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Fish Abundance and Physico-chemical Properties of Matingao River and Marbel River, Mount Apo Natural Park, Mindanao, Philippines

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ABSTRACT

Mount Apo Natural Park (MANP) is an important forest reserve in most part of Region XI and XII because of its watershed importance. However, the MANP may also threatened by habitat modification that may alter most of its water resource. Thus, this study was conducted to assess the abundance of freshwater fish and analyze the physico-chemical properties like water temperature, pH, turbidity, dissolved oxygen (DO), total dissolved solids (TDS), electric conductivity (EC), oxidation-reduction potential (ORP) of the two major rivers of MANP. A total of six freshwater fishes consisting of four native and two introduced species were collected and identified in the two sampling stations. The native *Barbodes binotatus* (Valenciennes 1842) was found to be the most abundant in all the years the survey was conducted. The data on physico-chemical properties showed fluctuations in all year (2012-13 and 2015). High turbidity rate in Marbel River and high water temperature recorded in upper station of Matingao River could have influenced the collection and abundance of freshwater fishes. Shannon diversity index in Marbel River and Matingao River are very low with values of 0.69 (2012-2013); 0.68 (2015) and 0.70 (2012-2013); 0.70 (2015) for the two rivers, respectively. This could be attributed to anthropogenic activities, characteristics and physico-chemical properties of the river.

Keywords: freshwater fish, introduced, native, turbidity, water quality

INTRODUCTION

Mount Apo Natural Park (MANP) is the highest mountain peak in the Philippines with an elevation of approximately 3,143 meters above sea level (masl). It is located at the southern part of Mindanao and declared as a natural park by virtue of Presidential Proclamation No. 882 last September 26, 1997, with a base cover of about 71,796 hectares which extends to two regions of Mindanao: Region XI (Davao City, Bansalan, Digos, and Sta. Cruz, Davao del Sur) and Region XII (Makilala, Magpet and Kidapawan, North Cotabato). The Mount Apo Natural Park is one of the Long-Term Ecological Research (LTER) sites in Mindanao and known to be the remaining frontiers in the Philippines which serves as the habitat of 629 species of flora, 227 species of fauna, 118 species of odonata and 272 species of avifauna (UNESCO, 2009). Due to its richness in biodiversity, it became a protected area through Republic Act 9237 in 2003.

The MANP has 19 major rivers and 21 creeks that drain its eight major watersheds. This includes the Kabacan-Pulangi River and the Marbel-Matingao River which were reported to have direct input flow to the geothermal plant located within the MANP (PASAlist, 1992). Meanwhile, the Marbel-Matingao River is found to be directly draining to the Kabacan River. Additionally, these river ecosystems provide less economic and commercial value due to its low biological productivity and species diversity as reported by SEA-BMB, consultants for the Mount Apo Geothermal Project Environment Impact Assessment in 1991.

The river may play a function in the dispersal of discharge from the industrial, municipal and agricultural land run-offs to the surrounding areas within the watershed (Sigua & Tweedley, 2003). Significantly, the MANP benefited the irrigation facilities, industries, commercial, household and water utilities that operate in the administrative areas of Kidapawan City, Bansalan, Digos and Davao City (DENR-PAWCZMS, 2013). However, habitat modification, through water quality detriment and changes in flow regime may alter most of a river's water resource (LÓpez- LÓpez & Sedeño-Díaz, 2015). This makes freshwater ecosystems the most endangered and threatened ecosystem worldwide (Dudgeon et al., 2006). The water quality of a river, is, therefore, characterized by a high level of changes in time and space due to cover-land characterization (Al-Badaii et al., 2013). Anthropogenic pollutants could be related to land use that may result in drastic deterioration of aquatic systems in watersheds (Massoud et al., 2006).

The utilization of resources in Mt. Apo through

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various types of anthropogenic activities within and surrounding its riverine system is one major source of ecological stressors; thus, the need to conduct inventory and monitoring studies is very crucial.

Monitoring on water quality provides basis as to how and for what water can be used and the support it gives to the aquatic organisms and its ecosystem (Perez-Martinico et al., 2016). Thus, the focus of this study is to monitor the water quality and assess the freshwater fish composition and diversity of the Marbel River and the Matingao River of the Mount Apo Natural Park.

MATERIALS AND METHODS

Duration and area of the study

The study was carried out last October 2012, February, May and October 2013 and January, April and September 2015 in the Marbel River and Matingao River (*Figure 1*). The study sites are among the 19 major rivers of Mount Apo Natural Park (MANP) and tributaries of the Kabacan River. These rivers were reported to be physically draining to the Mount Apo Geothermal Project within the MANP. The two rivers are characterized by narrow channels and clear waters at highly elevated areas, with rapid water flows and rock boulder-rich river banks and beds. The Marbel River and the Matingao River are strategically located at the foot of the Mount Apo Natural Park in the province of North Cotabato with elevations of 1,476 and 1,355 masl, respectively.

