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Diversity and Status of Plants in Three Mountain Ecosystems in Southern Mindanao, Philippines

VICTOR B. AMOROSO
CECILIA B. AMOROSO
FULGENT P. CORITICO
amorosovic@yahoo.com
Central Mindanao University, Musuan,
Bukidnon, Philippines

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Abstract - This paper presents the diversity and status of plants conservation initiatives in the three mountain ecosystems in Mindanao, Philippines. Representative specimen were pressed, dried, poisoned and mounted as herbarium vouchers. To determine the index of general diversity for trees, 20x20 m sampling plots were established per vegetation type, and in each sampling plot, a 5x5 m sub-plot was laid to determine the species diversity for pteridophytes. Transect walk and sampling plots in 3 mountain ecosystems revealed several vegetation types with Mt. Malindang having 9 types, Mt. Hamiguitan with 5 types and Mt. Kitanglad with 3 types. Species richness was highest in Mt. Malindang (1,164 spp.), followed by Mt. Hamiguitan (878 spp.) and the lowest in Mt. Kitanglad (661 spp.) Regardless of the mountain ecosystem and plant groups, the montane vegetation had high species richness and diversity values than the dipterocarp and mossy forests. Mt. Kitanglad had the highest number of threatened species (92 spp.) while Mt. Malindang and Mt. Hamiguitan had 34 and 35 threatened species each, respectively. As to endemism, it showed that Mt. Hamiguitan had high endemism (34 %) than Mt. Kitanglad (21%) and Mt, Malindang (16%). Furthermore, the three mountain

ecosystems showed 64 species as new record in Mindanao and 21 species in the Philippines while two species of *Nepenthes* are new to science.

Keywords - diversity, species richness, assessment, plants, conservation, protected areas, Mindanao

INTRODUCTION

The Philippine flora is composed of over 14,000 species of plants representing 5% of the world's flora. Of these, about 8,050 species are angiosperms, 33 species are gymnosperms, 1100 species pteridophytes, 1,271 species bryophytes, 3, 555 species fungi and molds, about 1355 species algae, and 790 species are lichens (Villareal and Fernando 1999; Gruezo 1979). Many plant groups, moreover, are still poorly known (Madulid 1995).

In terms of endemism, 26 genera of flowering plants and ferns are endemic to the Philippines. Generally, plant endemism in the Philippines ranges from 45 % to 60 % (DENR-UNEP 1997). The 2004 IUCN Red List of Threatened Species includes 279 species of Philippine plants belonging to 112 genera and 50 families while the National Assessment of (Fernando, et al. , 2008) recorded 454 species of threatened vascular plants.

Although we have estimates on the species richness, endemism and number of threatened vascular plants in the Philippines, there is very limited knowledge on what kind and numbers of plants occur in mountain ecosystems, its endemism and which species are threatened. Thus, this paper presents the diversity and status of plants three mountain ecosystems in Mindanao.

OBJECTIVES OF THE STUDY

This research was conducted to describe the vegetation types and diversity of plants in three mountain ecosystems in Mindanoa, Philippines. It aimed specifically to: (1) describe the vegetation types; (2) determine the diversity of vascular plants; (3) assess the conservation and taxonomic status of the species of plants; and (4) record the mountain and altitudinal distribution of plants.

MATERIALS AND METHODS

A. Prior Informed Consent (PIC) and Selection of Local Researchers

To satisfy the requirements of EO 247 (Bio prospecting) and RA 9147 (Wildlife Resources Conservation and Protection Act), prior informed consent from the community was obtained by presenting the research proposal , Likewise, this research proposal was presented to the members of the Protected Area Management Board (PAMB) for their approval and eventual issuance of the Gratuitous Permit from the Department of Environment and Natural Resources.

B. Description of Vegetation Types

Field reconnaissance and transect walk were conducted to identify and describe the vegetation types of each mountain ecosystem by considering the species richness and dominance, canopy cover, tree profile, altitude, location and other ecological parameters. GPS was used to determine the coordinates for each vegetation type.

C. Survey, Establishment of Sampling Sites, Collection and Processing of Specimens

Several transect walks towards the landscape were done with the members of Forest Guides to inventory and assess the floral species observed. Likewise, a transect belt of 2 km x 10 m wide was established per vegetation type. Within the transect belt, an inventory and assessment of plants were conducted, and their local names, uses and altitude were recorded. Representative specimens collected were pressed, poisoned and mounted as herbarium vouchers and deposited at the Herbarium of Central Mindanao University. Duplicates of the herbarium specimens were deposited at the Philippine National Herbarium.

