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ASSESSMENT OF MACRO-INVERTEBRATES BIODIVERSITY AND PLANT SPECIES IN A RIPARIAN ZONE OF TAGUIBO WATERSHED, BUTUAN CITY, PHILIPPINES

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Abstract

This aimed to assess and identify the abundance of macro-invertebrates and plant species diversity in the riparian zone of Taguibo Watershed, Butuan City, Agusan del Norte, Philippines. The study used quadrat method that was set in the area. Purposive method was used in the collection of data. Results showed that the macro-invertebrates found in the riparian zone were ants, flies, Japanesse shells, millipede, damselfly, earthworm, centipede, butterfly and dragonfly. For the plants, hagonoi (Wedeliabiflora Linn.) plant has the number distribution (1,520) with an average of 152 and a relative abundance of 31.56. The least species of plant is banana (Musa sapientum I. Var.) and papaya (Carica papaya) plant (1) species with an average of 0.1 and a relative abundance of 0.2. The abundance of the identified species was referred to the RED List of threatened species.

Keywords: Taguibo watershed, evenness, macro-invertebrates, relative abundance

INTRODUCTION

Riparian vegetation includes plant communities in streams, on river banks and in floodplains and is an integral part of riverine ecosystems. Riparian vegetation may grow in habitats exposed to lateral water flow, which may be the main force regulating the functions of riparian ecosystems and their biogeochemical cycles (Graf, 2008; Jahnson and McCormick, 2012; Maingi and Marsh 2006; Ali et al., 2011; Arif et al., 2012). Riparian vegetation along streams and rivers is diverse in species, structure and regeneration processes (Maingi and Marsh 2006), represents a unique biological community (Ledec, 2006) and has important ecological functions in maintaining landscapes and biodiversity (Hitoshi and Toshikazu 2008). Riparian habitats contain a diverse collection of valuable species and are regarded as biodiversity corridors (Corbacho *et al.* 2003). The riparian habitat harbors a wide range of vegetation communities (Leibowitz, 2003) that function as a link between terrestrial and aquatic zones (Malason, 2010) and may be considered as an ecotone between these two ecosystems. Riparian vegetation requires a perennial supply of water and sediments to perform ecological functions (Mligo 2007), such as stabilizing stream banks, storing nutrients, providing shade to stream banks and migratory fish, maintaining moisture in riparian soils and improving water quality (Castelli *et al.* 2000; Gillilan and Brown 1997; Johnson *et al.* 2000). Riparian habitats also provide diverse foraging and breeding sites that support the coexistence of many wildlife species (Tucker and Wayne, 2010). Mainly, ecosystem is the interaction of living organism in a particular natural environment (Allaby, 2015) thus, species are living organism such as plants, animals and microorganism were dependent to their habitat, the natural environment. The riparian zone is one part of the ecosystem that provides important habitat for the species (Tapen, 2014) and the character of a riparian zone is dependent upon the condition of its watershed (NRCS, 2013). In Butuan City, Taguibo watershed is one of the sources of water of the residence. This watershed has experienced historical modifications of its land-cover due to the presence of logging industries in the 1950s, and continuous deforestation due to illegal logging and slash-and-burn agriculture in the present time (Santillan, et al. 2011). The amounts and type of vegetative ground cover, the area of the watershed, and the slope of the terrain are directly related to the percentage of water that will enter the drainage system as surface flow or as percolated water. Riparian plant composition, habitat structure, and productivity are determined by the timing, duration, and extent of flooding (NRCS, 2013). However, Human activities, such as agriculture, timber harversting, development, and recreation cause

often damaged or removed vegetation. These could negatively have affected the wildlife habitat and also in the quality of water (PSE, 2015). Last 2010, the Department of Environment and Natural Resources (DENR) was fully involved for development of watershed and they conducted enrichment planting and reforestation (DENR, 2010). These activities could restore the health of riparian zone, because it helps to slow down the speed at which water flows into rivers; regulating the water level prevents extreme floods and droughts downstream and benefit both the species living in and alongside the water channel, and the people that are using the water (Gray, 2014).

