Floral Diversity and Habitat Assessment of Canbantug Forest, Argao, Central Visayas, Cebu, Philippines

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Abstract— The secondary forest of Canbantug, covering 49 hectares of forest patch, are one of important habitats for Cebu's rarest birds. Except for some non-systematic and non-comprehensive rapid surveys conducted in the area, no true plant diversity assessment has been done yet in the mountain. Mt. Canbantug is one of the least botanized karst forest mountains in Cebu as part of the Palinpinon range which is a key biodiversity area. It is safe to say that the plant diversity of. Mt. Canbantug is still unknown. Consequently, the lack of knowledge from these floral resources would mean loss of accounts to biodiversity. The survey primarily aims to know the remaining indigenous and endemic plant and tree species present in the mountain. An initial rapid plant diversity survey was conducted in Brgy. Canbantug on May 12-16, 2017 using 2-km transect method with 10 x 10 m sampling plots to completely account all tree species. Results reveal at least 132 morpho-species belonging to the seed plants (Angiosperms and Gymnosperms), ferns and their allies that were recorded from the area. About 68% (62/91) of which are native species, including 5 Philippine endemics. Noteworthy among the list are the 3 critically endangered (CR) species namely; Kamagong (*Diospyros blancoi*), Narra (*Pterocarpus indicus*) and Kaningag (*Cinnamomum cebuense*). Results of the rapid plant survey revealed that Mt. Canbantug has considerable plant diversity value. It is very important to emphasize that the area covered by the survey is a very small fraction of the target site, yet a significant number of ecologically important species were recorded. A laymanized pictorial guide on the flora of Mt. Canbantug can be developed to increase the knowledge and appreciation of the stakeholders on the beauty and importance of the native trees of the mountain.

Index Terms— floral diversity, habitat assessment, Canbantug forest, endemicity, urbanization, indigenous, biodiversity, limestone forest.

1 Introduction

THE Philippines is highly regarded as one of the top biodiversity "hot spot" areas of the world supporting 1.9 percent of the world's endemic plants and vertebrates species [1]. In fact, the Philippines is one of the 17 mega-diverse hotspots around the world in terms of species, habitat and other ecosystems as well as in terms of area in acre per acre basis [2]. Much of the diverse types of forest ecosystems in the country, Cebu has forest over limestone ecosystem that is now under many types of pressures [3]. Unlike the very scientific and organized conservation programs being poured into other forest ecosystems in the country, there is no consensus effort that would ensure effective biodiversity conservation and forest rehabilitation, most specifically in the Island of Cebu, where a unique forest over limestone ecosystem and diverse fragmented forest remains with imminent threat.

Protected areas have been established to conserve the Philippine 'biodiversity'. Repeated data sampling or 'monitoring' can show if the biodiversity of an area is being maintained in accordance with the NIPAS Act and the management objectives of the area [4],[5]. It is imperative that a more scientific and doable approach such as the permanent biodiversity monitoring system (PBMS) would give contributory impacts to biodiversity conservation and rehabilitation program in the region and be formulated and adopted by the concerned stakeholders to completely protect the remaining resilient biodiversity and forest ecosystems in the Island of Cebu [6]. As an Island, Cebu contains diverse flora and fauna from a large number of endemic families, genera and species that include many interesting forms [7]. Additionally, the research greater facilitate the overall efforts of the region towards the remaining fragmented and concentrated forest of Cebu and its conservation and rehabilitation program be formulated and adopted by the concerned stakeholders to create a more resilient forest biodiversity in the forest over limestone ecosystems as the strength of the Island [8]. Among the remaining forest areas, the four (4) KBAs namely Mt. Capayas (covering 4 municipalities: Catmon, Carmen, Danao and Asturias), Mt. Lantoy (Argao), Mt. Nug-As (Dalaguete, Alcoy and Boljo-on), Mts. Kangbulagsing and Lanaya (Alegria and Malabuyoc) are among of the least biologically explored mountains in Cebu [9]. Except for some non-systematic and non-comprehensive rapid surveys conducted in Mt. Nug-As, no true plant and animal diversity assessment has been done yet in the aforementioned KBAs. It is safe to say that the plant and animal diversity of the said KBAs is still totally unknown.