D. Diversity Indices

Sampling plots of 10x10 m area were established per vegetation type with the assistance of forest guards. Within these plots, a 5 x 5 m subplot was laid out to determine the species richness of pteridophytes. We assessed species diversity by using the Shannon index of general diversity (H).

For trees:

$H = - \Sigma$ ndbh/Ndbh log ndbh/Ndbh

Where, ndbh = diameter at breast height of individual tree species

Ndbh = total diameter at breast height of all tree species

For pteridophytes:

$H = - \Sigma$ [ni]/N log [ni]/N

Where, ni = number of individuals in an area

N = total number of individuals in an area

● Species Importance Value (SIV) was computed using the formula of Brower and Zhar (1977):

SIV or ni = RD + RF + Rdom

Where, RD = Relative Density

RF = Relative Frequency

Rdom = Relative Dominance

E. Identification and Assessment of Concervation and Taxonomic Status

The collected plants were identified using taxonomic keys from floras and monographs of Merrill, E.D. (1923-1926); Linder, G.R. (1987); Madulid, D.A. (1995); Flora Malesiana Series (1995-1996); Flora of Taiwan (1996); Rojo, J.P. (1999); Jebb, M. and M. Cheek (2001); Cootes, J. (2001); Barcelona et al., (1996);Tan, Fernando, Rojo (1996); Zamora and Co (1986); Amoroso, Pava and Acma (1993, 1996).

The assessment of status for each species whether threatened, endemic, rare or economically important was based on the national list of threatened Philippine plants (Fernando et al. 2008) the IUCN (2007) and from published floristic works and monographs.

Knowing the conservation and taxonomic status of each species served as basis for the monitoring and protection. Together with the local researchers, the specific local names and uses of plants were also recorded.

F. Information, Education and Communication (IEC) Materials

IEC materials were prepared to disseminate information regarding threatened, endemic, rare and economically important species of plants and as basis for the protection and conservation of the species. The IEC materials were distributed to the Forest Guides during fieldworks as their reference in identifying and monitoring the species.

RESULTS AND DISCUSSION

A. Vegetation Types and Distribution

Transect walk and establishment of sampling plots with the local researchers were done along the trail in the three mountain ecosystems to identify and describe the vegetation types by considering the coordinates, species richness and dominance, tree profile, altitude, and other ecological parameters (Fig. 1). The vegetation types in the three mountain ecosystems are described on the following page:

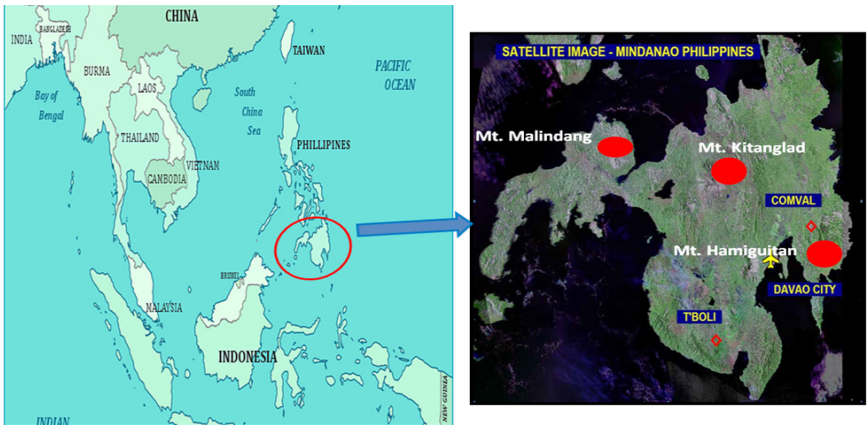


Fig. 1. Relative location of the 3 mountain ecosystems in Mindanao

Mt. Malindang Mountain Ecosystem (Fig. 2)

a. The agroecosystems were found at an altitude ranging from 150 to 1400 m asl. These were typified by planted vegetables like *Brassica oleracea, Sechium edule* and *Allium fistulosum* (cabbage, chayote and green onions) and cereals like *Oryza sativa* and *Zea mays* (rice and corn). For agroforestry, there were *Cocos nucifera (coconut)* and *Lansium domesticum* (lanzones). Grass-dominated fallowed areas (*Cyathea* spp. and *Paspalum conjugatum*) were part of the characteristics of the agroecosystem. The agroecosystem was located in all Villages covered by the research sites of Mt. Malindang Range Natural Park, Misamis Occidental ,

b. The lowland dipterocarp forest was a secondary forest type. Its stands occurred in patches of remnant natural forest located at altitudes ranging from 220 to 500 m asl. The lowland dipterocarp forest was characterized by the dominance of Lithocarpus spp. and Shorea spp. *Ficus variegata,* the endemic *Macaranga grandifolia* and the threatened *Toona calantas*. The presence of pioneering trees such as Ficus variegata and Macaranga grandifolia indicate a disturbed (early middle stage secondary forest) habitat. Important constant tree species in this community were: *Knema glomerata, Shorea contorta* and *Shorea mindanaensis,* all endemic, threatened, and of economic importance. This forest was characterized by tall dipterocarp trees, which also occurred in the submontane dipterocarp and mixed-dipterocarp forests. This tree layer of 20-25 m high covers about 60%.

