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RESEARCH ARTICLE

WATER QUALITY AND BIOLOGICAL ASSESSMENT OF DICAYO RIVER

***Ma. Dulce C. Guillena**

Jose Rizal Memorial State University, Katipunan Campus, Katipunan, Zamboanga del Norte, Philippines

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ABSTRACT

Assessments on the conditions of biological organisms in an aquatic ecosystem evaluate the condition of waterbodies desirable for aquatic life uses. This study was carried out to survey the biotic community and water quality of Dicayo. Specifically, this aimed to determine the level of physico-chemical parameters measurements such as the temperature, pH, nitrate, total suspended solids, total coliform, depth and width. Moreover, this sought to identify the flora and faunal composition and determine the significant difference on the quality of water and biological composition among the sampling sites. Descriptive method of gathering data was done with the aid of chemical, biological and physical laboratory analyses. Indices of diversity and dominance were determined using Shannon Index. Results revealed that the physico-chemical parameters were within the standard of the DENR but the total coliform did not meet the standard. The river is supported by its floral and faunal composition wherein 61 plant species, and 8 classes of animal species were identified. Catch Per Unit Effort value was highest for fish net with a mean of 0.367 kg/manhr. The biodiversity indices of flora and fauna showed moderately diverse level. Further study should be done to ensure the maintenance of water quality in the river.

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INTRODUCTION

Water serves as a significant utility in the unending activities of man and animals such as municipal water supply, generation of hydroelectric power, irrigation of agricultural lands, fishing, boating and many others. It is also a receptor of industrial waste, domestic waste and wastewater as a result of using water (Chapman, 1996; Rosemberg and Reish, 1993). The hydrological cycle connects all bodies of water thus water constitutes a continuum with different stages ranging from rainwater to inland freshwaters. Inland freshwater which appear in the form of rivers, lakes and groundwater are closely inter-connected and may influence each other directly. Rivers are characterized by uni-directional current with a relatively high, average flow velocity ranging from 0.1 to 1m/s. The river flow is highly variable in time, depending on the climatic situation and the drainage pattern. In general, thorough and continuous vertical mixing is achieved in rivers due to the prevailing currents and turbulence (Chapman, 1996). Rivers have been affected with environmental deterioration and degradation due to increased human population and increased waste generation (Thorne and Williams, 1997). Wastes released in to the aquatic environment contain harmful chemicals such as oils, heavy metals, nutrients and ammonia which have various effects on habitat of plants and animals (McClugge, 1991). Depletion of their numbers and species in diversity seems to be a major effect. This will go back to man as its insatiable consumption of freshwater resources remains unending. Thus, man is facing a great physiological threat (Clark, 1994). The Department of Environment and Natural Resources Administrative Order (DAO) No. 34 Series of 1990 and in accordance with the Manual of Procedure for Water Classification evaluates water bodies all over the country. The classes of fresh waters were AA, A, B, C, and D with corresponding definition. Dicayo River had been classified as Class A for upstream and Class B for downstream. Upstream is considered as a Public Water Supply II that will require complete treatment while the downstream is a Recreational Class I which for primary contact recreation such as bathing, swimming, skin diving, etc. (DENR 2014). The upstream part of the river has been a source of drinking water for the people living nearby since antiquity. However, there was no record to prove that these sources of water had undergone complete treatment. With increasing population and human activities, wastes and toxic materials could have leached to the water thus posing a threat to the health of the people. This study therefore will assess the water quality. The water quality using the physico-chemical parameters which is important for sustainable management on the present status of the resource.

Corresponding author:* **Ma.Dulce C. Guillena,
Jose Rizal Memorial State University, Katipunan Campus, Katipunan, Zamboanga del Norte, Philippines.

Objectives

This study aimed to assess the water quality and biological composition of Dicayo River. Specifically, this sought to answer the following objectives:

- Determine the level of the following physico-chemical parameter measurements such as the temperature, pH, nitrates, total suspended solids (TSS);
- Identify the total coliforms, flora and faunal composition of the Dicayo river;
- Determine the relative abundance of fishes and crustaceans and catch per unit effort of fishing gears used by fisher

MATERIALS AND METHODS

Study Area

The Dicayo River is a stream (class H – Hydrohraphic)located in the municipality of Katipunan, province of Zamboanga del Norte, latitude 8^0 31' 03'' N and longitude 123^0 17' 30'' E. Dicayoflows all the way from Mt. Malindang, traverses through Sergio Osmeña, Zamboangadel Norte and continued its way through the highland barangays of Katipunan, Zamboanga del Norte and flows towards the Sulu Sea. Its tributaries include a stream that originate from San Francisco, Osmeña which merges at Dabiak and a stream that flows from Fimagas, Katipunan which merges at Matam, Katipunan, Zamboanga del Norte.