The abundance of plants species and macroinvertebrates is subject as indicator to determine the development of watershed specially the riparian zone. This would also help to manage in maintaining well balanced ecosystem by realizing how the riparian zones function as a habitat of plant species and macro-invertebrates. The used of determining the plant species is, it gives a natural coordination with each species' life cycle that highly dependent on the others particularly for plants (The Native Plant Society of Northern Ohio, 2014). It also macro-invertebrates exhibit varying responses to changes in water chemistry, water quality and physical habitat. Each macro-invertebrate's response to environmental perturbations produces measurable, and often predictable, shifts in abundance and composition at the community level. Many watershed monitoring programs include biological indicators in addition to chemical and physical tests for routine monitoring (EnviroScience, Inc., 2017). This study on the riparian macro-invertebrates and plants of the Taguibo River joins the ongoing studies conducted of many researchers in the region. Building a history of riparian vegetation dynamics in this river system in relation to anthropogenic disturbances has been difficult because limited information has hampered the determination of the riparian plant ecology. The Taguibo River is situated in a matrix of various land-use systems, including protected areas, cultivated areas (farmlands), and settlements.

MATERIALS AND METHODS

Location of the study area: The study was focused on determining and identifying the richness of the plant species and macro-invertebrates in Taguibo, Watershed. The researcher seeks information if the riparian zone has well-function as habitat of both plants and macro-invertebrates. The Taguibo River covers an area of 4,367.44 hectares which includes Barangay Anticala in Butuan City, Barangay San Antonio in Remedios Trinidad Romualdez (RTR) and Barangay Mahaba in Cabadbaran and a portion of Sibagat, Agusan del Sur. The area has set 10 quadrants with 5 meters width and 5 meters length for every quadrant with equal chances to the given area is taken for the samples of study.

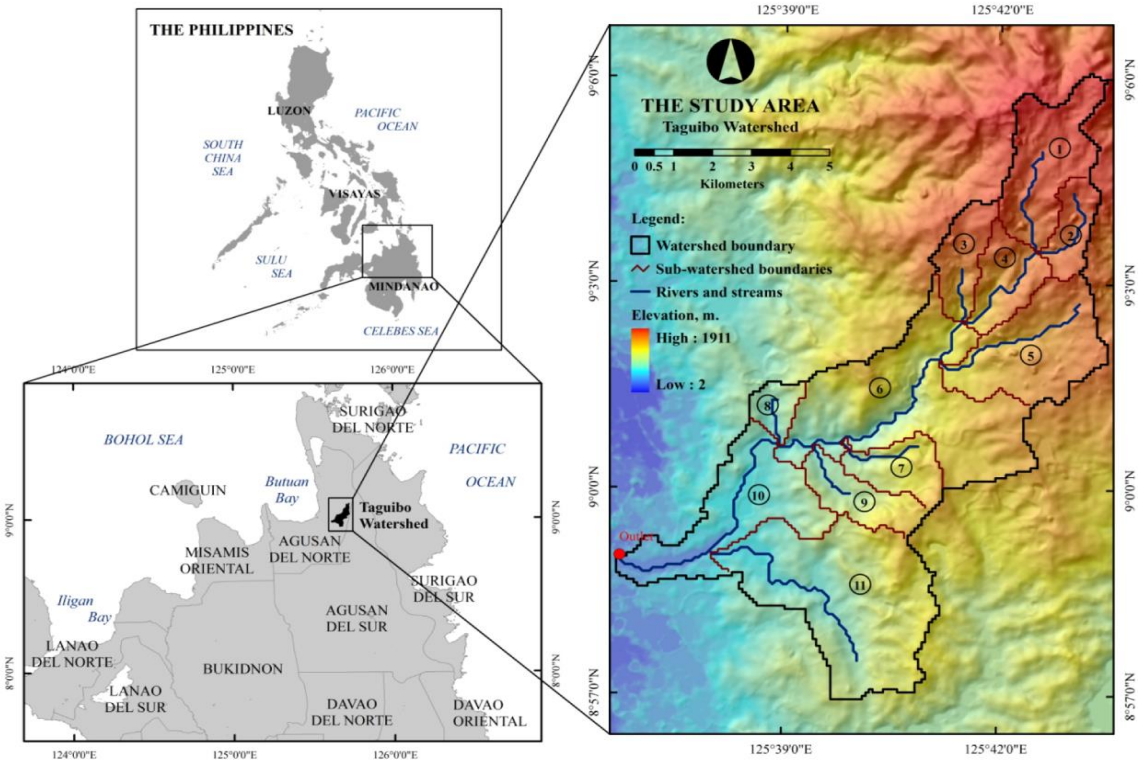

Figure 1. The map of Taguibo Watershed, Anticala, Butuan City.