Consequently, without the knowledge of those plant and animal species present in the KBAs, the people of the nearby Municipalities and Barangays are being deprived of the potential benefits that can be derived from the plant and animal resources. The survey primarily aims to know the important medicinal plants present in the mountain. Additionally, updated data on floral diversity, are needed to planning, project formulation, budget allocation, identification of research needs and directing management intervention programs for municipalities containing the KBAs and eco-tourism sites in Cebu

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province.

2 METHODOLOGY

2.1 Survey and Data Collection

An initial rapid plant diversity survey was conducted in Brgy. Canbantug on May 12-16, 2017 using 2-km transect method with 10 x 10 m sampling plots to completely account all tree species. One of the areas of interest for this survey is the diversity transect plots for the wildlife monitoring. Hence, the team also used the transect plot method for plant survey. All plant species within the 10-meter width (5 meters from each side of the trail) along the more than 2-km BMS transect (approximately 2.3 kilometers) were identified. Trees with diameter of not less than 10 centimeters (> 10 cm) were measured i.e. diameter at breast height (DBH), total height (TH), and merchantable height (MH). Since the whole transect is basically a limestone vegetated area, heavily dominated by Molave (*Vitex parviflora*), Moraceae species (*Ficus spp*.) and Narra (*Pterocarpus indicus*), the team decided not to count the number of individuals for each species. Instead, dominant species were noted. Apart from the BMS transect, the forested area at the higher elevation of the mountain was also surveyed. Three 10 x 10 meters transects were established and surveyed at three portions of the forest with different vegetation/stand maturity. One of the transects was established at the transition area between the grassland and the secondary forest, while the other two transects on early second growth forest. Similar with the survey along the BMS transect, all plant species along transects were identified. Diameter and height of trees with diameter > 10 cm were measured. In addition, to have a good idea of the stand structure and species composition of the forest, abundance or count of each species more than 1meter in height was obtained. An opportunistic flora survey involving listing and photo documentation of the different species encountered outside transects, was also carried out to account for maximum possible species in the area

2.2 Collection of Voucher Specimens

Sample specimens were taken of each species that are difficult to identify in the field. These were returned to base camp and processed at the end of each day of survey in order to preserve the specimens prior to identification at the end of the survey period. The Sweinfurth's method (commonly known as "wet collection" method), a standard plant collection technique was employed for collected specimens. This involves the soaking of properly labelled specimens in ethyl alcohol to avoid rapid wilting and crumpled drying. Important information as to the habitat, physiognomy, slope and aspect, characteristics of the plants that will be lost after drying, DBH and TH were noted down. The specimens were then packed in polyethylene bags and sealed for further analysis at the laboratory.

An opportunistic flora survey involving listing and photo documentation of the different species encountered outside transects, was also carried out to account for maximum possible species in the area.

2.3 Identification of Plant Materials

All specimens collected during the survey period were dried and systematically processed at the Taxonomy Laboratory of the Forestry Department, Cebu Technological University-Argao Campus. Relevant literature (Flora Malesiana, Flora of Manila, Enumeration of Philippine Flowering Plants, Lexicon of Philippine Plants, Blumea, Leaflets of Botany among others) were consulted for the initial identification of the dried plant materials. Specimens were then compared with the image database on type materials of the Philippines for final identification.

