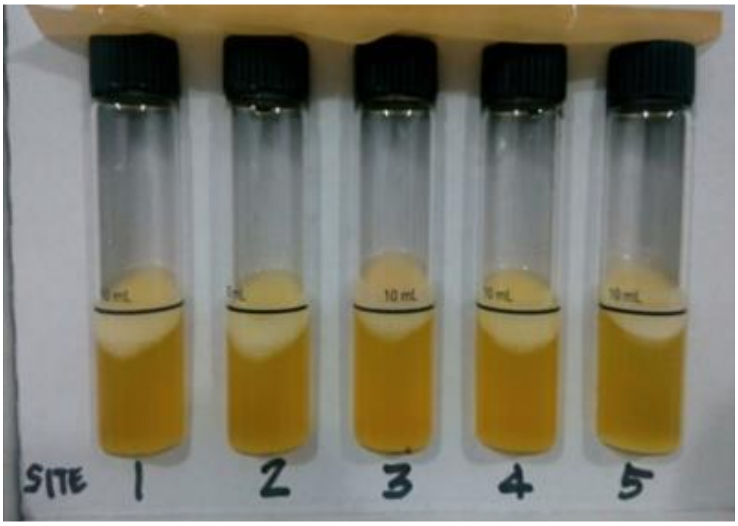

Figure 4: Shows that all five collection sites of Bongoy River are positive (+) or with the presence of bacterial coliform contamination after 48 hours incubation at room temperature.

Figure 5: Shows representative macro invertebrates gathered from Bongoy River

1.6 Conclusions

Based on the macroinvertebrates collected and identified, the Biological Monitoring Working Party (BMWP) score of Bongoy River is 57 points. In the aspect of stations of every sampling site, the downstream stations have the highest richness of macroinvertebrates taxa followed by midstream and upstream stations. Furthermore, it was also found out that macroinvertebrates are more present during high tide. Add to this, all five collection sites have positive results in the presence of bacterial coliform contamination. Overall, Bongoy River is categorized as “Moderately Impacted/Polluted” river based on macroinvertebrates present and there is a potential for a serious bacterial contamination.

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