c. The submontane forest was found at an altitude ranging from 900 to 1,100 m asl. The forest type had distinct layers: a canopy layer consisting of tall trees with big buttresses like *Shorea polysperma, S. mindanaensis* and *Ficus* sp., covering 60-75%. The buttresses extended to about a meter from the tree and its function was to support it. This forest was also strongly differentiated against almaciga forests by *Shorea polysperma.*

d. The Almaciga forest was found between 1,200-1,400 m asl. and characterized by 90% dominance of the tree species *Almaciga*

philippinensis, the largest (180-230 cm in diameter) and the tallest (35 to 45 m in height). Although threatened and endemic, it had the highest canopy cover. The almaciga forest was the best identified plant community of Mt. Malindang due to the presence of large number of characteristic species, many of which were endemic and threatened. Examples of these were: the constant character species *Agathis philippinensis, Cinnamomum mercadoi, Astronia cumingii* and *Ziziphus angustifolius.* This community was observed in the southeastern side of Village Sibucal ,

e. The montane forest was situated at an altitude of 1,400 to 1,700 m asl. and characterized by trees taller (on the average) than those observed in the mossy forest. The height of the tree layer was from 30 to 35 m and with 90% species crown cover. Trees with big trunks were also found here. *Lithocarpus philippinensis, L. mindanaensis and Mastixia premnoides* were endemic species that had the largest canopy cover. The shrub layer did not grow more than 5 m and with 10 to 15% cover. The moss layer was less conspicuous than in the mossy forest.

f. The mossy forest, usually found at altitudes ranging from 1,700 to 2,450 m asl, is also known as the cloud belt, due to the persistence of clouds. The mossy forest was characterized by the presence of small trees with prop and aerial roots coming out from one to a few meters from the base of irregularly shaped tree trunks. The presence of proproots indicated the adaptation of trees to steep slopes, which was prevalent in this zone. The proproots seek new resources of nutrients in crevices and the aerial roots give extra support to the growing tree. As in other mossy forests in the Philippines, the trees were dwarfed and their trunks gnarled, especially those that grew near the mountain peak, due to strong wind pressure. Compared with those in montane forests, the trees were shorter by 10 to 20 m. The tree layer was also relatively denser (75% to 85% cover). The branches and trunks of trees and the forest floor were largely covered with mosses, thus the name mossy forest. Aside from the endemic *Ascarina philippinensis* and *Xanthomyrtus diplycosifolium,* the community was characterized by four additional species, namely: *Ilex* sp., *Phyllocladus hypophyllus, Elaeocarpus calomala* and *Dacrycarpus cumingii*. The latter two species were present in the montane forest at lower density.

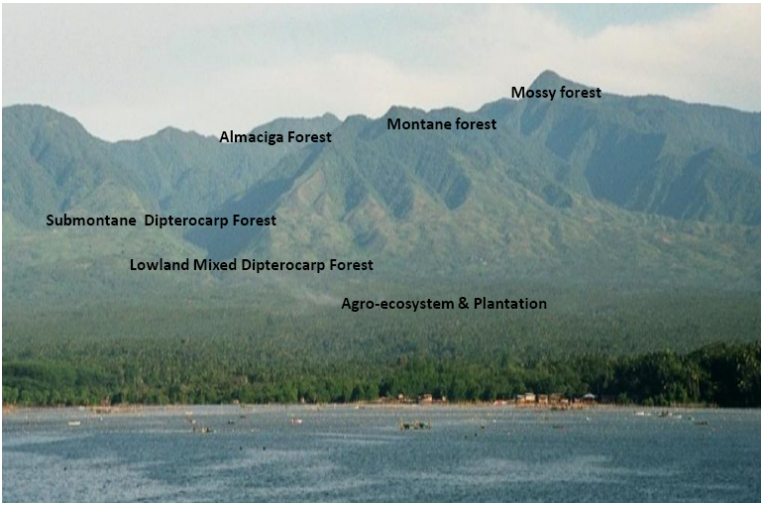


Fig. 2. The Malindang Mountain Ecosystem showing the six vegetation types

Mt. Hamiguitan Mountain Ecosystem (Fig. 3)

a. The agro-ecosystem is situated at 06° 43′ 15″ N and 126° 07′ 22″ E and in altitude ranging from 70-410 m asl (Figs. 2a and 3). Coconut and banana plantations and other valuable crops dominated this type of ecosystem. However, dipterocarp trees were also found occurring within the vegetation. Noteworthy are the presence of *Shorea guiso* and *Shorea polysperma*, a critically endangered species.

