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Diversity and structure of Native trees on Mount Capayas key biodiversity area, Catmon, Cebu, Philippines

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Abstract

The forest cover of Cebu Island was now less than 1% of its total land area due to rampant anthropogenic activities, leading to the extinction of many native trees and other biodiversity species. Assessing native trees on Mount Capayas Key Biodiversity Area was important in decision-making process particularly in the conservation of the area. Eight Permanent plots with 20m x 100m dimension were established in the study site. A total of 132 species were recorded in the area, classified into 54 families and 98 genera. Out of 132 species, 118 were native trees, five shrubs, seven ferns, and two vines, highlighted with three species as new record. Majority of the species were recorded in Plot number 2, 3, 5, and 8. Ten native trees were categorized as threatened, with one species considered as Critically Endangered, four Endangered, three Vulnerable, and two as Other Threatened Species. Mount Capayas has moderate species diversity (H'=2.74), dominated by *Neonauclea calysina* (Bartl. ex DC.) Merr. (14.95%). Majority of the native trees have a diameter of 10–19cm (79%) and basal area of 8.8 m2/ha. All this information on native trees were essential for the rehabilitation and conservation of Mount Capayas.

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Introduction

The Philippines is one of 17 mega diverse countries, with more than 52,117 described species (Myers *et al.*, 2000). Biodiversity loss from Asia is alarming based from the record of PCAARRD (2017), due to rampant anthropogenic activities leading to environmental degradation. This phenomenon makes the Philippines being part of the biological hotspot (Agenda, 2018), supporting 1.9 percent of the word's endemic plants and vertebrate species (Myers *et al.,* 2000).

Cebu Island is known to have the most important karst and non-karst landscapes in the Visayas. Its flora and fauna are remarkably unique from one island to another within the region (Fernando *et al.*, 2008). Biodiversity in this island is extraordinarily rich and diverse. As reported by Collar *et al.* (1999) the island of Cebu was already considered as the most denuded island in the central Philippines. The forest cover of Cebu Island according to Mallari *et al.* (2001) is now less than 1% of its total land area. Bensel (2008) reiterating further for the rampant expansion of agriculture and fuel wood gathering, creating pressure on the last remaining forests of Cebu Island. The almost complete deforestation of Cebu Island has apparently led to the extinction of many native trees, birds and other wildlife (Brooks *et al.*, 1995).

Department of Environment and Natural Resources-United National Environment Program (DENR-UNEP) revealed that there are no known management plans for addressing the plants threat in the Philippines, particularly in Cebu Island where some of the unique fauna and flora exist (i.e., Cebu cinnamon, Cebu flowerpecker, Cebu cinnamon and Cebu blueberry (Salares *et al.,* 2018; UNEP 2012).

Mount Capayas was identified as one of the Key Biodiversity Areas (KBA) in Cebu Island by the Department of Environment and Natural Resources (KBA 81) with an area of 13,610 hectares (CI, DENR, and Haribon 2006). Mount Capayas also serve as conservation priority area (CPA101), covering the Municipality of Carmen, Danao, Asturias, and Catmon. Based from the study conducted by Conservation International Philippines, Department of Environment and Natural Resources, and Haribon Foundation (2006) Mount Capayas as a KBA also hosting two endangered tree species, and 16 restricted-range species of fauna.

Native trees constitute the basic foundation of the country's forest ecosystems. Countless centuries of evolution through natural selection has given native trees adaptability to their respective local environments (Lantican, 2015). Information on the diversity and structure of native trees in Cebu Island still inadequate. Apparently, no extensive exploration has been done in Mount Capayas. Evaluating and updating the diversity and structure of the native tree species in KBA's are essentials. This information are necessary for creating conservation plans and programs for native plants (Hyvärinen *et al.,* 2011), as well as basis in the formulation of effective policies regarding areas focusing on the conservation of forests (PCARRD, 2017; UNEP, 2012). The study aimed of determining the diversity and structure of Native trees on Mount Capayas KBA, for management and conservation planning.

Materials and methods

Study site

The study was conducted in Mount Capayas Key Biodiversity Area (KBA), lies at coordinates 10.64286N, and 123.94244E, elevation ranges from 200m to 725m (e.g. Fig. 1). The distance from Cebu City is 57.9 km. The KBA covering the Municipality of Carmen, Danao, Asturias and Catmon with an area of 13,610 hectares (CI, DENR, and Haribon, 2006). Mount Capayas Key biodiversity Areas is among the remaining areas with patches of closed forests in the Northernpart of Cebu Island.

It contains some remnant primary lowland forest, but is characterized by highly disturbed secondary growth forest. *Field data collection* Permanent plots were established in lower (200m) and upper elevation (above 500m) areas of Mount Capayas. The size of the plots was 20m x 100m, and a total of 8 plots were established in highly stratified vegetation to generate information in all vegetation classes. A vegetation class is usually composed of different strata or layers such as tree canopies, shrub canopies, grass cover, and litter (Wang *et al.,* 2001; Wu and Zhao, 2001; Zhang *et al.,* 2006). Coordinates of all the trees within the plots were taken and recorded.