The Matingao River has coordinates of 125˚13'22.89" E to 125˚11'21.46" E; 07˚1'9.03" N to 07˚1'55.69" N. The upstream of Matingao River begins in the geothermal project site situated in MANP, whereas, the midstream portion is being partly used in the small-scale industrial work such as hollow block making. The midstream area of Matingao River is a residential with proximity of approximately 10 households with no toilet. Additionally, the hot water from the Lake Agco also directly flows in the upstream portion of the Matingao River.

The Marbel River with coordinates of 125˚13'28.54" E to 125˚14'45.19" E; 07˚1'29.47" N to 07˚0'11.39" N- is narrower and rapid than the Matingao River. This river is being used primarily for river bank trekking of mountaineers mounting to the peak of Mount Apo.

Site selection and sampling scheme

Marbel River and Matingao River were divided into four sampling stations designated as: **S1**, upstream; **S2**, upper midstream; **S3**, lower midstream; and, **S4**, downstream. The location and elevation of the sampling stations were determined using a Global Positioning System (GPS) device. Surrounding land uses were also noted during survey.

Data Analysis

The Shannon-Weiner Diversity Index (H') was used to analyze the diversity index of collected fish species. Species richness and abundance of the fish were also determined in this study.

Fish collection and identification

The collection of fish was done along the 3 sampling stations within the river gradient using a low voltage (10V) improvised backpack electrofishing gear accompanied with gill net with approximately 1.2mm x 1.2mm mesh size employed in the down part of the river's gradient. The electric fishing method was intentionally used to catch specific fish species of interest where seine netting is not applicable (Paller et al., 2011).

The stunned fish caught by this method were immediately put in a bucket, documented and initially identified in the field. Description of the live fish was done by noting their color, number of fins, and barbels if present, shape of the tail and head, body structure and mouth. Voucher specimens for each species were preserved in a 10% formalin solution, and other stunned fish were returned to the water after their recovery from the current shock. Samples were identified and assessed in their current systematic status using the FishBase website (Froese & Pauly, 2018). Consultation with experts was also done for the verification of species.

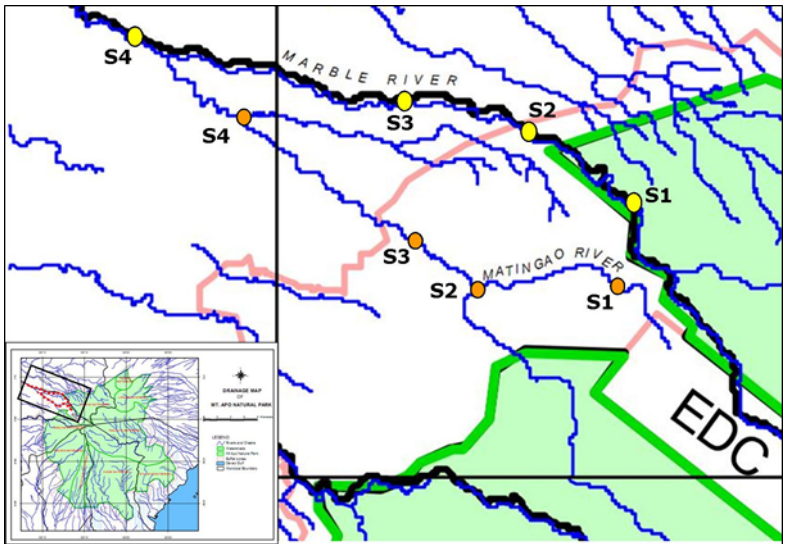

Figure 1. Modified study area and sampling stations map along the Marbel River and Matingao River, Mount Apo Natural Park.

Physico-chemical analysis

Parameters like water temperature, pH, oxidation reduction potential (ORP), electrical conductivity (EC), turbidity, dissolved oxygen (DO) and total dissolved solids (TDS) were measured in-situ using HORIBA U-52G multiparameter probe during wet and dry season. In every sampling stations of the river, nine (9) sampling points were randomly selected close to the right and left river banks and in the middle of the river with triplicates.