b. The dipterocarp forest is situated around 6°43′30″ N and 126°09′01″ E, with altitude ranging from 420–920 m. *Shorea spp*. (*Dipterocarpaceae*) and vines (*Smilax* spp., *Smilacaceae*) dominate the forest. The height of trees ranges from 5–30 m.

c. The montane forest is situated around 6°44′08″ N and 126°20′08″ E, with altitude ranging from 920–1160 m. *Agathis philippinensis* Warb.(*Araucariaceae*), various species of *Nepenthes* sp. (*Nepenthaceae*) and epiphytes characterize this type. The height of trees ranges from 5–25 m, decreasing as the altitude increases.

d. The typical mossy forest is situated around 6°42′16″ N and 126°11′52″ E, in altitude ranging from 1160–1350 m. Mosses form thick mats covering roots and tree trunks. *Calophyllum blancoi* Planch. & Triana (*Clusiaceae*), *Dacrydium elatum* (Roxb.) Wall. (*Podocarpaceae*), *Calamus* spp. (*Arecaceae*) and *Pinanga* spp. (*Arecaceae*) species are dominant in the area. *Freycinetia* sp. (*Pandanaceae*) are the dominant epiphytic plants, often festooned over large trees. The height of trees ranged from 6–15 m.

e. The mossy-pygmy forest is situated around 6°43′24″ N and 126°11′11″ E, ranging in altitude from 1160–1600 m. However, pygmy forest (but not mossy) was also observed as low as 75–275 m in Mati around 6°43′44″ N and 126°13′27″ E. The mossy-pygmy forest occupies c. 225 ha. The height of trees ranges from 0.5–2.5 m and the average diam is 8 cm. The forest is dominated by *Leptospermum* sp. (*Myrtaceae*), *Weinmannia* sp. (*Cunoniaceae*), *Elaeocarpus* sp. (*Elaeocarpaceae*) and *Dacrydium* sp. (*Podocarpaceae*). Abundant mosses are present on the forest floor.

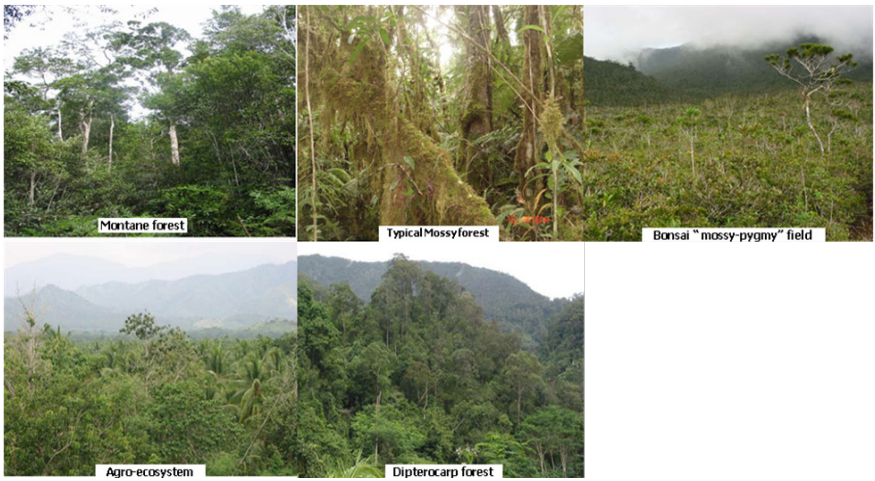


Fig. 3. Hamiguitan Mountain Ecosystem

Mt. Kitanglad Mountain Ecosystem (Fig. 4)

a. The agro-ecosystem is situated at 08º10'17"N and 124º56'09"E and in altitude ranging from 1,200 -1,700 masl. Potatoes (*Solanum tuberosum* L.), cabbage (*Brassica oleracea* L.), carrots (*Daucus carota* L.) and tomatoes (*Lycopersicum esculentum* Mill.) dominated this vegetation. This vegetation was originally a dipterocarp forest but was logged and later converted as an agricultural land and planted with cash crops. Threatened plants such as *Cyathea contaminans* (Wall) Copel, (Anonotong*), Podocarpus macrocarpus* de Launbenf and *Dicranopteris linearis* (Burm.) Underw. (Agsam) which is an indicator of a disturbed habitat was observed at the edge of the vegetable plantation. The agroecosystem in Mt. Malindang is also dominated with crops like vegetables, cereals and agroforestry species (Amoroso,Pava, & Acma, 1996).