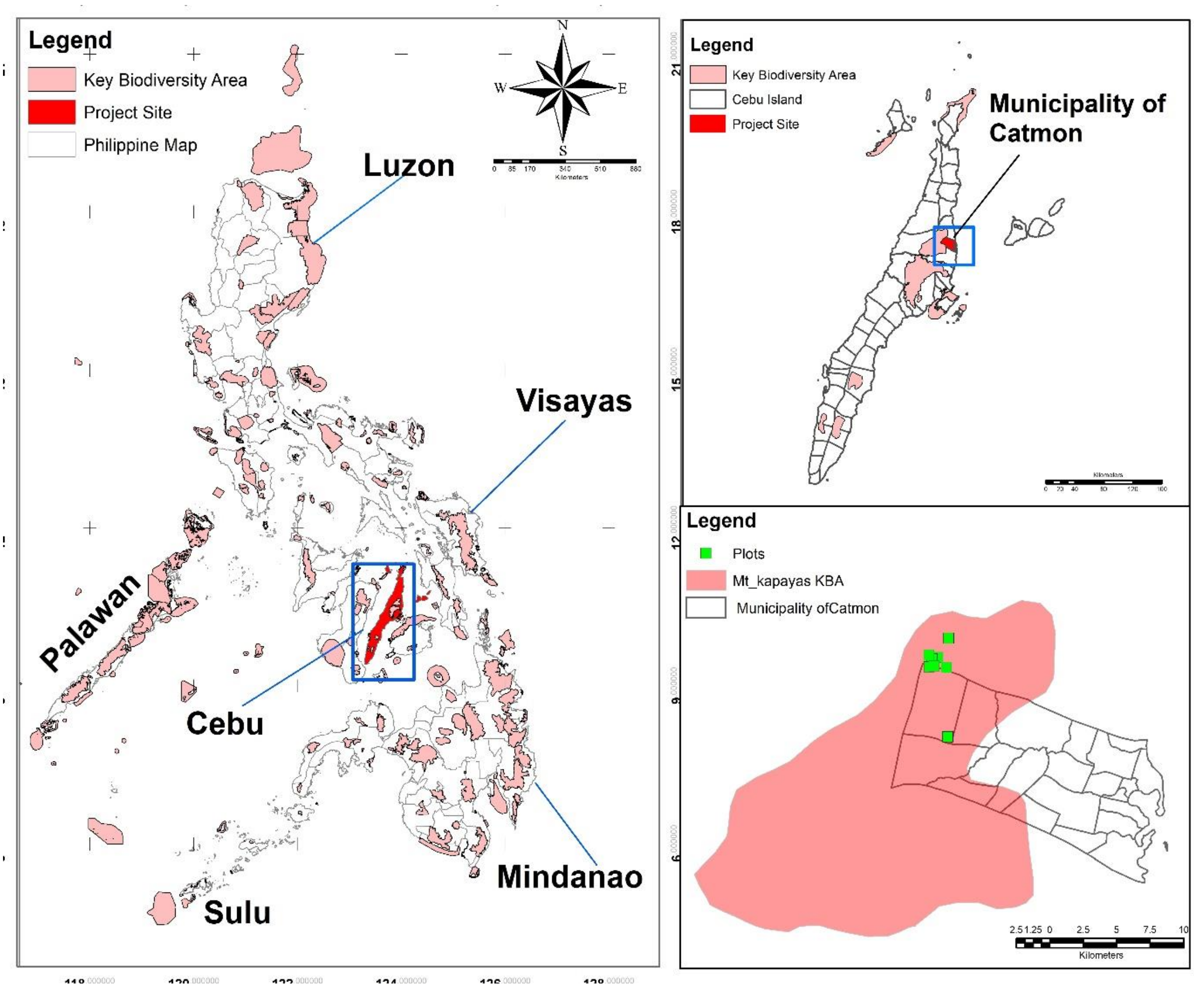


Fig. 1. Location of Cebu Island in the Philippine map, Municipality of Catmon, and the Study site (Mount Capayas) (GIS generated map and from Google earth).

Each sampling plot was further divided into five (5) equal segments (20m x 20m) to facilitate recording of plants in the canopy layer having diameter at breast height (DBH, cm) of 10cm and above. Nested subplot of 5m x 5m, on the other hand, was laid at the center of each segment for data recording of plants in the intermediate layer having DBH of less than 10cm. Further, four (4) smallest nested plots (1m x 1m) on the inner edges of the 5m x 5m plot were also laid to list down species in suppressed ground cover vegetation.

Data recorded in the field were: (i) plant names from family down to species level; (ii) bio-measurements on diameter at breast height (cm) and total height (m); and (iii) GPS coordinates of all corners of each segment and nested plots. Relative locations of trees were sketched on the gridded portion of the record sheets.

Plant Species Identification and Conservation Status

Voucher specimens for every individual of plants within the plots were collected and tagged. The collected specimens were brought to the herbarium laboratory of Cebu Technological University – Argao Campus for proper identification after oven-drying. Identification of sample specimens were done through manual means (Checklist of Species in Mount Makiling; Fernando, 2007), herbarium comparison (Philippine National Museum file), digital database (Co's Digital Flora of the Philippines), and online literature (http://www.theplantlist.org), and the expertise of Dr. Inocencio E. Buot (plant botanist UPLB, Laguna, Philippines) as project consultants. Conservation status of the species was determined based on classifications by the Department of Environment and Natural Resources (DENR, 2017) and the International Union for the Conservation of Nature (IUCN, 2017). Endemicity of the species were determined based on its biogeography. Biogeography of the native tree species were determined through Co – Digital flora of the Philippines (https://www. philippineplants.org), Published literature/online literature, books (Lexicon of Philippine Tree by Rojo *et al.* 1999), Merrill's Enumeration of Philippine Flowering (1923), Leaflets of Philippine Botany (Elmer 1906 -1939), and Flora Malesiana volumes 1 – 14 (1948-2000). The identified herbarium specimens were deposited in the newly established mini-museum of the institution (CTU-DOST NICER Biodiversity Museum) as well to other accredited biodiversity museum. The mini-museum showcased the different species collected from Cebu Island KBA for instruction and research purposes.

Mapping of Native Tree Species

The location and distribution of native trees in each site were indicated in the map, as well as the location of each sample plot. The ground coordinates and elevation of each plot were determined by using GPS. The plot was oriented in North - East direction to have an easy estimation on the local coordinates of individual tree within plot. The local coordinates of each individual tree within the plot was determined by adding the X and Y distances to plot coordinates (Bantayan *et al.,* 2015).

Data Analysis

Plant species density, dominance, frequency, and importance value

All the recorded data were stored in a Microsoft Excel database and analyzed quantitatively by using Microsoft Excel statistics. Vegetation analysis was done using the formula of density, relative density, dominance or basal area, relative dominance, frequency, relative frequency, and the Importance Value (IV) Index. The ecological importance of each species in relation to the total forest community was calculated by summing its relative density, relative dominance, and relative frequency (Curtis and Macintosh, 1951). Importance Value (IV) of trees provides a better index than density alone regarding the importance or function of a species in its habitat.

Diversity of plant species

Native tree species diversity was computed and interpreted by using the Shannon index of diversity (H'), Simpson's (Ds), and Brillouin index of diversity facilitated through the Multi-Variate Statistical Package (MVSP) software. Shannon diversity index was sensitive to areas with fragmented forest like Mount Capayas. Compilation of species diversity values of all sample plots provide valuable information, particularly in explaining relationship with diversity and the presence/absence of anthropogenic or natural stress factors in the site.

Clustering of native tree species community

Clustering analysis of native tree community and composition were determined using the Jaccard's, Simpson's and Sorensen dissimilarity matrix through the MVSP software. Differences in native tree species composition between sites were assessed with floristic dissimilarity matrices in terms of presence/absence (PRAB) and species abundance (ABU) data criteria.

Results and discussion

Study site characterization

Mount Capayas Key Biodiversity Area's (KBA) in general was characterized as forest over limestone habitat types. Its geological composition was mostly raised sedimentary and metamorphic rocks and was covered by large size of outcrop bedrocks with shallow soil and undecomposed organic matters. The KBA has an elevation ranges from 200m to 725m or described as mountainous topography. The habitat type description can be characterized as Karst topography and conformed to the forest over limestone of the Philippine (Audley-Charles *et al.*, 1979; Fernando *et al.,* 2008).