Method Used

The descriptive method of research was utilized in the study with the aid of chemical, biological and physical laboratory analyses. Sampling were done from 5 stations for four months from July 2015 to October 2015. The Global Positioning System was used to determine the coordinates of the sampling sites. Study sites included 4 upstream and 1 downstream points. To determine the current habitat conditions, water quality were measured including the temperature, pH, nitrates, total suspended solids and total coliform. The collection of water samples for physico-chemical analysis and total coliforms followed the standard procedures. Samples were placed in containers and transported to the laboratory for analysis. The temperature, pH, depth and width of the river were measured directly in the field.

Field documentation of collected biological samples were facilitated using identification materials including books, field guides and online sources. Representative specimens were collected, photographed and were pressed for identification. Identification of species was done through the help of the local people. The usual gears used by local fishers include hook and line, spear gun (pana), electricity (kuryente), fish net (pukot) and bare hands (sikup). Catch per unit effort (CPUE) was computed for each fishing gear using the formula by Calumpong *et al.* (1997) as quoted by Argente (2009):CPUE) kg/man-hour) = Total weight of Catch/ No. of Hrs. Fishing x No. of Fishermen CPUE values are indicative of relative abundance of fishes and crustaceans in each of the sampling site. Higher values indicated greater efficiency of the fishing gear type and greater fish biomass available for food (Calumpong *et al*., 1997). Relative Abundance (RA) was calculated for each fish and crustacean species in each station. These were expressed in percentages by using the formula below (Calumpong *et al*, 1997). Relative Abundance

Species 1 =Total weight species 1 x 100/ Total weight of sample.

RESULTS AND DISCUSSIONS

Physico-chemical Analysis

Table 1 shows the physico-chemical analysis of water in the five sampling sites of Dicayo. As revealed, Bucana had the highest at 28.74 ± 0.42^0C and the rest of the study sites had almost the same temperature readings with a mean of 27.81 ± 0.12^0C. The quality of water systems are affected with temperature. Fluctuations of river water temperature can be affected by increased water turbidity and maybe further worsened by cutting down of trees (Michaud, 2001). Preferable water temperature for fishes range from $19\text{-}32^0$C (www.kywater.org.ww/ramp/rmtemp.htm). Fishes will migrate once they can sense changes in the tolerable water temperature (http://www.h2ou.com/h2wtrqual.htm). The water temperature readings in Dicayo River are within the tolerable ranged for fishes and other aquatic organisms. Cuivillas (2010) found out that in Layawan River, the water temperature reading during the dry season was 27±0.80 which is comparable to the result of this study but the water readings during the wet season was one degree lower. The table further shows the pH level of water in Dicayo. It was highest in Bucana and lowest in San Francsico at 7.68±0.39 and 7.5±0.25 respectively. Water's pH is critical to the survival of aquatic life. pH is influenced by the chemical discharges from communities and industries. Expectedly, fishes can tolerate waters with pH ranging from 5.0 to 9.0, therefore, the pH range of Dicayo River is within the tolerable level for aquatic organisms. Hansel *et al.* (2006) found out that pH of Layawan Headwaters ranges from 6.8 to 7.8 which is slightly acidic.

Moreover the table shows the nitrates concentration of the water. As revealed, Bucana had the lowest concentration of 0.04±0.01 mg/L. Nitrates enter waterways through waste from laundries, farm fertilizers and human and animal wastes. The presence of nitrates in Dicayo River could be attributed to human activities such washing clothes and bathing as seen during sampling time. Farm animals were also seen on the river grazing grasses on the riverbanks. Nitrate compounds are necessary for the growth of planktons and other aquatic plants. These plants are the source of food for food zooplanktons, fishes, humans and other animals. Nitrates do not hurt people or animals unless they are present in very high concentration. Nitrate concentrations above 10 mg/L can cause blood disorders in infants (blue baby disease) (www.google.com). Nitrates in the waters of Dicayo is at tolerable amount. Eutrophication is likely impossible to occur. On the other hand, the Total Suspended Solids (TSS) in Dicayo River range from 0.93±0.25 mg/L to 1.95±0.37 mg/L. Total Suspended Solids include all particles suspended in water coming from sanitary waste water, industrial waste water, and soil erosion from agricultural and construction sites and runoff during rainy days. The highest total suspended solids in Bucana could be attributed to sediments brought about by quarrying in barangay Nanginan. A body of water begins to lose its ability to support a diversity of aquatic life when levels of TSS increase. Photosynthetic activity decreases since less light penetrates the water thus less oxygen is produced causing a dropped in dissolved oxygen levels. Moreover, fish habitat will be