RESULTS AND DISCUSSION

Physico-chemical analysis

Table 1 shows the summary of the mean average values of physico-chemical parameters of Marbel River and Matingao River. Water temperatures in both river sites were high in year 2012-2013 (*Figure 2*). Minimal fluctuations for the pH (7.98-8.15) in Marbel River and Matingao River (8.39-7.66) for year 2012-2013 and 2015, respectively were observed. Whereas, a very low values of EC and TDS were noted in the two rivers in all year. The DO level varies between 9.3 (2012-2013) and 9.17 (2015) in Marbel River and 9.1 (2012-2013) and 8.94 (2015) in Matingao River. The water turbidity in Matingao River has low value of about 18.21 NTU in the year 2012-2013 and increases to 46.49 NTU in year 2015.

The study showed a fluctuation trend of physico-chemical parameters from 2012-2013 to 2015 across the two rivers of MANP (*Figure 2*) which may be due to elevation gradient and surrounding land use. The mean water temperature of both rivers was low which ranges between 18.9°C and 22.08°C. This is closely comparable to Layawan River (21.2°C-22.5°C) in Misamis Occidental (Cuivillas et al., 2016). A high temperature (22°C- 22.7°C) was observed in Station 1 and Station 2 in Matingao River which may be attributed to its proximity in the geothermal site of MANP and the sulfuric Lake Agco.

During the years of monitoring, a decrease trend of electric conductivity, total dissolved solids and turbidity in both rivers were observed (*Figure 2*). The high temperature of water recorded (22.7°C) in station 2 of Matingao River may be attributed to the total dissolved solid with value of 0.34 mg/L. Martinez et al. (2011) reported that increase in suspended and dissolved solids can increase the temperature primarily because they absorb heat from sunlight. The high rate of TDS of about 0.74 was recorded in the midstream station of Matingao River in the year 2015 which may be linked to the on-going road construction near the sampling site.

High turbidity rate (142 NTU) was observed in year 2012-2013 in upstream (S1) in Marbel River which gradually decreased in year 2015 (30.7 NTU). The high turbidity indicates the presence of colloidal particles arising from clay and silt during rainfall or from discharges of sewage and industrial waste or the presence of a large number of microorganisms (Olatayo, 2013). Hence, the geothermal plant in the upstream station may contribute to the turbidity in the Marbel River.

A decreasing trend of DO level from the upstream to downstream gradient of Marbel River in year 2012-2013 was evident (Figure 2). Inverse relationship was observed that when the concentration of DO decreases, water temperature increases. This corroborates the report of George *et al*. (2003) which states that higher temperatures reveal low DO concentrations. The highest DO level was recorded in year 2012-13 is 20.1mg/L and 19.2mg/L in Matingao River and Matingao River, respectively. It was observed that there was an increasing trend of pH value (7-8.8) from downstream to upstream gradient of the Matingao River in the year 2012-2013.

The water conductivity of the two rivers was high in S2 with the similar value of 0.54 in all years. The oxidation reduction potential (ORP) which is an essential indicator of natural and wastewater (Goncharuk et al., 2010) and classifies condition of a river has values ranging from 76 mV to 344.6 mV observed in all years. George et al. (2013) reported the inverse relationship of temperature and ORP, as the temperature increases, the ORP value decreases.

In the case of Matingao River in year 2012-2013, low ORP value (76 mV) was observed in S2 with high water temperature recorded at 22.66°C. However, it was noted in Marbel River in all years that station with high water temperature (21.97°C-21.76°C) has the high recorded rate of ORP value (154.9 mV-286.29 mV).

In general, Marbel River and Matingao River are naturally slightly alkaline with high pH values noted in Station 2 (8.84) and Station 4 (8.3) in Matingao River.

Table 1

Mean Parameter Values of Marbel River and Matingao River (2012-2013 and 2015)

Parameter	2012-2013		2015	
	Marbel River	Matingao River	Marbel River	Matingao River
Temp (C)	20.83	22.09	19.83	20.95
pH	7.98	8.39	8.15	7.66
ORP	141.69	82.91	269.38	312.02
EC (mS/cm)	0.39	0.26	0.45	0.19
Turbidity	50.73	18.21	53.56	46.49
DO (mg/L)	9.3	9.1	9.17	8.94
TDS (mg/L)	0.25	0.16	0.35	0.26