Mount Capayas KBA was covered by less dense vegetation, small size trees, and few large trees. Lesser vegetation and smaller size trees were observed in the lower part of the mountain.

The mountain was dominated by the species of Alstonia *macrophylla* Wall. Ex G. Don., *Cratoxylum sumatranum* (Jack) Blume., *Ficus ampelas* Burm.f, *Leucaena leucocephala* (Lam.) de Wit, *Neonauclea calysina* (Bartl. ex DC.) Merr. *Rhus taitensis* Guill. *Schefflera obtusifolia* Merr., *Psychotria luzoniensis* (Cham. & Schltdl.) Fern.-Vill., and *Radermachera pinnata* (Blanco) Seem.

The characteristics and description of the vegetation in the study site conformed to the Philippines forest over limestone as described by Fernando *et al*., (2008), and similar to the so-called 'Molave' *(Vitex parviflora)* forest as described by Whitford (1911).

Composition of Native trees

Mount Capayas KBA recorded a total of 132 species, classified into 54 families and 98 genera for the 8 plots (20mx100m). Out of 132 species, 118 were categorized as Native tree species, 7 ferns, 5 shrubs, and 2 vines (Table 1). Majority of the native tree species were recorded in plot 2, 3, 5, and 8. Less species were recorded in plot 1, 4 and 7 (Table 1). The most recorded genera were *Ficus, Cinnamomum*, and *Artocarpus*. For families, the most dominant were Moraceae, Rubiaceae, and Lauraceae. In the case of species, the area was dominated by *Ficus ampelas* Burm.f, *Neonauclea calycina* (Bartl. ex DC.) Merr, and *Psychotria gitingensis* Elmer. All the dominant species were considered as pioneer species or belong to secondary growth forest, and classified as small tree category (Rojo *et al.,* 1999). The recorded frequency of native tree species in Mount Capayas were higher as compared to Mount Lantoy KBA with 88 (Lillo *et al.*, 2019).

Table 1. Species composition of different life forms in Mount Capayas per plot.

Plots	Family	Genus	Species	Native trees	Ferns
1	17	24	32	28	4
2	21	36	50	40	9
3	24	32	42	34	6
4	15	21	26	22	4
5	21	34	49	39	8
6	18	29	37	30	5
7	15	20	32	23	7
8	20	27	50	32	7
Total	54	98	132	118	7

Mount Capayas KBA was highlighted with three native tree species as new record. These three species were considered as new record because based from the study of Lillo *et al.*, (2019) in Mount Lantoy KBA of the Municipality of Argao, the southern portion of Cebu Island, and none of these species were encountered. These species were *Toona calantas* Merr. & Rolfe, *Agathis philippinensis* Warb, and *Cinnamomum iners* Reinw. ex Blume, Bijdr. (Table 2).

The three species were classified as native trees but under the category of non-endemic indigenous species (https://www.philippineplants.org/FamsAlph.html) because the species were also recorded in other countries. Two of the species (*Toona calantas* Merr. & Rolfe, and *Agathis philippinensis* Warb) were categorized as threatened under the category of vulnerable (DENR, 2017-11), and Endangered in IUCN 2.3.

The three species were recorded in Plot eight, at an elevation of 671m above sea level. Of the 132 species, 76 native tree species were endemic to the Philippines and eight were endemic to Cebu Island (https://www. philippineplants.org/ FamsAlph.html). The result was equivalent to only 2.5% of the total number of endemic tree species in the Philippines. The country has 3000 endemic trees (Philippines: Biodiversity-Plants, 2005). Comparing the result to Hamiguitan Range Wildlife Sanctuary in the Province of Davao Oriental in Mindanao Island with 163 endemic species of vascular plants (Amoroso *et al.,* 2009, Madulid, 1991), it was equivalent to 46% in terms of endemicity. The result implies that Mount Capayas KBA serve also as habitat to endemic native tree species which need to be conserved and protected.

Table 2. New record of native tree species in Mount Kapayas (KBA), Cebu, Island.

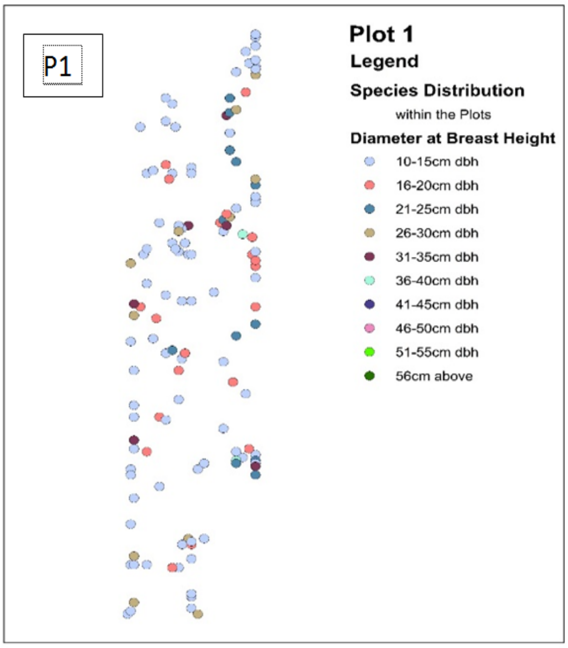
Species	Family	Endemicity	Conservation Status	
			DENR-DAO 2017-11)	IUCN 2.3
Toona calantas Merr. & Rolfe	Meliaceae	Non-Endemic Indigenous species (Sumatra)	VU	Endangered
Cinnamomum iners Reinw. ex Blume, Bijdr.	Lauraceae	Non-Endemic Indigenous species (Java)	Not assessed	LC
Agathis philippinensis Warb.	Araucariaceae	Philippines	VU	Endangered