b. The montane forest is already the foot of Mt. Kitanglad situated at 08º09'54"N and 124º55'58"E and ranging from 1700-2100 masl. This type of forest is characterized by the presence of numerous species of mosses, lichens and other epiphytes. The dominant tree species include *Phyllocladus hypophyllus* Hook F. (Mountain Tungog), *Lithocarpus spp.* (Ulayan), *Erythrina subumbrans* (Hasskarl) Merr. (Anii) while the common shrubs observed were the endemic *Hydrangea scandens*, *Drimys piperata* Hook f. and several *Medinilla spp.* The average height of the emergent trees is 12 m and ranging from 5-20 m. The moss cover ranges from 50-75%. The edge of the montane forest is usually inhabited by *Trema orientalis* (L.) Blume (Andaluyong), *Pteridium aquilinum* (Linn.) Kuhn (Sigpang)/ (Bracken fern) and *Cyathea spp.* (Anonotong/Tree ferns) This is the same with the observation of Amoroso (2006) at the montane forest in Mt. Malindang which has high relative moisture and rainfall and characterized by trees taller (on the average) than those observed in the mossy forest. They further stated that the moss layer was also less conspicuous than in the mossy forest.

c. The mossy forest starts from 2100 masl to the peak as described below. The branches and trunks of trees and the forest floor were largely covered with mosses, thus the name mossy forest (Amoroso, Acma,

Pava 2006). Due to establishment of sampling plots and computation for diversity, this is delineated into lower and upper mossy forests.

1. The lower mossy forest is situated at 08º09'27"N and 124º55'49"E to 08º09'16"N and 124º55'30"E. It starts from 2100 masl to 2400 masl. Mosses are thick in this vegetation type which covers the ground, roots, trunks and branches of trees. *Lithocarpus sp., Phyllocladus hypophyllus* Hook. f., *Podocarpus spp.* were the abundant trees. The average height of trees is 10 m and ranges from 7-13 m.

2. The upper mossy forest is situated at 08º09'16"N and 124º55'30"E to the peak 08º08'38'' N and 124º55'06'' E. It starts from 2401 masl to 2,900 masl. Mosses were observed to be very thick in this vegetation type which covers largely the forest floor, roots, twisted trunks and branches of trees. Trees of *Leptospermum flavescens* J.Sm. were abundant trees while *Rhododendron spp., Dimorphanthera apoana* (Merr.) Schltr, *Vaccinium spp., Rubus spp.* were the abundant shrubs. The summit of the park has the abundance of the dwarf bamboo (*Yushania nitakayamensis* (Hayata) Keng f.) and the wet ground is covered with *Nertera diffusa* (Mutis ex L.f.) Druce, *Sphagnum* moss and *Lycopods*. The average height of the trees in this forest is 9 m and ranging from 6-12 m.

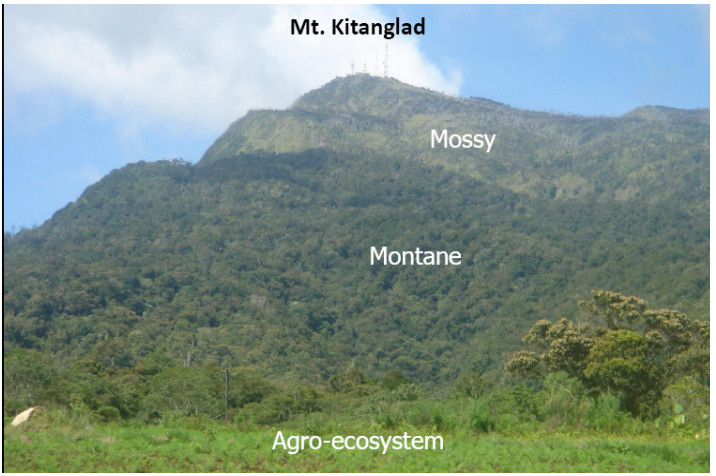


Fig. 4. The three vegetation types of Mt. Kitanglad Mountain Ecosystem

(Amoroso, Arreza, Bernales, Cambel, Roxas, Estuita, Lariosa, Mero, and Roxas 2004) observed that the mossy forest of Mt. Malindang was characterized by the presence of small trees with prop and aerial roots coming out one to few meters from the base of irregularly shaped tree trunks. The presence of prop roots indicated the adaptation of trees to steep slopes, which was prevalent in this zone. As in other mossy forests in the Philippines, the trees were dwarfed and their trunks gnarled, especially those that grew near the mountain peak, due to strong wind pressure.