2.3 Data Analysis

Information gathered in the field were tabulated and analyzed to characterize every species recorded from the study area. The status of plant diversity was assessed using parameters such as species abundance, dominance, density, and importance value (IV). In addition, endemism, ecological status and economic uses of the different species were assessed to determine the ecological importance of the vegetation in the area. Species names followed the latest Angiosperm Phylogeny Group classification (APG version 13) while the common names adapted that of Rojo (2001) [10]. Local names provided by the community guides were also incorporated.

$$\text{Density} = \frac{\text{number of individuals}}{\text{area sampled}}$$

$$\text{Relative Density} = \frac{\text{density for a species}}{\text{total density for all species}} \times 100$$

$$\text{Frequency} = \frac{\text{number of plots in which species occur}}{\text{total number of plots sampled}}$$

$$\text{Relative Frequency} = \frac{\text{frequency value for a species}}{\text{total frequency for all species}} \times 100$$

$$\text{Dominance} = \frac{\text{basal area or volume for a species}}{\text{area sampled}}$$

$$\text{Relative Dominance} = \frac{\text{dominance for a species}}{\text{total dominance for all species}} \times 100$$

$$\text{Importance Value} = \text{Relative Density} + \text{Relative Frequency} + \text{Relative Dominance}$$

3 RESULTS AND DISCUSSION

Lowland forest over limestone or otherwise known as "karst forest ecosystem" varies with regards to forest structure, species richness as well as species composition, hence, variation is in line with respect to high diversity known from other types of rain forest [11]. Canbantug limestone forest is generally a part of the Palinpinon range of Argao-Dalaguete karst forest corridor and part of the local conservation area in Mt. Lantoy [9]. It is characterized by a limestone vegetation or karst forest. It comprises a mosaic of different plant and tree species representing different families. The forest structure of limestone area in Canbantug shows

different stages of recovery from the previous human and natural disturbances. The conservation area is predominantly a forestland with a large proportion (> 40%) being a natural forest while the remaining forests are man-made from a long history of reforestation efforts by the DENR. Despite the very limited survey time and effort, the results of the rapid plant survey revealed that Mt. Canbantug has remarkable plant diversity. At least 192 morpho-species belonging to the seed plants (Angiosperms and Gymnosperms), ferns and their allies were recorded from the area. Some specimens were not able to be identified to the species level and have therefore been tentatively assigned to the most probable taxon (family or genus). Most of these are in their juvenile stage (seedlings/saplings) and/or are sterile specimens (without flowers or spores), as identification of plant species is very much dependent on the variation exhibited by the reproductive structures.

There can be significant differences in the vegetation between plots in the area just a few kilometers apart, and major differences in tree species composition between prestratified plots from only a few hundred meters from each other. Whether variation at a larger spatial scale is due to distance between sites, environmental variables that differ between sites, or a mixture of both cannot be distinguished in this study. In the multivariate analyses performed, there is correlation between the slope gradient and differences in species composition. This can be seen at a smaller scale, from within site comparison, and can be speculated to influence the distinct grouping of the rocky site in comparison to the other sites. Overall, there are a total of 192 species, 159 genera belonging to 62 plant families documented from the families of Myrtaceae, Fabaceae, Moraceae, Malvaceae, Lamiaceae, Burseraceae, Anacardiaceae, Annonaceae, Melastomataceae, Combretaceae, Sapindaceae, Monimiaceae and Rubiaceae. The most frequently occurring species were *Matthaea sp*., *Memecylon paniculatum*, *Diospyros philippinensis* A. DC., *Ixora macrophylla* Bartl. ex DC., and *Casuarina equisetifolia* Forst. The aforementioned species were present in all transects except for the *Strombosia sp*., of the family Olacaceae.

Tree Flora

A total of 142 tree species with 675 individuals were recorded to have a diameter of more than 10 cm. The average number of trees per quadrat (10m x 10m) is about 15 individuals or an average density of 0.150 tree/m^2 (15 trees for every 100 m^2). This is slightly higher than the normal average stocking density of a second growth forest which is .05 tree/m^2 (5 tree for every 100m^2). The relatively higher tree density of the quadrats can be attributed to the maturity of the forests. Most areas surveyed are in the early advanced stage of forest succession characterized by the dominance of medium-sized trees. The trees with the largest diameter are Narra (*Pterocarpus indicus*), Malaiba (*Rhus taitensis*), Paguringon (*Cratoxylum sumatranum*), Lamio (*Dracontomelon edule*), Piling-liitan (*Canarium luzonicum*), Molave (*Vitex parviflora*), Amugis (*Koordersiodendron pinnatum*), Bolong eta (*Diospyros pilosanthera*) and Ditaan (*Lepiniopsis ternantensis*).