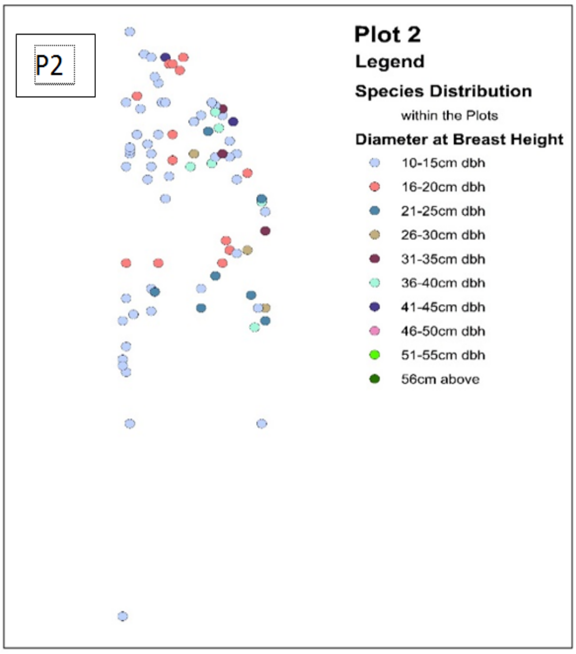
Vegetation Structure

The vegetation structure of a certain forest served to give insight into its stand density (Podong *et al.,* 2013). Vegetation structure would further described and give insight on the vertical stratification of the native trees in the area. In this study Mount Capayas was covered by 1023 individuals of native trees. Most of this native trees were recorded in plots 6, 5, 1 and 3 (Table 3; e.g. Fig. 2a and 2b). The diameter of the majority of native trees were from 10-19cm. (79%), with basal area of 8.88m²/ha, mostly recorded in plots 6 and 5 (Table 3; e.g. Fig. 2b). Only 21% of the native trees has diameter of more than 20cm. However, trees with diameter of 20cm and above have larger basal area (9,67m²/ha), as compared to smaller trees (Table 3). Majority of this larger in diameter trees were recorded in plot 7, 1 and 6 (Table 3; e.g. Fig. 2a and 2b).

Table 3. Diameter classes and frequency of native trees per plot.

Diameter classes (cm)	Frequency								Total	%	Basal Area (m²/ha)
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8			
10 - 19	113	69	113	88	136	171	35	79	804	79	8.88
20 – 29	27	11	16	18	9	24	25	13	143	14	4.39
30 – 39	9	10	7	2	3	2	23	2	58	5	3.49
40 and above	0	2	4	1	3	0	8	0	18	2	1.79
Total	149	92	140	109	151	197	91	94	1023	100	





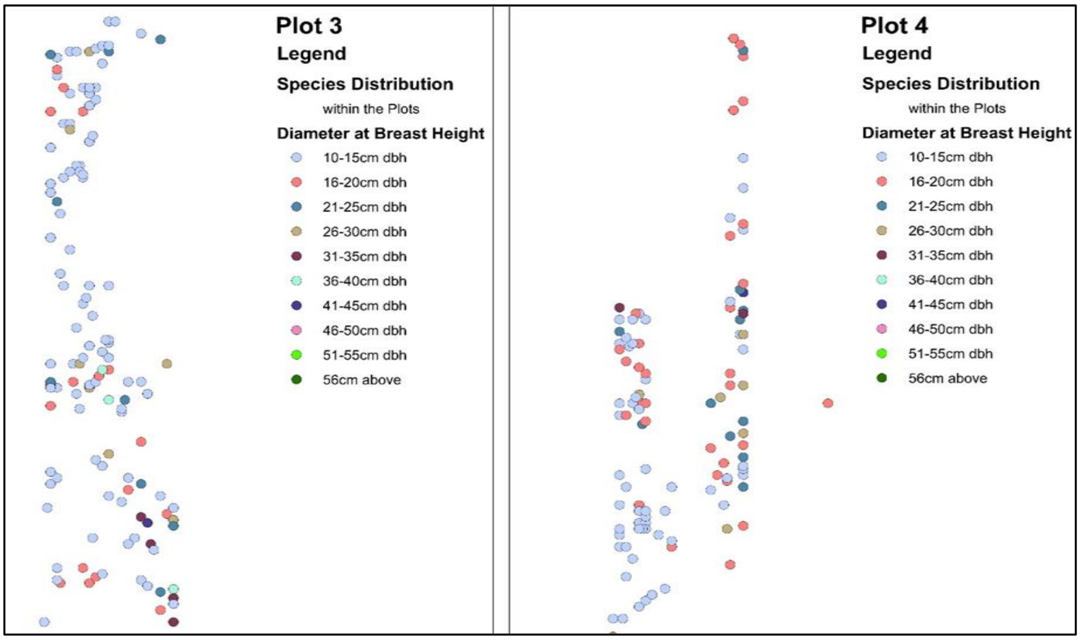


Fig. 2a. Structure and density of native trees on Mount Capayas KBA's (Plot 1, 2, 3, 4).