If Mt. Kitanglad had three vegetation types, Mt. Hamiguitan showed five vegetation types, viz., the agroecosystem, dipterocarp, montane, typical mossy and mossy-pygmy forests Amoroso, Aspiras and Polison (2009) while Mt. Malindang exhibited six vegetation types, viz.,agro-ecosystem, lowland dipterocarp, submontane forest, Almaciga forest, montane forest and mossy forest (Amoroso, et al. 2004).

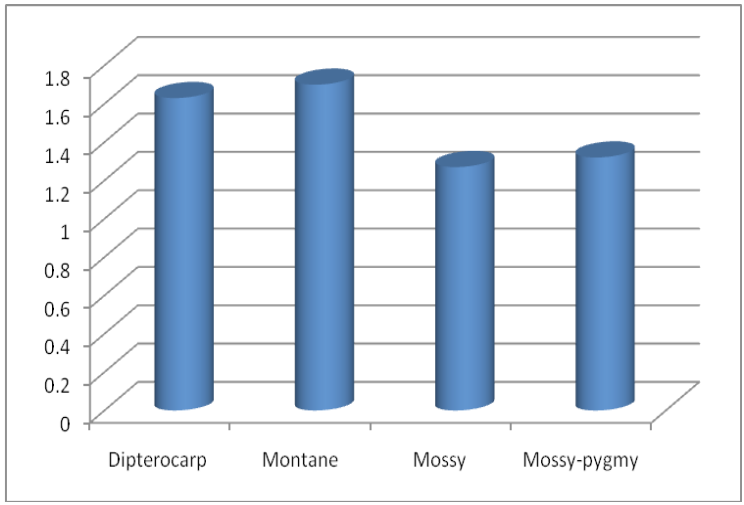
B. Species Richness and Diversity

Sampling plots and transect walk revealed a total of 1164 species in Mt. Malindang, 661 species in Mt. Kitanglad and 878 species of vascular plants in Mt. Hamiguitan. The Philippines has a total of 9,060+ species of vascular plants (Madulid 1991). Of these, Mt. Kitanglad has 42.8% of the Philippines pteridophytes, 33.3% of the Philippine gymnosperms and 2.6% of the Philippine angiosperms Species composition of vascular plants in Mt. Kitanglad is lower than in Mt. Hamiguitan and Mt. Malindang with 7.3%, 9.6% and 12.8%, respectively, of the Philippine species.(Tables I & II). The lower species richness of angiosperms in Mt. Kitanglad is due to the absence of dipterocarp forest in the study area, while this forest type was observed in Mt. Malindang and Mt. Hamiguitan. Mt. Kitanglad, however, had higher species richness of pteridophytes compared with Mt. Hamiguitan and Mt. Malindang mountain ecosystems.

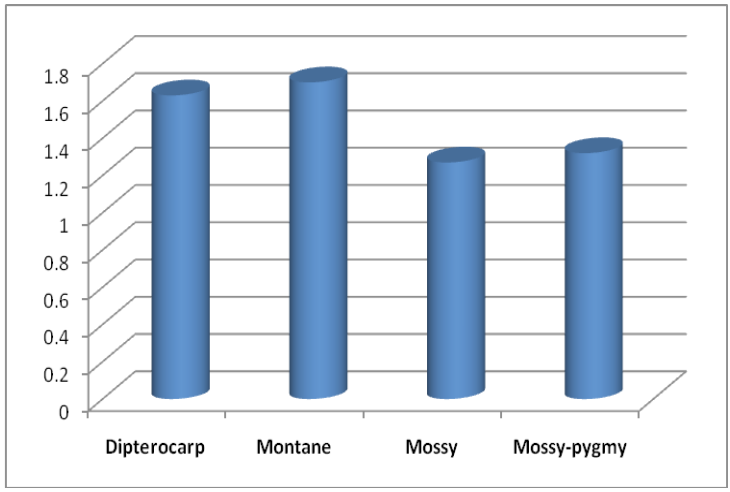
Table 1. Species richness of plants in three mountain ecosystems in relation to the Philippine species

Plant Group	Total number and percentage of species			
	Philippines	Malindang (Amoroso et al., 2006)	Hamiguitan (Amoroso et al., 2009)	Kitanglad (Amoroso et al., 2010)
Pteridophytes	1027	280 (27.3%)	155 (15%)	439 (42.8%)
Gymnosperms	33	11(33.3%)	25 (75.8%)	11(33.3%)
Angiosperms	8000+	873 (10.9%)	698 (8.7%)	211 (2.6%)
TOTAL	**9060+**	**1164 (12.8%)**	**878 (9.6%)**	**661 (7.3%)**