The relative density, relative dominance and relative frequency values for each tree species in all the quadrats were determined to obtain their Importance Value (IV), a standard measure in ecology that determines the rank relationships of species. High Importance values of species indicate a composite score for high relative species dominance, density and frequency. Based on the computed IV (Table 1), the three most important species (with the highest IV) are Narra (62.22), Molave (54.16), and Malaiba (17.209). It is interesting to note that all of these species are all indigenous species and yet they are all dominating and thriving in the area. This imply a high conservation value of the area.

TABLE 1
TOP 10 SPECIES WITH THE HIGHEST IMPORTANCE VALUE (IV).

Scientific Name	Common Name	Family Name	IV
Pterocarpus indicus	Naga	Fabaceae	62.223
Vitex parviflora	Tugas	Lamiaceae	54.165
Rhus taitensis	Malaiba	Anacradiaceae	18.209
Lepiniopsis ternantensis	Ditaan	Rubiaceae	11.322
Cratoxylum sumatranum	Paguringon	Hypericaceae	7.959
Canarium luzonicum	Piling liitan	Burseraceae	7.214
Diospyros pilosanthera	Bolong eta	Ebenaceae	6.049
Koordersiodendron pinnatum	Amugis	Euphorbiaceae	6.000
Aglaia elliptica	Salakin pula	Hypericaceae	5.176
Dracontomelon edule	Lamio	Anacardiaceae	5.121

Intermediate and Understorey

A total of 142 individuals belonging to 26 species were recorded for intermediate species. The average density is slightly higher than that of trees, at 0.72 individual/m2 or equivalent to 72 individuals for every 100m^2. The two most abundant understorey species are Salakin pula (*Aglaia elliptica*) with 41 individuals and Tamayuan (*Strombosia sp*.) with 34. Both species are Philippine endemics which confirm the high biodiversity value of Mt. Canbantug.

TABLE 2

TOP 10 SPECIES WITH THE HIGHEST RELATIVE COVER

Scientific Name	Common Name	Family Name	Relative % Cover
Aglaia elliptica	Salakin pula	Meliaceae	23.16
Matthaea sp.	Matthaea	Monimiaceae	15.47
Aglaonema philippinense	Aglaonema	Araceae	14.86
Mikania cordata	Uoko	Asteraceae	5.56
Christella dentata	Christella	Ptelypteridaceae	3.18
Paspalum conjugatum	Carabao grass	Poaceae	3.15
Psuedolepanthopus spicatus	Dilang baka	Asteraceae	2.12
Alpinia sp.	Luyahan	Zingeberaceae	2.10
Calamus sp.	Calamus	Arecaceae	1.34
Calophyllum blancoi	Bitanghol	Clusiaceae	1.13

Ground Cover

There are 24 ground cover species recorded from the thirty 1m x 1m quadrats. It must be noted that the ground cover species referred in this survey are all species (crawling or erect) inside the 1m x 1m quadrat with height of less than 1 meter. Hence, seedlings of different tree species are included as ground cover. This treatment gives us better understanding of the stand structure of the forest from the ground to the canopy. Based on the survey, forest litter occupies more than 52% of the forest floor leaving less growing spaces for the ground cover species, hence, low species diversity. The most dominant species that occupy the highest relative cover are Bagang-aso (23.21%), Carabao grass (5.47%), and a species of aroid, Aglaonema (4.86%) (Table 4).

Diversity Index

Based on the number and abundance of all the species, Paleontological Statistical software package for education and data analysis (PAST version 3.12) was used to compute for diversity indices including Shannon (H'), Evenness (J') and Simpson's (D) index for all the transects and quadrats. Shannon Index gives an estimate of species richness and distribution. Evenness Index tells us how evenly species and/or individuals are distributed inside a plot or quadrat. Simpson's Index gives the probability of getting different species when two individuals were drawn (with replacement) inside a plot.