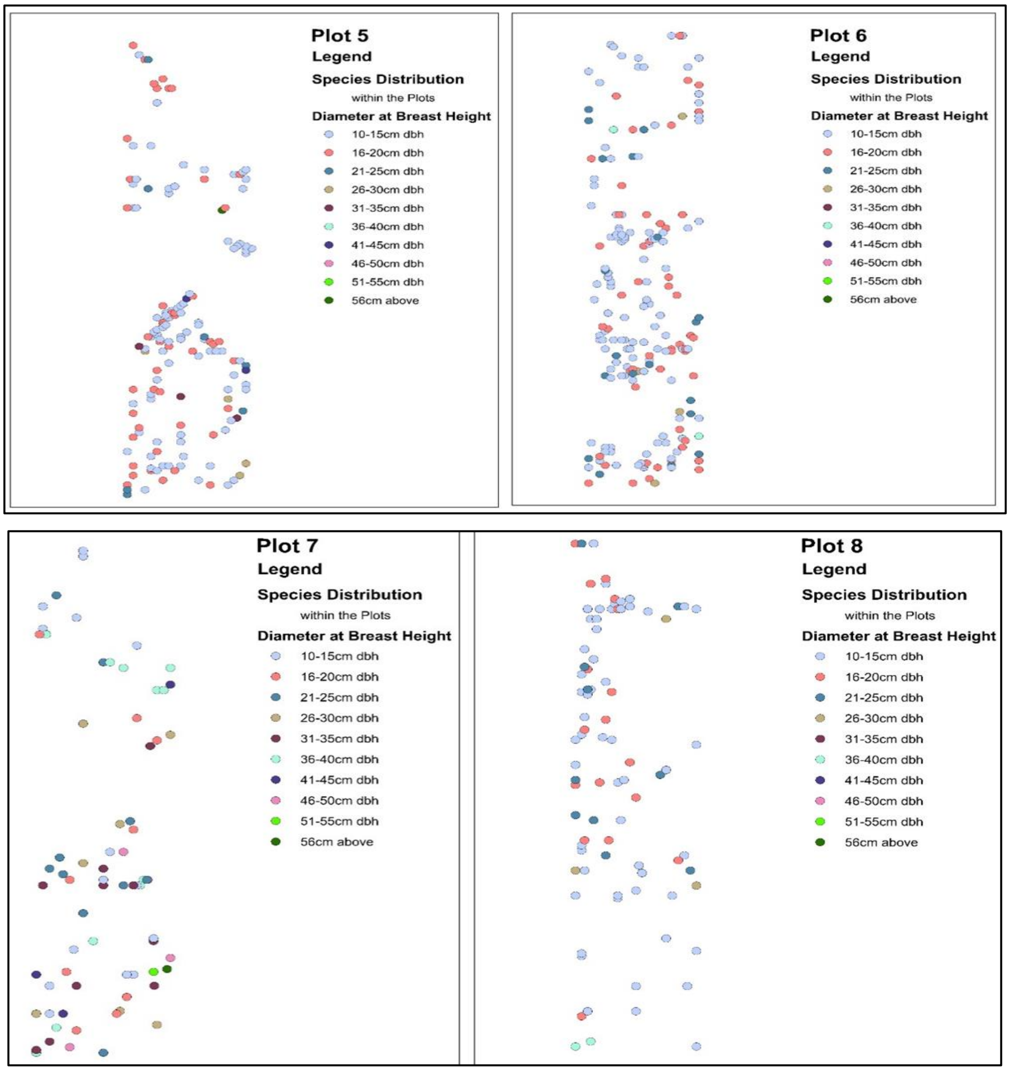


Fig. 2b. Structure and density of native trees on Mount Capayas KBA's (Plot 5, 6, 7, 8).

The higher percentage in small diameter trees in Mount Capayas (Table 3; e.g.Fig. 2a and 2b) reflects the dominance of small-sized individuals in the forest and in turn, suggests the high rate of regeneration (Bekele, 1994; Senbeta, 2006). The presence of small size trees in the site allows greater penetration of sunlight down to the forest floor (Senbeta, 2006). Tesfaye Burju *et al.*, (2013) added that diameter class distribution of tree species demonstrated various patterns of population structure, implying different population dynamics among species. In addition the higher percentage of small diameter trees in Mount Capayas conformed to the vegetation and characteristics of the Philippines forest over limestone as described by Fernando *et al.,* (2008).

Importance Value

Based on computation the most dominant species on Mount Capayas KBA was *Neonauclea calysina* (Bartl. ex DC.) Merr. (14.95%) (Table 4). Based on observation and record, the species considered as the most dominant in terms of frequency and diameter. The distribution of the species was found in all corners of the established permanent plots of the KBA. Wildlings and sapling of the species were scattered in the forest floor of Mount Capayas KBA.

The second in rank as could be seen in Table 4 was *Rhus taitensis* Guill. (10.52%), the species as observed in the area was attaining a maximum diameter of 20cm. Wildlings and sapling of the species were scattered in the forest floor in all plots. Other dominant species were Radermachera *pinnata* (Blanco) Seem. (8.53%), *Ficus ampelas* Burm. (8.52%), *Pangium edule* Reinw. (8.34%). *Alstonia macrophylla* Wall. Ex G. Don (8.18%), *Parishia malabog* Merr (8.0), *Ficus benjamina* L (7.07%), and *Palaquium obovatum* (Griff.) Engl. (5.11%) (Table 4).

Table 4. Dominant native trees with high Importance value (I.V.).

Species	Family	Rel. Density	Rel. Dominance	Rel. Frequency	Importance Value (I.V)	Rank
Neonauclea calysina (Bartl. ex DC.) Merr.	Rubiaceae	11.93	0.85	2.17	14.95	1
Rhus taitensis Guill.	Anacardiaceae	6.52	0.95	3.04	10.52	2
Radermachera pinnata (Blanco) Seem.	Bignoniaceae	5.61	0.75	2.17	8.53	3
Ficus ampelas Burm.f	Moraceae	4.79	1.56	2.17	8.52	4
Pangium edule Reinw.		0.41	7.06	0.87	8.34	5
Alstonia macrophylla Wall. Ex G. Don	Apocynaceae	4.38	0.75	3.04	8.18	6
Parishia malabog Merr.	Anacardiaceae	5.50	0.75	1.74	8.00	7
Ficus benjamina L.	Moraceae	2.85	2.47	1.74	7.07	8
Elaeocarpus cumingii Turcz.	Elaeocarpaceae	2.24	1.06	3.04	6.35	9
Cratoxylum sumatranum (Jack) Blume	Hypericaceae	3.06	0.75	2.17	5.99	10
Ormosia calavensis Azaola ex Blanco	Fabaceae	2.34	1.18	1.74	5.26	11
Palaquium obovatum (Griff.) Engl.	Sapotaceae	0.20	4.48	0.43	5.11	12

Majority of the native tree species belong to Rubiaceae, Anacardiaceae, Moraceae and Bignoniaceae, family. Rojo (1999) classified those dominant trees based on its growth formed as small tree. Importance value measures the degree of significance of tree species in a given forest community.

In the conservation of Mount Capayas, dominant native trees play a vital role as priority species for reforestation and rehabilitation in the area, since they were adapted to the environment (Lantican, 2015).

Diversity of Native trees

Diversity is a community attribute related to stability, productivity, and trophic structure (McIntosh, 1967; mc Naughton, 1977; Tilman, 1996), as well as migration (Wisheu and Keddy, 1996; Caley and Schluter, 1997; Colwell and Lees, 2000). An area with high species diversity results to a more stable and productive ecosystem.

In this study Mount Capayas KBA has a computed species diversity value of H' = 2.74 for Shannon index of diversity. The result on the estimation of species diversity by Shannon index signifies that Mount Capayas has a moderate species diversity (Mac Donald, 2003). Among the plot, plot 5 has a computed species diversity of 3. 194 which implies for a high species diversity (Table 5), rest of the plots have a moderate species diversity.

Table 5. Diversity of native trees in different study plots of Mount Capayas KBA.

Plot	Diversity Index			Evenness index		
	Brillouin's	Shannon	Simpson's	Brillouin's Evenness	Shannon Evenness	Simpson's Evenness
1	2.454	2.702	0.902	0.829	0.829	0.938
2	2.451	2.841	0.901	0.833	0.835	0.932
3	2.512	2.805	0.901	0.817	0.817	0.931
4	2.038	2.283	0.844	0.746	0.75	0.886
5	2.857	3.194	0.94	0.872	0.872	0.965
6	2.445	2.66	0.888	0.781	0.782	0.918
7	2.147	2.456	0.856	0.779	0.783	0.895
8	2.57	2.968	0.928	0.865	0.864	0.959
Average	2.43	2.74	0.895	0.815	0.816	0.928

In Brillouin's index of diversity, plot three, five and eight have moderate species diversity, while the rest of the plots have low species diversity. The result of the Brillouin's index of diversity was lower as compared to Shannon index of diversity. However, Simpson's index of diversity signify for a high species diversity in all of the plots (Table 5). For evenness index, the three diversity indices signify that 80 to 90% of the species were similar among the plots.