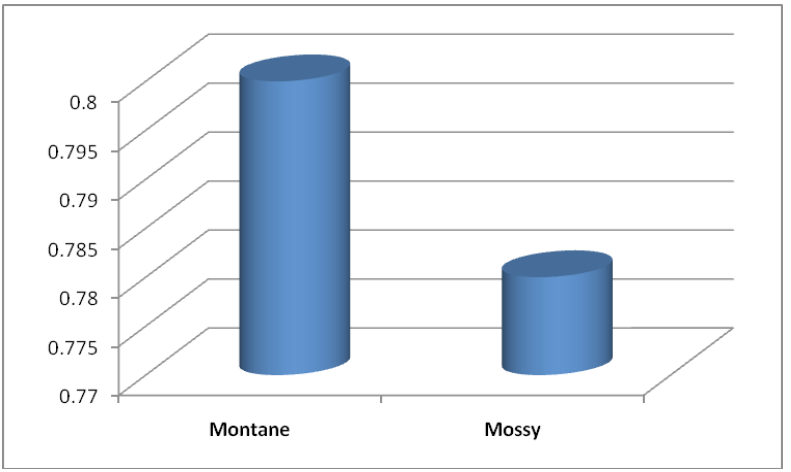
As per vegetation type, the richness of pteridophytes decreases from montane to mossy forest. Likewise, species richness of trees decreases from montane to mossy forest (Fig. 5). The same pattern was observed for trees in Mt. Malindang and Mt. Hamiguitan by Amoroso (2006) and Amoroso, Aspiras and Polizon (2009). Regardless of the montane ecosystem, the montane forest attained high diversity values than the mossy and dipterocarp forest (Fig. 5).These facts support the contention of various of ecologists that the number of species or diversity values at higher altitude is lower as a response to increasing environmental stresses like wind pressure, steep slopes, thin soil substrates, etc. (Perez 2004).



Mt. Malindang



Mt. Hamiguitan



Mt. Kitanglad

Of the 9,060 species of vascular plants in the Philippines, 3357 species (37%) are endemic to the Philippines (DENR-UNEP, 1997). Considering the three mountain ecosystems, Mt. Hamiguitan exhibited the highest endemism with 34 %, followed by Mt. Kitanglad with 21 % endemism and the lowest was observed in Mt. Malindang with 16 % (Table II). Among the plant groups, the angiosperms had high endemism as observed in Mt. Hamiguitan and Mt. Kitanglad with 41 % and 51 % endemism, respectively (Table V).

Five hundred thirty species out of 9,060 species were reported by Fernando et al., to be threatened species. Mt. Kitanglad had the most number of threatened species because of the conversion of the lowland dipterocarp forest into agricultural land. The endemic species found in the montane forest will be endangered in the near future because of the absence of lowland dipterocarp forest (Table III).

The Philippines has 10 species of *Paphiopedilum* (Cootes 1999) Of these, four species are endemic to the Philippines. Two of the Philippine critically endangered species were found in Mt. Malindang, viz., *P. hennisianum* (M.W. Wood) Fowlie and *Paphiopedilum haynaldianum* (Rchb.f.) Stein and another 2 species, *P. ciliolare* (Rchb.f.) Stein and *P. adductum* Asher were recorded in Mt. Hamiguitan.

Table III. Number of threatened plants in three mountain ecosystems

Plant Group	Total number and percentage of endemic species							
	Philippines		Malindang (Amoroso et al., 2006)		Hamiguitan (Amoroso et al., 2009)		Kitanglad (Amoroso et al., 2010)	
	Species	Endemism	Species	Endemism	Species	Endemism	Species	Endemism
Pteridophytes	1027	351	246	28 (11%)	99	9 (9%)	363	45 (12%)
Gymnosperms	33	6	11	3 (27%)	13	1 (7%)	11	1 (9%)
Angiosperms	8000+	3200	450	107 (23%)	365	153 (41%)	121	62 (51%)
TOTAL	9060+	3557	825	138 (16%)	477	163 (34%)	495	108 (21%)

Plant Group	Philippines		Malindang (Amoroso et al., 2006)		Hamiguitan (Amoroso et al., 2009)		Kitanglad (Amoroso et al., 2010)	
	NS	TS	NS	TS	NS	TS	NS	TS
Pteridophytes	1027	85	246	4 (4.7%)	99	9 (10.6%)	363	77 (90.6%)
Gymnosperms	33	5	11	5 (100%)	13	1 (20.0%)	11	7 (140.0%)
Angiosperms	8000+	440	450	45 (10.2%)	365	25 (5.7%)	121	8 (1.8%)
TOTAL	9060+	530	716	54 (10.2%)	477	35 (6.6%)	495	92 (17.4%)