Table 1. Physico-chemical Parameters of Dicayo River

Study Sites	Temperature (^{0}C)	pH	Nitrates (mg/L)	TSS (mg/L)
Bucana	28.74±0.42	7.68±0.39	0.03±0.02	1.95±0.37
Matam	27.92±0.32	7.65±0.10	0.05±0.03	1.70 ±0.32
Sitog	27.75±0.42	7.55±0.17	0.05±0.01	0.93±0.25
Dabiak	27.91±0.50	7.54±0.09	0.05±0.01	1.55±0.41
San Francisco	27.67±0.27	7.5±0.25	0.04±0.02	1.09±0.25

Table 2. Bacteriological Examinations Water

Study Sites	Total Coliforms (MPN/100ml)	Remarks	Fecal Coliforms (MPN/100ml)	Remarks	HPC (CFU/ml)	Remarks
Matam	4.53±0.10	Failed	1.1±0.10	Failed	66.26±0.96	Passed
Sitog	2.83±0.17	Failed	1.1±0.10	Failed	97.50±0.58	Passed
Dabiak	4.50±0.08	Failed	2.6±0.08	Failed	27.25±0.96	Passed
San Francisco	4.53±0.10	Failed	2.6±0.21	Failed	51.00±0.82	Passed

Reference: Philippine National Standards for Drinking Water 2007 (DOH A.O. No. 2007-0012)

Table 3. Diversity Index of Riparian Flora

Indices		Bucana	Matam	Sitog	Dabiak	San Francisco
Shannon Index of Diversity	Trees	0.915	0.255	1.72	1.89	1.96
	Plants	0.727	0.458	1.04	0.965	0.968

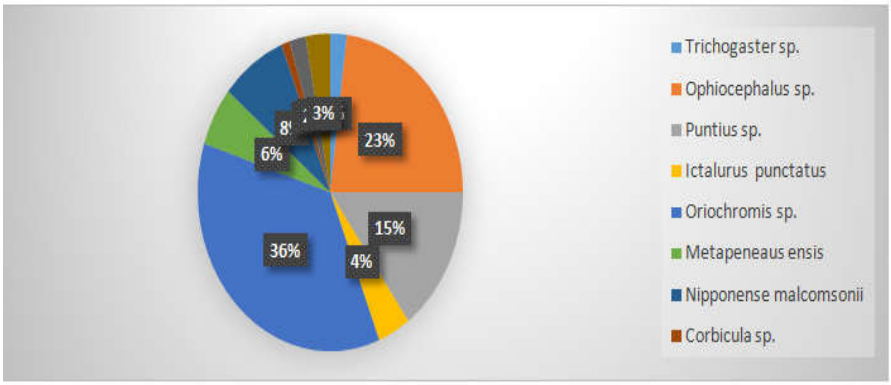

Fig. 1. Relative Abundance of Fishes of Fishes and Crustaceans in Dicayo River

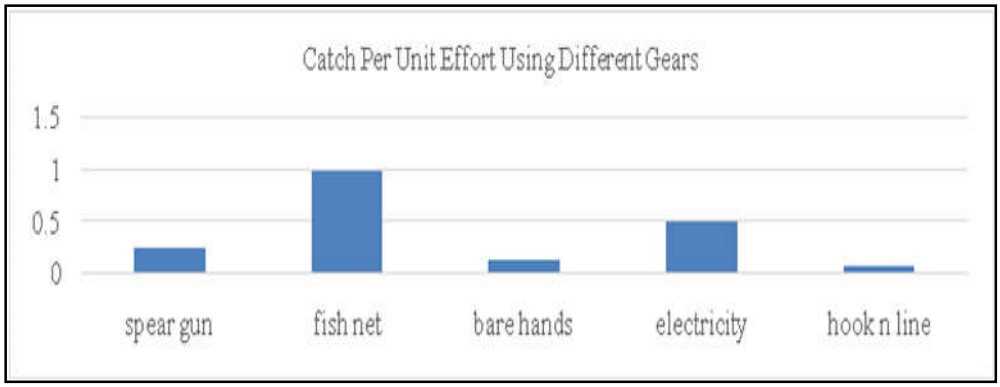

Fig. 2 Catch Per Unit Effort per Gear in Dicayo River

Moreover, fish habitat will be destroyed because suspended solids settle to the bottom and eventually blanket the river bed. Changes in aquatic environment can harm aquatic organisms since natural movements and migration of aquatic populations may be disrupted.

Depth and Width

The depth of Dicayo River range from .5 m to 4.5 m. The deepest area was observed in Dabiak (4.5 m) and the shallowest portion (.3 m) at San Francisco.

The average depth was 2.99m. The width values ranged from 2m to 35 m wide. The widest portion (35 m) at Bucana and the narrowest portion (2 m) at San Francisco. The average width value was 17.5 m.