In this study the value of Shannon index of diversity will be recognized, because according to May (1975), Shannon's Index (H') is sensitive to sample size, and it was the most commonly used diversity index in measuring species diversity, as compared to Simpson's Index (Ds). The Simpson's index of diversity deals to the measurement of dominance as basis for species diversity determination (May, 1975).

The result of the study was lower as compared to the study of Lillo *et al.*, (2019) on the native trees in Mount Lantoy KBA with species diversity of H'=3.5, and a relative value of high species diversity (Mac Donald, 2003). The result further emphasized that Mount Capayas was more disturbed due to rampant anthropogenic activities as observed in the area as compared to Mount Lantoy.

Conservation Status of Native trees

Conservation status of the native tree species in Mount Capayas were determined based from DENR and IUCN Classification (Table 6). Using the Latest DENR classification (DENR, 2017), 10 native tree species were categorized as threatened. Out of the 10 threatened species, one species identified as Critically Endangered (*Diospyros longiciliata* Merr.), four species identified as Endangered (Cinnamomum *cebuense* Kosterm, *Vitex parviflora* Juss. *Guioa acuminata* Radlk., and *Agathis philippinensis* Warb.), three Vulnerable species, and two species identified as other threatened species (Table 6). Using the IUCN classification, one species categorized as Critically Endangered (*Diospyros longiciliata* Merr.), and seven species categorized as Vulnerable (Table 6).

Table 6. Conservation Status of Native trees in Mount Capayas KBA.

NL	Scientific name	Family	Common name	Conservation status: IUCN (2017-3)	Conservation status: DENR DAO 2017-11	Conservation status: Endemicity
1	*Diospyros longiciliata* Merr.	Ebenaceae	Itom-itom	CR	CR	PE
2	*Cinnamomum cebuense* Kosterm.	Lauraceae	Kalingag	Not assessed	EN	PE (CEBU)
3	*Vitex parviflora* Juss.	Lamiaceae	Molave	VU	EN	NE
4	*Guioa acuminata* Radlk.	Sapindaceae			EN	PE
5	*Agathis philippinensis* Warb.	Araucariaceae	Almaciga	VU	EN	NE
6	*Palaquium luzoniense* (F. Vill.)	Sapotaceae	Nato	VU	VU	NE
7	*Toona calantas* Merr. & Rolfe	Meliaceae	Kalantas		VU	NE
8	*Nephelium lappaceum* L.	Sapindaceae			VU	NE
9	*Cinnamomum mercadoi* S.Vidal	Lauraceae	Mercadoi	VU	OTS	PE
10	*Flueggea flexuosa* Müll.Arg.	Phyllanthacea			OTS	NE

PE- Philippine endemic

NE- Non endemic

Both DENR and IUCN were two known authorities in listing threatened plant species. Both agencies provide information on the flora and fauna that were in need of conservation action (Villanueva *et al.,* 2015), particularly those species with high risk of extinction (Brooks *et al.*, 2006).

However, some species were categorized as already threatened under the DENR classification but in IUCN record the species was still declared as not yet been assessed (Table 6). The contradiction of IUCN and DENR classification could be due to the scale of work.

The IUCN classified species at the global scale and the probability of updating their record regularly was very slow. Whereas the DENR classified species at local scale of work, advantageous as compared to IUCN in terms of time, priority and expenses.

Despite the existence of International Union and Conservation of Nature list of endangered species, local government units, institution and researcher still need to have the local survey (DENR, 2017) because local communities were the most knowledgeable concerning the conservation status of species as they were the one on the ground. Local communities know which species were still abundant, rare, threatened and those facing risk of extinction.

Localized survey could give regular update on the number of individual on a certain species particularly those species that were already threatened because it requires only less budget (Sopsop and Buot, 2009).

Of the threatened species, 40% were endemic to the Philippines and the Sixty percent (60%) were non–endemic indigenous tree species. The non–endemic indigenous tree species were also considered as native trees because their appearance in the country was through natural process (Table 6).

Native trees were plant that lives or grows naturally in a particular region without direct or indirect human intervention. Endemic species were Native species whose distributions were confined only within the geographic area of reference. Thus native species includes both endemic species and non–endemic indigenous species whose natural geographic ranges extend beyond the geographic area of reference (Coil, 2002).

Phenology of Native Trees

In plants, the timing of seasonal events, such as flowering time, is highly sensitive to climate, making phenology one of the most variable plant traits (Chuine, 2010). The phenology of the Native trees were very useful in the conservation of the species, as well as in the rehabilitation of Mount Capayas. Evaluation on the Phenology of the native trees in Mount Capayas could give as an idea on when to collect a possible source of planting materials.

Recording on the phenology of species was done during the gathering of data. Gathering of data in Mount Capayas was conducted during the dry season (April –May) and wet season (Oct.–Nov.).

During this period the species of the family of Primulaceae, Elaeocarpaceae, Sapotaceae, Anacardiaceae, Moraceae, Rutaceae, Leeaceae, Rubiaceae, Araliaceae, Burseraceae, Pittosporaceae, Phyllanthaceae and Euphorbiaceae were observed bearing flowers and fruits (Table 7).

The native tree species observed bearing flowers and fruits were only the species directly encountered in the study plot. Species not encountered in the study plots could hardly be evaluated.

Based from the result 17% of the total native trees directly encountered during data collection were bearing flowers and fruits. Unfortunately, only one species coincide with the record of the co digital flora of the Philippines (*Elaeocarpus cumingii* Turcz.) (Table 7). Fruiting and flowering native trees recorded during the collection were not yet recorded in the Co's Digital Flora of the Philippines (https://www.philippineplants.org/FamsAlph.htm) or no available data (Table 7).

Table 7. Fruiting and flowering native trees during the collection of data.

Scientific name	Family	Fruiting/ flowering	Date of collection	Co digital flora
Rapanea philippinensis (A. DC.) Mez	Primulaceae	Fr	April	No data
Elaeocarpus cumingii Turcz.	Elaeocarpaceae	Fr	April	May - June
Mallotus cumingii Müll.Arg.	Euphorbiaceae	Fl	April	No data
Planchonella duclitan (Blanco) Bakh.f.	Sapotaceae	Fl	April	No data
Semecarpus cuneiformis Blanco	Anacardiaceae	Fl/Fr	May	No data
Ficus benjamina L.	Moraceae	Fl/Fr	April	No data
Ficus ampelas Burm.f	Moraceae	Fl/Fr	May	No data
Leea philippinensis	Leeaceae	Fl	May	No data
Severinia paniculata (Warb.) Swingle	Rutaceae	Fr	May	No data
Schefflera obtusifolia Merr.	Araliaceae	Fl/Fr	May	No data
Streblus glaber (Merr.) Corner	Moraceae	Fr	May	No data
Canarium denticulatum Blume	Burseraceae	Fl/Fr	May	No data
Pittosporum pentandrum	Pittosporaceae	Fl/Fr	May	No data
Phyllanthus albus	Phyllanthaceae	Fl/Fr	May	No data
Rhus taitensis Guill.	Anacardiaceae	Fl/Fr	May	No data

Clustering of Native tree community (Jaccard's, Simpson's, and Sorensen dissimilarity Matrix).