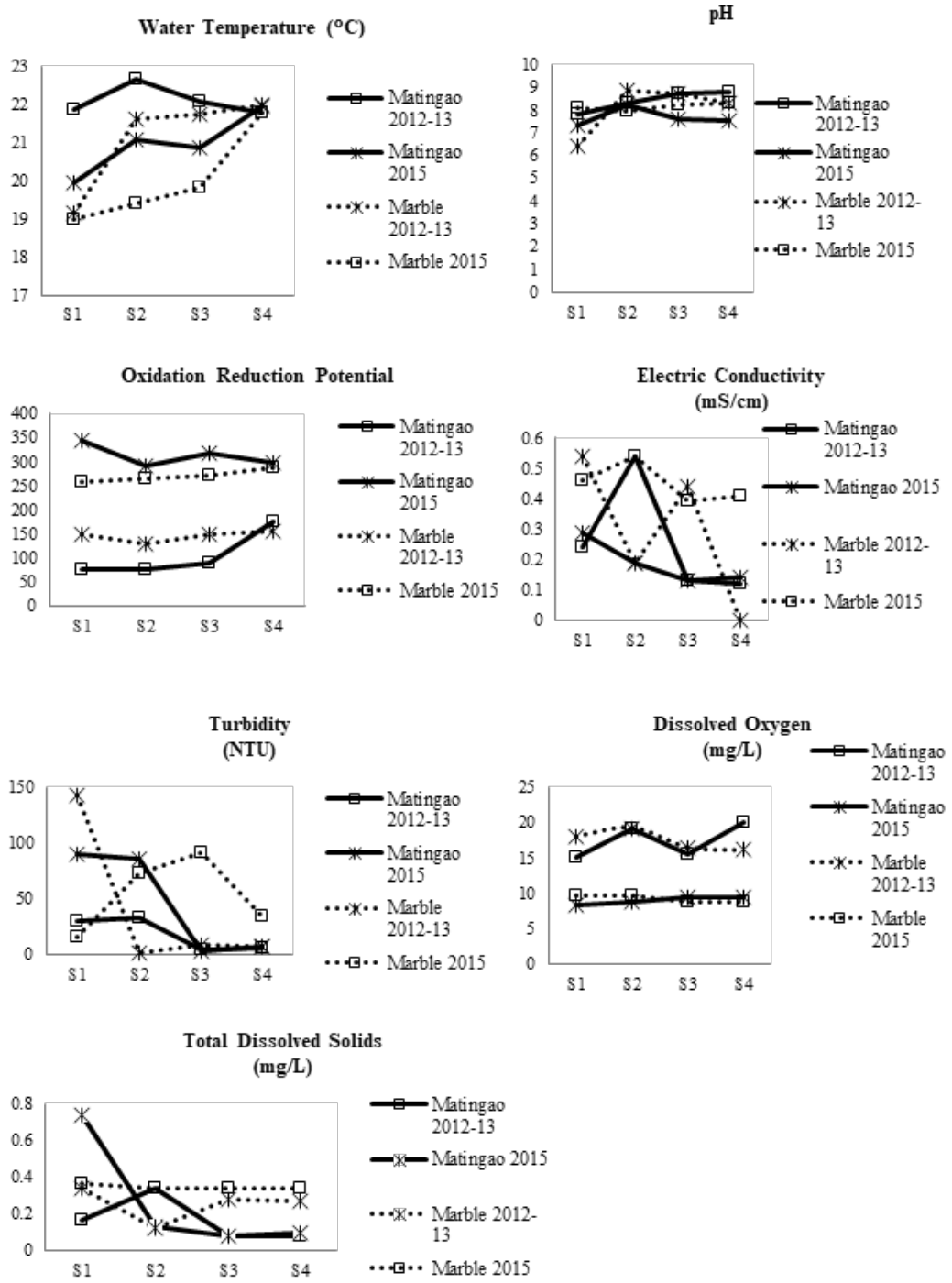

Figure 2. Distribution Mean Values of Physico-chemical Properties of Marbel River and Matingao River from 2012-2013 to 2015

High pH noted in Marbel River in year 2012-2013 was in Station 2 (8.84) and Station 4 (8.3) in year the monitoring year (2015). In the case of Matingao River, high pH was observed in Station 4 (8.8) in 2012-13 and Station 2 (8.2) in 2015.Whereas, low pH (6.39) was recorded in year 2012-2013 in Station 1 of Marbel River.

Reading of pH and other parameters that were done after rainfall could be the possible reason for the low reading of pH in Station 1. This corroborates the statement of Davie (2008), that rainfall naturally lowers the pH between ranges of 5 to 6. The pH finding in this study was closely comparable to the findings of Cuivillas et al. (2016) in Layawan River, Misamis Occidental that ranges between 7.62 and 8.30. As cited by Cuivillas et al. (2016), the water's pH in a river is primarily affected by its age and the chemicals discharged by communities and industries. In the case of Matingao River, high pH noted in Station 2 and 4 could be attributed to its proximity to residential houses were frequent bathing, and laundry were observed. Theoretically, pure water has pH of 7.0 (ASCC, 2003), such water with a little high pH refers to increase concentration of bicarbonates (Lutz and Francois, 2007).