Total coliforms

Table 2 showsthe different tests done to test for bacteriological quality of the drinking water. As seen from the table, tests for total coliforms and fecal coliforms showed a failing remarks while test for Heterotrophic Plate Count showed a passing

remarks based on the standards set by the Philippine National Standards for Drinking Water of 2007 (Agape Health Care Center). No organism fulfills all the criteria for an indicator organism, but the total coliforms fulfill most. Total coliform is define as all the aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 35□C. This definition include *Eschirichia coli,* the most numerous facultative bacterium in the feces of warm-blooded animals.

Fecal coliforms are a subgroup of total coliforms that are differentiated from total coliforms through laboratory examinations. Although fecal coliforms provide stronger evidence of fecal contamination than total coliforms, they could not be distinguished as human or animal origin. E. coli is the indicator organism of choice for fecal contamination. On the other hand, Heterotrophic Plate Count (HPC) describes broad group of bacteria that include pathogens, nonpathogens and opportunistic microorganisms. HPC could be used to indicate general biological condition of drinking-water as a consequence of insufficiency of treatment processes, regrowth or recontamination of drinking water in the distribution system (http://www.doh.gove.ph). Identification of specific disease-producing micro-organisms is difficult, total coliform is often used as an indicator of the water possibly containing disease-producing organisms that normally live in the intestinal tracts of man and warm-blooded animals (Driscoll, 1986). Coliforms are relatively harmless but large quantities in water posed risk of pathogens in water. Based on bacteriological analysis, there is a coliform contamination in water therefore it is not safe for the people to drink water from the river. The coliform load still meet the standard for recreational purposes.

The Flora of Dicayo River

There were 61 plant species identified belonging to 11 families of trees and 50 families of weeds. It was found out that some species have medicinal importance like the tawa-tawa (*Euphorbia hirta*), sunting (*Cassia alata)* and hibi-hibi (*Mimosa pudica*). On the other hand, the kompay (*Brachia mutica*) and kanding-kanding (*Stachytarphetajamaicensis*) are food for the ruminants. The study of Hansel *et al* (2006) revealed that there were 415 plant species identified in the Layawan Headwaters in Misamis Occidental. Accompanying the clearing of forest, these plants are characterized by a predominance of introduced weeds. The Shannon Index for the trees and plants/weeds in each sampling site is presented in Table 6. Relatively high value of diversity are in Sitog, Dabiak and San Francisco at 1.72, 1.89 and 1.96 respectively.

The Faunal Composition of Dicayo River

There were 4 phyla identified: Mollusca, Annelida, Arthropoda and Chordata and 8 classes of freshwater organisms which include classes of Bivalvia, Gastropoda, Clitella/Herudinea, Crustacea, Insecta, Amphibia, Reptilia, and Osteichthyes. Five classes were of economic importance to the people in the community. These species serve as their source of protein such as the Taiwan mussel (*Corbiculasp), (Metapenaeusensis),* ow angdagko *(Metapenaeusensis)* and many others.

The Relative Abundance (RA) of economically important fishes and crustaceans in Dicayo River was determined and presented in Figure 3. As shown in the figure, tilapia (*Oreochromis sp*.) has the highest relative abundance. The abundance of tilapia in Dicayo River maybe attributed to the fingerling dispersal program of the Department of Agriculture for sustainability purposes. Moreover, this species has high tolerance to varying temperatures and resistance to viral and bacterial diseases than other fishes, especially at optimum temperatures for growth (29.4^0C to 31.1^0C) (Popma *et al*., 2005). This finding corroborates with the study of Cuivillas (2010) that in Layawan River, tilapia (*Oreochromis sp*.) had the highest the relative abundance value. On the contrary, the study of Hansel *et al* (2010) revealed that paitan (*Puntius sp*.) dominate the catch with a total weight of 3,800 g with a total number of individuals of 269.

Catch Per Unit Effort

Fishers in Dicayocommonly used spear gun, fish net, bare hands, electricity and hook and line in fishing. Figure 2 showed the catch per unit effort of the commonly used fishing gears. CPUE values was highest for fish net with a mean of 1.0 kg/manhr. High CPUE value is an indication of greater fish biomass available for food Calumpong (1997) as quoted by Argente (2009). In this study, the CPUE value is quiet low which would mean lesser source of protein.

Conclusion

The levels of physico-chemical parameters of Dicayo River are within the tolerable level for aquatic organisms' survival. The presence/number of coliforms in all sites makes the river water unsafe for drinking. Floral composition comprises of 11 families of trees and 50 families of weeds. Some species have medicinal and economic importance to the people in the community. Among the fishes, tilapia is relatively abundant however relative abundance of other fishes and crustaceans was quiet low as the Catch per Unit Effort showed lower values.

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