Clustering analysis of native tree species by both Jaccard's, Simpson's, and Sorensen dissimilarity matrix shows that all the plots sampled from Mount Capayas KBA were forming five cluster or five groups correspondingly based on species compositions and habitat types. The 8 plots from Mount Capayas KBA proved to have distinctive native tree species association, hence grouping them together into five cluster (e.g. Fig. 3a, 3b, 3c). For Jaccard's and Sorensen dissimilarity matrix, all the plots sampled were clustered into five groups correspondingly (e.g. Fig. 3a and 3c). The eight plots from Mount Capayas proved to have distinctive native tree species association, hence grouping them together into five cluster. Plot 8 and 7 formed as one subgroup, Plot 6 and 7 also as another subgroup, Plot 2 formed as another subgroup same with plot 4, while Plot 3 and 1 also formed as one subgroup (e.g. Fig. 3a and 3c).

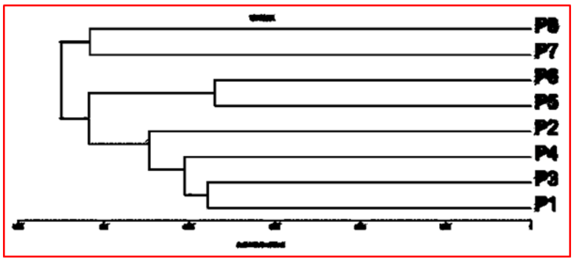


Fig. 3a. Dendrogram of the native tree species in Mount Capayas KBA (8 plots) per Jaccard similarity coefficient and clustering using the Unweighted Pair Group Method with Arithmetic mean (UPGMA) showing 5 cluster of plant communities.

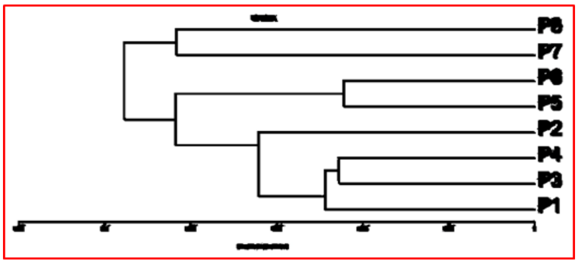


Fig. 3b. Dendrogram of the native tree species in Mount Capayas KBA (8 plots) per Simpson's similarity coefficient and clustering using the Unweighted Pair Group Method with Arithmetic mean (UPGMA) showing 5 cluster of plant communities.

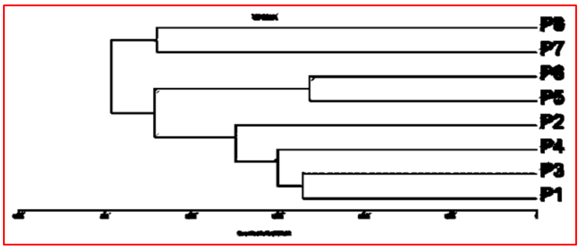


Fig. 3c. Dendrogram of the native tree species in Mount Capayas KBA (8 plots) per Sorensen similarity coefficient and clustering using the Unweighted Pair Group Method with Arithmetic mean (UPGMA) showing 5 cluster of plant communities.

Simpson's dissimilarity matrix consider Plot 4 and 3 as similar in vegetation type and formed as one subgroup/cluster, and Plot 1 has distinct vegetation and formed as another subgroup/cluster, as well as with plot 2. While Jaccard's and Sorensen matrix consider Plot 4 distinct and formed one subgroup/cluster, then Plot 3 and 1 group together as one subgroup/cluster.

Jaccard's and Sorensen index considered as the two of the most often used similarity coefficients for binary data (Clifford and Stephenson, 1975; Romesburg, 1984). The cluster analysis using Jaccard's , Sorensen and even Simpson's similarity index reveals that Mount Capayas were covered by different vegetation types with high species diversity.

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References

AGENDA P. 2018. United Nations Environment Programme. Group 11.

Amoroso VB, Obsioma LD, Arlalejo JB, Aspiras RA, Capili DP, Polizon JJA, Sumile EB. 2009. Inventory and conservation of endangered, endemic and economically important flora of Hamiguitan Range, Southern Philippines. *Blumea* **54(1-3),** 71-76.

Audley-Charlesmg, Carter DJ, Barber AJ, Norvick MS, Tjokrosapoetro S.1979**.** Reinterpretation of the geology of Seram: implications for the Banda Arc and northern Australia. Journal of the Geological Society **136,** 547-568.

Bantayan CN, Combalicer EA, Tiburan CLJR, Barua LD, Dida JJA. 2015. GIS in the Philippines. Principles and application in Forestry and Natural Resources. Second Edition 150 p.

Bekele T. 1994. Phytosociology and ecology of humid Afromontane forest in the Central Plateaus of Ethiopia. J. veg. Sci. **5,** 87-98.

Bensel T. 2008. Fuelwood, deforestation, and land degradation: 10 years of evidence from Cebu Province, the Philippines. Land Degradation & Development **19,** 587-605.

Brooks TM, Magsalay P, Dutson G, Allen R. 1995. Forest loss, extinctions and last hope for birds on Cebu. Oriental Bird Club Bull **21,** 24-2.

Brooks TM, Mittermeier RA, Fonseca GAB, Gerlach J, Hoffmann M, Amoreux JF, Mittermeier CG, Pilgrim JD, Rodrigues ASL. 2006. Global biodiversity conservation priorities. Science **313,** 58-61.

Caley MJ, and Schluter D. 1997. The relationship between local and regional diversity. Ecology **78,** 70-80.

Chuine I. 2010. Why does phenology drive species distribution? Philosophical Transactions of the Royal Society B Biological Sciences **365(1555),** 3149-60.

Clifford HT, Stepphenson W. 1975. Review: An Introduction to Numerical Classification. Systematic Zoology. Vol **25,** No. 1 pp. 92-95.

Coile NC. 2002. Native plant? Wildflower? Endemic? Exotic? Invasive? Rare? Endangered? Botany Circular No. 35. Fla. Dept. Agriculture & Consumer Services. Division of Plant Industry.