Fish species diversity and composition

Table 2 shows comparative data for abundance of freshwater fishes collected in Marbel River and Matingao River for the year 2012-2013 and 2015. A total of six species (*Figure 3*) belonging to four families were collected in the Marbel River and the Matingao River. The native Barbodes binotatus (Valenciennes 1842) was found to be the most

abundant species in all years with values of 22.7% (2012-2013) and 13.40% (2015) in Marbel River and 16.9% (2012-2013) and 19.1% (2015) in Matingao River. Two species of introduced species belonging to family Poecillidae were also recorded in the two rivers, namely: Xiphophorus hellerii Heckel 1848, and Poecilia reticulata Peters 1859.

Shannon diversity index was found to be low in both study areas with values of 0.69 (2012-2013) and 0.68 (2015) for Marbel River and 0.70 in Matingao River, respectively in all years (*Table 3*). This shows that there were no variations of fish collected in all years among the two river sites.

During this study, no additional species have been collected in the monitoring year (2015). The most collected fish species is the native B. *binotatus* which is commonly found in most riverine ecosystem of Mindanao (Ismail, 2011) as cited by Cudal et al. (2019). Further, the native *Rhinogobius* sp. and *S. lagocephalus* of the family Gobiidae were collected during the whole period of the study. In terms of species individual counts per station, it was found out that the maximum numbers were recorded from low altitude areas particularly in midstream and downstream. This supports the study of Shaikh et al. (2011), which freshwater fish diversity in low and middle land areas was found to be higher.

CONCLUSIONS

The Marbel River and Matingao River supports low diversity of fish fauna comprising of four native (B. *binotatus*, *Rhinogobius* sp., *S. lagocephalus* and *A. marmorata*) and two introduced species (*X. hellerii*, and *P. reticulata*). The fishes of the Marbel River and Matingao River were mostly dominated by the native B. *binotatus*. Hence, the presence of introduced freshwater fishes indicates the disturbed state of the area. Further, the high turbidity rate was recorded in the Marbel River may be attributed to the presence of geothermal plant in the upstream portion of the river.

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Table 2

Freshwater Fish Species Recorded in Marbel River and Matingao River (2012-2013 and 2015)

Species	Year	Marbel River				Matingao River			
		Relative Abundance (%)				Relative Abundance (%)			
		S1	S2	S3	S4	S1	S2	S3	S4
Cyprinidae									
Barbodes binotatus *	2012-2013	17.10	25.50	6.20	22.70	10.5	8.2	12.3	16.9
	2015	14.95	13.76	16.25	13.40	8.5	7.7	7.8	19.1
Gobiidae									
Rhinogobius sp.*	2012-2013	10.1	8.8	11.0	13.1	10.8	8.5	12.0	7.6
	2015	9.8	8.0	14.4	7.2	11.9	8.1	7.9	6.7
Sicyopterus lagocephalus*	2012-2013	9.4	7.4	11.2	10.2	11.9	7.8	7.6	7.5
	2015	7.8	7.4	8.9	5.4	9.2	9.0	13.3	6.9
Poeciliidae									
*Poecilia reticulata***	2012-2013	8.0	7.0	8.2	7.2	5.0	9.4	13.2	10.2
	2015	5.5	6.0	7.1	5.7	8.9	11.6	8.3	10.1
*Xiphophorus hellerii***	2012-2013	10.0	8.4	8.9	10.0	11.4	9.0	9.1	6.8
	2015	6.9	7.8	7.6	4.6	10.7	11.5	8.2	7.9
Anguillidae									
*Anguilla marmorata**	2012-13	1[a]	-	1[a]	3[a]	-	-	1[a]	2[a]
	2015	1[a]	-	-	-	-	1[a]	2[a]	1[a]

Note: [a] individual count only
* native species
** introduced species

Table 3

Diversity Index of Marbel and Matingao River (2012-2013 and 2015)

Diversity Indices	2012-2013		2015	
	Marbel River	Matingao River	Marbel River	Matingao River
Shannon-Weiner (H')	0.69	0.70	0.68	0.70
Species Richness	6	6	6	6

Figure 3. Freshwater fish collected in Marbel River and Matingao River, MANP. (A) *Barbodes binotatus* (Valenciennes 1842); (B) *Anguilla marmorata* Quoy and Gaimard 1824; (C) *Sicyopterus lagocephalus* (Pallas 1770); (D) *Rhinogobius* sp.; (E) *male and female Xiphophorus hellerii* Heckel 1848; (F) *Poecilia reticulata* Peters 1859.

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