All four transects showed high diversity in both Shannon (H') and Simpson's (D) diversity index, following the classification scheme suggested by [12] (Table 5). Transect established near Natural secondary forest (NatF) had the highest Shannon index (4.316), followed by the plot in mixed secondary forest (Sf), along Mixed forest (Mf), then the lowest is the plots established along the trail where the DENR conducts their reforestation (Plantation forest, Pf). The high diversity index for the plot is understandable considering the number of species and individuals recorded. All transects have more than 90 species and 320 individuals. It is important to note that in terms of Shannon diversity index, the ordering of the plots is inversely related to the maturity of the forests where the transects were established. NatF and Sf are relatively young secondary forests characterized by denser stands but smaller sized and stunted trees. More pioneer/gap species is also present in these young secondary forest. On the otherhand, Mf and Pf are obviously more advanced, older second growth forests comprised of few larger trees and less understorey species.

TABLE 3
DIVERSITY INDICES AND NUMBER OF SPECIES AND INDIVIDUALS IN FOUR TRANSECTS

TRANSECT PLOT	Diversity Indices		
	Shannon Index (H')	Simpson Index (D')	Evenness (J)
NatF	3.316	0.9808	0.6466
Sf	3.169	0.9708	0.5875
Mf	3.008	0.9495	0.5720
Pf	2.286	0.9312	0.5622

Value interpretation for H': Very High = ≥3.5 above, High = 3.0-3.49, Moderate = 2.5-2.99, Low = 2.0-2.49, Very Low = ≤1.9 and below

Biodiversity Value

The ecological or biodiversity value of an area is always measured in terms of species richness and in the number of endemic and threatened species present [14]. Species that are of botanical importance (endemic, threatened, and new record) are listed below:

Endemic Species

The geographical distribution of plant species has been very useful for assessing biodiversity values of regions, countries, and islands. Species confined to a particular site should be given particular conservation management strategies, as they are more vulnerable to disturbance due to their narrow range. Of the total 192 taxa identified to species level, 19 species (10%) were found to be Philippine endemics or have natural habitat confined only in the country (Table 4) [13]. Noteworthy among the list are those species that are also included in either the Philippine red list or in the International Union for Conservation of Nature (IUCN). These include Antipolo, Piling liitan, Kaningag, Bolong eta, Lamio, Dao, Narra, and Molave. These trees should be prioritize for species conservation.

It should be emphasized that categorizing species as endemic is very much dependent on availability of published biodiversity data, recent taxonomic revisions, nomenclatural

changes, and new evidences from various disciplines used in systematics among others. Thus, estimates of endemism should be interpreted within the context of the methodologies and limitations imposed by contributing factors aforementioned. In this study, a number of specimens have not been identified to the species level. This definitely will influence the percent endemism estimates.

TABLE 4
LIST OF PHILIPPINE ENDEMIC SPECIES RECORDED IN MT. CANBANTUG

SPECIES	Common Name	Family Name
Artocarpus blancoi	Antipolo	Moraceae
Artocarpus ovatus	Anubing	Moraceae
Callicarpa elegans	Tigau ganda	Lamiaceae
Canarium luzonicum	Piling liitan	Burseraceae
Christella dentata	Christella	Thelypteridaceae
Cinnamomum cebuense	Kaningag	Lauraceae
Cratoxylum sumatranum	Guyong-guyong	Hypericaceae
Dasymaschalon clusiflorum	Malaates	Annonaceae
Dracontomelon edule	Lamio	Anacardiaceae
Goniothalamus amuyon	Amuyong	Annonaceae
Macaranga bicolor	Hamindang	Euphorbiaceae
Macaranga grandifolia	Takip Asin	Euphorbiaceae
Melicope triphylla	Matang-araw	Rutaceae
Neonauclea bartlingii	Lisak	Rubiaceae
Palaquium philippense	Malak-malak	Sapotaceae
Pandanus luzoniensis	Alas-as	Pandanaceae
Pterospermum obliquum	Kulatingan	Sterculiaceae
Terminalia nitens	Sakat	Combretaceae
Ziziphus talanai	Balakat	Rhamnaceae