Sampling procedure of the riparian zone:

The method used in the study is descriptive research. This method is tested with a given scientific inquiry related to the concerned statement of the problem. This involves descriptive, analysis, classification and interpretation existed. The study aimed to determine the species diversity of plants and macro-invertebrates found in Taguibo Watershed, Butuan City.

On the collection of data,The researchers used a quadrants with a 5 meters in height and 5 meters in width in which researchers set 10 quadrants in the area given. The data found within those set of quadrants both plant species and macro-invertebrates are then named and counted based on what plants and macro-invertebrates in order to know the relative population. Data are then interpreted by a Biologist so that data gathered are credible.

Data analysis: Riparian plant species diversity was determined by using the Shannon diversity index (Shannon and Weaver 1948) according to the following formula (Equation 1);

$$Diversity\ Index\ (H') = -\sum \infty ipiln\ piDiversity\ Index\ (H') = -\sum i \infty piln\ pi$$

..... (eq.1)

where pi = ni/N and is the proportion of the total number of all species in a plot and

ln = natural logarithm to base *e*.

Evenness (E) was calculated using the formula by Alatalo (1981) (Equation 2):

$$Evennes\ (E) = \frac{(H')}{ln\ S}$$

..... (eq.2)

where H′ is the Shannon–Weaver diversity index and S is the total number of species at a site. An analysis of variance (ANOVA) was used to test whether there were significant differences in the species diversity and evenness among sites and Tukey's test was used to identify the data sets that were significantly different (Graphpad Instat 2003).

Classification of vegetation communities using TWINSPAN: Two-way indicator species analysis (TWINSPAN) is a technique in the community analysis package (CAP) software program (Henerson and Seaby 1999) that identifies riparian plant communities based on species composition and indicator species (Hill et al. 1979). Using TWINSPAN, the riparian vegetation samples were separated into two groups at the center of gravity of the ordination to produce a dichotomy and an indicator species that defined the two emerging groups of samples. Each of the groups required a division of levels to represent homogeneity among the inclusive vegetation samples of the riparian plant community. The indicator species identified associated communities and the major differences in plant species composition among them based on levels of disturbance. This analysis provided an indicator value (ranging from 0 to 100%) for all the species, and a species was considered an indicator of a given site if its indicator value was >25%, which follows the method of Dufrene and Legendre (1997). During the analysis, however, the rare plant species (species that had less than a 5% frequency in all the sampling sites) were excluded to minimize noise in the data set.

RESULTS AND DISCUSSION

Relative abundance of plant: Table 1 shows the abundance of plants species as identified in the riparian zone of the watershed. As identified, *Wedeliaflora (Linn.)* or Hagonoi has the most number of distribution with a total of 1,520 individuals, an average of 152, and relative abundance of 31.56. On the other hand, the least number of species in the riparian area is *Musa sapientum I. var.* (Saging) and *Carica papaya* plants with a distribution of 1 species and a relative abundance of 0.02. Based on results, there were 5,064 plant species in 11 families recorded in the riparian zone of Taguibo Watershed with a Shannon diversity index in the range of 1.63–2.94 and a significantly decreasing trend downstream were recorded from all sites. The species diversity ranged between 1.63 and 2.94, whereas the species evenness ranged between 0.314 and 0.488 and displayed an apparent decreasing pattern downstream in the river system for the first three sites from the upstream (Fig. 1). This downstream trend did not continue because of intensive disturbances in the latter site resulting from cultivation in the floodplains and areas close to the riverbanks.

Table 1. Relative abundance of plant species

	QUADRATS												
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**	**Total no. of Species**	**Relative Abundance**
Wedeliabiflora (Linn.)	177	198	225	188	8	162	153	162	76	171	152	1520	31.56
Paspalumrengger steud.	96	63	90	10	67	34	42	25	101	14	54.2	542	11.25
Justiciagendarussa	176	15	14	121	42	0	16	5	23	65	47.7	477	9.90
Mimosa pudica	70	54	63	8	140	14	17	16	65	1	44.8	448	9.30
Miscanthusseninsis	65	43	65	30	31	5	14	32	162	0	44.7	447	9.28
Cynodondactylon	154	26	75	8	58	0	73	0	4	21	41.9	419	8.70
Euphorbia hirta	25	12	5	53	10	0	176	15	32	10	33.8	338	7.02
Imperatacylindrical	0	26	15	23	32	5	70	101	12	1	28.5	285	5.92
Carigolahastata (L.) raf.	15	0	13	26	43	22	16	17	19	12	18.3	183	3.80
Malabulak	0	12	10	12	17	0	65	34	16	15	18.1	181	3.76
Bidenspilosa	16	75	1	4	7	10	1	3	4	0	12.1	121	2.51
Ipomoea aquatica	14	20	10	2	0	15	17	23	0	0	10.1	101	2.10
Musa sapientum I. var.	1	0	0	0	0	0	0	0	0	0	0.1	1	0.02
Carica papaya	1	0	0	0	0	0	0	0	0	0	0.1	1	0.02
Total	**810**	**544**	**586**	**485**	**455**	**367**	**660**	**433**	**514**	**310**	**506.4**	**5064**	**105.15**