Collar NJ, Mallari NAD, Tabaranza BR JR. 1999. Threatened birds of the Philippines. The Haribon Foundation/Birdlife international red data book. Bookmark, Makati City, The Philippines 559pp.

Colwell RK, Lees DC. 2000. The mid-domain effect: geometric constraints on the geography of species richness. Trends in Ecology & Evolution **15,** 70-76.

Curtis JT, Macintosh RP. 1951. An upland forest continuum in the prairie forest border region of Wisconsin. Ecology **32,** 476-498.

Denr Administrative Order. 2017. Updated National List of Threatened Philippine Plants and their Categories. (DAO No. 2017-11).

Fernando ES, Suh MN, Lee J, Lee DK. 2008. Forest formation of the Philippines. ASEAN – Korea Environmental Cooperation Unit (AKECU). GeoBook Publishing Co. ISBN 978-89-92239-40-093530. 119p. www.geobook.co.kr.

Fernando ES. 2007. Checklist of Species in FBS 21 (Taxonomy of Forest Plants), 2007. 12th edition 29p.

Flora Malesiana. 2000. Series I, Volume 14 (2000) iv + 1-634, by W.J.J.O. de Wilde (edited by P. F. Stevens), published by the Nationaal Herbarium Nederland, Universiteit Leiden branch, The Netherlands, under the auspices of Foundation Flora Malesiana. ISBN 90-71236-47-1.

Hyvärinen M, Miranto M, Hiltunen R, Schulman L. 2011. Strategy and action plan for ex-situ conservation of threatened plants in Finland—Action 11: assessment of the impacts of climate change on biodiversity in coastal ecosystems and the implementation of new policies and conservation strategies. Available at www. ymparisto.fi/ download.asp?contentid=132157&lan=fi

Lantican CB, Phil D. 2015. Philippine Native Trees-What to Plant in Different Provinces. www.pcaarrd.dost.gov.ph *33p.*

Lillo EP, Malaki ABB, Alcazar SMT, Nuevo RU, Rosales R. 2019. Native Trees on Mount Lantoy Key BiodiversityAreas (KBA), Argao, Cebu, Philippines. Philippine Journal of Science **148(2),** 359-371, June 2019. ISSN 0031–7683.

Macdonald GM. 2003. Biogeography: Space, Time, and Life. New York, NY: John Wiley & Sons, Inc.ISBN: 978-0-471-24193-5. 528p.

Madulid D. 1991. The endemic genera of flowering plants in the Philippines. Acta Manilana **39,** 47-58.

Mallari NAD, Tabaranza BR JR, Crosby MJ. 2001. Key Conservation Sites in the Philippines: A Haribon Foundation and Bird Life International Directory of Important Bird Areas. With contributions from M. Lepiten-Tabao and G.A. Gee, in collaboration with Department of Environment and Natural Resources and Bookmark, Inc., Makati City 484p.

May RM. 1975. Patterns of species abundance and diversity, p. 81-120. *In* M.L. Cody & J.M. Diamond (eds.). Ecology and Evolution of Communities. Harvard University, Cambridge, Massachusetts, USA.

Mcintosh RI. 1967. An index of diversity and the relation of certain concepts to diversity. Ecology **48,** 392-404.

Mcnaughton SJ. 1977. Diversity and stability of ecological communities: a comment on the role of empiricism in ecology. American Naturalist **111,** 515-525.

Merrill ED. 1923. An Enumeration of Philippine Flowering Plants (Volume 2). Bureau of Printing, Manila 530 pp.

Myers NA, Mittermeier RA, Mittermeier CG, Fonseca DA, Gab KJ. 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853- 858 CrossRef | PubMed | CAS. Web of Science® Times Cited: 5340 | ADS.

PCARRD. 2017. Manual on vegetational analysis for grassland and forest ecosystems. Philippine Council for Agriculture, Forestry and Natural Resources Research and Development. Department of Science and Technology, Los Baños.

Podong C, Poolsiri R. 2013. Above ground biomass and litter productivity in relation with carbon and nitrogen content in various landuse small watershed, lower Northern Thailand. Journal of Biodiversity and Environmental Sciences (JBES). **Vol. 3 No. 8,** p. 121-132, http://www.innspub.net.

Romesburg HC. 1984. Cluster Analysis for Researchers. Lifetime Learning Publications, Belmont, California. URL: http://print. google. com/print? isbn= 1411606175). 330p.

Salares VB, Obico JJA, Ormerod P, Barcelona JF, Pelser PB. 2018. Taxonomic novelties from Cebu: a new species of Vaccinium (Ericaceae) and a new record of Phaius (Orchidaceae) for the Philippines. Phytotaxa **360(3),** 255-262 (8 pages).

Senbeta F, Denich M. 2006. Effects of wild coffee management on species diversity in the Afro montane rainforests of Ethiopia. For. Ecol. Management **232,** 68-74.

Shannon CE, Weaver W. 1949. The Mathematical Theory of Communication. Urbana, Chicago: Univ. Illinois Press 117p.

Simpson EH.1949. Measurement of diversity. Nature **163,** 688.

Sopsop LB, Buot IEJR. 2009. The Endangered plants of Palawan Island, Philippines. Asia Life Sciences **18(2),** 251-279.

Tesfaye B, Hundera K, Kelbessa, E. 2013. Floristic Composition and Structural Analysis of Jibat Humid Afromontane Forest, West Shewa Zone, Oromia National Regional State, Ethiopia. Ethiop. J. Educ. & Sc. Vol. 8 No. 2 March 2013 12. 23p.

Tilman D. 1996. Biodiversity: population versus ecosystem stability. Ecology **77,** 350-363.

UNEP. 2012. Green economy advisory services: United National Environment Program. The Philippines. preventing soil erosion. Chinese Journal of Eco-Agriculture **9(2),** 54-56.

Villanueva ELC, Buot IEJR. 2015. Threatened Plant Species of Mindoro, Philippines. IAMURE International Journal of Ecology and Conservation. Volume **14,** pp. 168-189.

Wang H, Liu G, Wang Q. 2001. Structural characteristics of effective evegetation for

Whitford HN. 1911. The forests of the Philippines. Philippine Bureau of Forestry Bulletin No. **10,** 113p.

Wisheu IC, Keddy P. 1996. Three competing models for predicting the size of species pools: a test using eastern North American wetlands. Oikos **76,** 253-256.

Wu Q, Zhao H. 2001. Basic laws of soil and water conservation by vegetation and its summation. Journal of Soil and Water Conservation **15(4),** 13-16.

Zhang H, Sun Y, Cheng Y, Cheng J. 2006. Effect on surface runoff coefficient of different vegetation types in Jinyun Mountain of Chongqing. Journal of Soil and Water Conservation **20(6),** 11-14.