Threatened Species

The conservation status of species is based on the most recent recommendations of the Philippine Plant Conservation Committee (PPCC) of the Protected Areas and Wildlife Bureau (PAWB), DENR officially issued as DENR Administrative Order No. 2007-01 better known as ''The National List of Threatened Philippine Plants and their Categories'. The listing of threatened species of the IUCN red list was also used as reference. Eighteen (18) species (Table 5) recorded from Mt Canbantug are listed under either the Philippine Red List (DAO 2007-01) or the IUCN Red List of Threatened Species (2016.1). Noteworthy among the list are the critically endangered (EN) Lauaraceae species, Kaningag [16], and the ornamental native tree, Bagauak morado [12], [15].

Even if Narra and Molave are one of the most dominant tree species in the protected area, appropriate management and monitoring strategies to ensure the continued survival of its population (as well as other threatened species) should be developed.

TABLE 5
LIST OF THREATENED SPECIES RECORDED IN MT. CANBANTUG

Scientific Name	Common Name	Family Name	DAO 2007-01	IUCN (2016-1)
Aglaia edulis	Malasaging	Meliaceae	VU	
Aglaia rimosa	Bayanti	Meliaceae	VU	
Aphanamixis polystachya	Kangko	Meliaceae	VU	
Artocarpus blancoi	Antipolo	Moraceae		VU
Canarium luzonicum	Piling liitan	Burseraceae		VU
Cinnamomum cebuense	Kaningag	Lauraceae	EN	EN
Clerodendron quadriloculare	Bagauak-morado	Lamiaceae	CR	
Diospyros pilosanthera	Bolong eta	Ebenaceae	EN	
Dracontomelon dao	Dao	Anacardiaceae	VU	
Dracontomelon edule	Lamio	Anacardiaceae	VU	
Drynarya quercifolia	Kabkab	Polypodiaceae	VU	
Koordersiodendron pinnatum	Amugis	Anacardiaceae	VU	
Macaranga bicolor	Hamindang	Euphorbiaceae		VU
Pterocarpus indicus	Narra	Fabaceae		VU
Swietenia macrophylla	Big Leaf Mahogany	Meliaceae		VU
Terminalia nitens	Sakat	Combretaceae		VU
Vitex parviflora	Molave	Lamiaceae	EN	VU
Ziziphus talanai	Balakat	Rhamnaceae		VU

Note: CR – Critically endangered; EN – Endangered; VU - Vulnerable

4 Conclusion

Results of the plant diversity assessment revealed that Mt. Canbantug has very high biodiversity value. The local conservation areas (LCA) [9] is home to at least 192 plant and tree

species. More than 14% of which are exclusively found in the country. Moreover, a significant number of threatened species were observed in the area. Many of these threatened species (i.e. Kaningag, Piling liitan, Bolong eta, Narra) are dominating the remaining natural forests of the study site. It is therefore highly justified to conclude that Mt. Canbantug is an ecologically critical area. PAMB and all other concerned stakeholders should by all means exert their best effort to protect and conserve the area. Though, the primary reason for this is the obvious scarcity of flora exploration in the region, Mt. Canbantug (as part of the Mt. Lantoy KBA) will now be listed as native habitat of these native species.

Considering the paucity of biological information in the flora of Mt. Canbantug, the information incorporated in this report should find its way into the mainstream of the science of biodiversity conservation. Information that were initially gathered as well as how such information will be utilized for management purposes need to be documented and eventually worked out. It should serve as guide and reference, not only for the KBA staff but also to the general public, particularly to those involve in forest and native tree conservation. As part of the ecotourism and people awareness campaign of the PAMB, it is also recommended that those trees, particularly those along the commonly traversed trail should be labeled by its name and other important information (uses, distribution, historical account, etc.) regarding the species. This will allow the visitors know more about our native trees that will eventually raise their awareness and appreciation to their conservation.

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