The Philippines has 21 species of *Nepenthes*. Of these, 13 species are Mindanao endemic (McPherson 2009). Five of these 13 species were observed in Mt. Hamiguitan, viz., *N. alata, N. copelandii, N. bellii, N. argentii and N. peltata* and all are endemic to our country. Recently, 2 new species were described in Mt. Hamiguitan namely, *N. micramphora* V. Heinrich, McPherson et Amoroso and *N. hamiguitanensis* Gronemeyer, Wistuba, Heinrich, McPherson, Gronemeyer, Mey, and Amoroso (2010)

A B

Fig. 6. New Species of *Nepenthes*

a. *N. micramphora* V. Heinrich, McPherson et Amoroso
b. *N. hamiguitanensis* Gronemeyer et al.

It is noteworthy to mention that Mt. Kitanglad is the habitat of 7 species of *Rhododendrons* out of the 18 Philippine species. Of these, 7 species are endemic to our country and 2 are threatened, *Rhododendron kochii* Stein and *R. javanicum* Blume.

C. Conservation Initiatives

Ex-situ conservation was conducted by collecting seeds, wildlings and other planting materials from the forests. These were planted and propagated in the Mt. Musuan Zoological and Botanical Garden (MMZBG), and University Fernery. The MMZBG is now the habitat of some endemic and threatened plants like *Podocarpus spp.,Agathis philippinensis* Warb, *Cinnamomum mercadoi,* Vid,etc. Likewise, our University Fernery houses more than 100 species collected from different mountain ecosystems in Mindanao. Some of the fern plants growing in the University Fernery have originated from spores of plants collected from the wild and have germinated in our University Fernery. Some of the endemic, threatened and rare species of pteridophytes in the University Fernery include: *Platycerium grande* (Fee)Kunze., *Aglaomorpha cornucopia* (Copel.) Roos, *Cyathea spp*., *Psilotum complanatum* Sw., *Christensenia aesculifolia* (Blume) Maxon, *Ophioglossum spp., Helminthostachys zeylanica* (L.)Hook. etc. Also the University has a Tissue and Spore Culture Laboratory where tissues and spores are cultured to mass propagate threatened and endemic vascular plants.

With the participation of the indigenous people as local researchers, our research documented the distribution of threatened, endemic, rare and economically important plants according to vegetation types for each mountain ecosystem and a transect map was produced (Fig. 7) These botanically important species of plants will be given high priority for protection and will be monitored by the forest guards and by the staff of the Park Superintendent office.

Other conservation efforts include biodiversity monitoring, production of IEC materials, and capacity building of forest guards and guides.

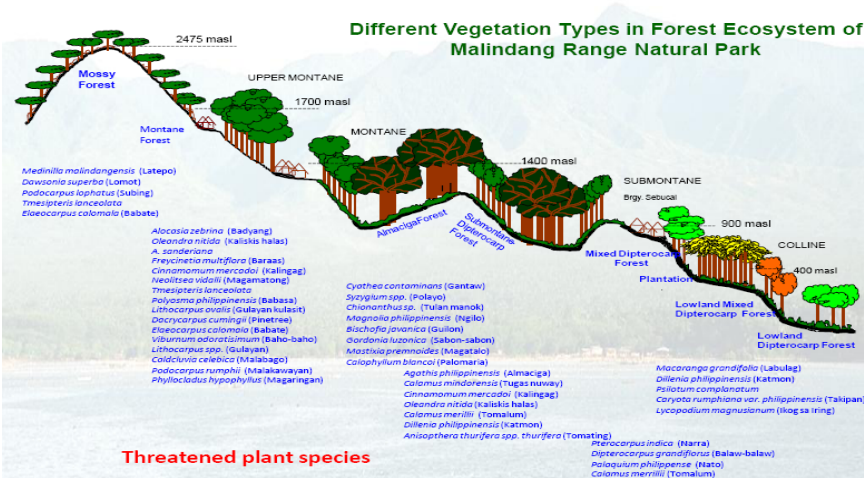


Fig. 7. Transect map showing the vegetation types and threatened plant species.

CONCLUSIONS

a. Mt. Malindang had more vegetation types and with highest species richness/diversity values than in Mt. Hamiguitan and Mt. Kitanglad.
b. Regardless of the mountain ecosystems, the montane forest had higher diversity values than the mossy forest and dipterocarp forest.
c. Mt. Hamiguitan had high endemism than in the other two mountain ecosystems.
d. Rare, economic and endemic species are threatened due to forest conversion and over-exploitation.
e. Ex-situ and ***in-situ*** conservation are strategies for protection of the remaining important flora in the three mountain ecosystems.

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