Table 2. Relative assessment of macro-invertebrates in the riparian zone of Taguibo Watershed

Local Name	Family Name	Scientific Name	Abundant / Limited
Ants	Formicoidea	*Formicidae*	Limited
Flies	Nematocera	*Diptera*	Abundant
Japanese Shells	Mollusca	*Venerupis philippnarum*	Abundant
Millipede	Myrapodia	*Diplopoda*	Limited
Damsefly	Odonata	*Zygoptera*	Abundant
Dragonfly		*Anisoptera*	Limited
Earthworm	Oligochaeta	*Lumbricina*	Abundant
Centepede	Myriapoda	*Chilopoda*	Limited
Butterfly	Nymphalidae	*Rhopalocera*	Limited
Grasshopper	Orthoptera	*Caelifera*	Limited
Spider	Arachnae	*Arachnida*	Limited
Beetle	Coccinelidae	*Coleopteran*	Limited

Relative assessment of macro-invertebrates:

Table 2 shows the relative assessment of macro-invertebrates in the riparian zone of Taguibo Watershed. Study revealed that there were four (4) types of species are abundant (*Diptera, Venerupis philippnarum, Zygoptera, and Lumbricina)* and eight (8) macro-invertebrates were limited (*Formicidae, Diplopoda, Anisoptera, Chilopoda, Rhopalocera, Caelifera, Arachnida, and Coleopteran).*

Based on actual observations and documentations, ants are the most abundant species in the riparian zone and beetle is the least species. Ant assemblages are focal ecological indicators of progress in the site, often showing increasing species richness with restoration. Certain functional groups also behave in predictable ways in response to disturbance and changes in the environment due to rehabilitation and construction of dikes along the area. Whether these ant responses can be applied to other types of restoration and ecosystems is unknown, especially in dynamic environments and where gradients may not be as severe as in the area. The ant assemblages would be expected to perform

poorly as ecological indicators in dynamic environments because such environ is a watershed where sometimes undergone reconstruction due to improvements or rehabilitations. Indeed, periodic disturbance may limit the predictive power of any ecological indicator. In contrast to the findings of others, species richness was variable among replicate locations of the same habitat type, and did not differ in the rest of the quadrants. There were also fairly distinct species assemblages associated with unplanted zone of the area. Additionally, there was no evidence in the riparian zone why beetle has least number found in the area. This result contrast previous studies showing positive relationships between beetle species richness and dung removal in riparian zone. It found weak but significant positive relationships between riparian reserve width and beetle diversity, and between reserve vegetation complexity and beetle abundance, suggesting that these features may increase the conservation value of riparian reserves. This demonstrates that the preservations of riparian reserves increase biodiversity within the landscapes. However, the lack of correlation between beetle community characteristics and reconstruction of dikes will results to the removal highlights the need for further research into spatial variation in biodiversity–ecosystem function relationships and how the results of such studies are affected by methodological choices.

CONCLUSION

The most abundant species were *Wedeliabiflora (Linn.)* or Hagonoi and least plant species were *Musa sapientum I. var.* (Saging) and *Carica papaya*. For macro-invertebrates there were 12 species and 11 families. Based on the above observation, a change in land use planning for the conservation of riparian ecosystems and improved water shed management is required to ease the pressure on riparian ecosystems by minimizing anthropogenic disturbance. Agreements must be reached among various sectors and institutions so that the efforts to conserve are shared and the local community should not be left out since they are the beneficiary of the ecosystem at a local scale. Such efforts will tremendously reduce the ongoing disturbances and degradation of riparian habitat in Taguibo Watershed ecosystem. It is recommended that wide buffer zones be established along riverbank with protected habitat types in the associated riparian areas to reduce the direct impact from agriculture.

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