Fern species diversity across various land use types of Mt. Makiling, Luzon Island, Philippines

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Abstract. Alcala AA, Delos Angeles MD, Buot Jr IE. 2019. Fern species diversity across various land use types of Mt. Makiling, Luzon Island, Philippines. *Biodiversitas* 20: 2437-2445. Mt. Makiling of Luzon Island, Philippines is home to many living organisms including ferns and fern allies which are one of the important understory vegetation in many forest communities and having various economic uses like food, medicine and ornamentation. This study identified fern species found in various land use types across the northeastern slope of Mt. Makiling, Los Baños, Philippines. The plot technique was employed using a 20x20 meter quadrat. Three (3) 5x2 subquadrats were randomly distributed within the established quadrat. Fern specimens were identified (sensu PPG 2016) and measured. Samples were collected for herbarium voucher deposited in the PBDH. A total of 28 fern species with 22 genera from 14 families were found across land use types. Identified land use types were: (i) Mahogany (341 m asl.); (ii) Agriculture (355 m asl.); (iii) Buffer zone (365 m asl.); (iv) Agroforest (368 m asl.); (v) Roadside (455 m asl.), and (vi) Forest (482 m asl.). The most represented fern families were found out to be Thelypteridaceae (5 spp), Dryopteridaceae (3 spp), Polypodiaceae (3 spp.), Pteridaceae (3 spp), Aspleniaceae (2 spp), Dennstaedtiaceae (2 spp), Selaginellaceae (2 spp.) and Tectariaceae (2 spp.). On the other hand, the families Schizaeaceae, Lindsaeaceae, Davalliaceae, Nephrolepidaceae, and Marattiaceae are comprised of one species only. *Pteris blumeana* C. Agardh and *Tectaria crenata* Cav. were found only in buffer zone area. *Dennstaedtia philippinensis* Copel., *Lygodium circinnatum* (Burm. f.) Sw. and *Microlepia* sp., were found only in agroforest area; *Sphaerostephanos unitus* (L.) Holttum found only in agricultural; *Bolbitis heteroclita* (C. Presl) Ching and *Microsorium membranifolium* (R. Br.) Ching were found in roadside while *Asplenium tenerum* G. Forst., *Christella* sp., *Lindsaea fissa* Copel. and *Nephrolepis cordifolia* (L.) C. Presl were found in forest area. *Pneumatopteris nitidula* (C. Presl) Holttum. is a dominant fern species found in agriculture and mahogany plantation area. There is a need to document fern species along with its population across land use types in order to utilize ferns as plant indicators due to their vulnerability to changes in environmental conditions. These results can shed light on the appropriate strategy for the conservation and management of ferns in Mt. Makiling.

Keywords: Fern diversity, land use types, Mt. Makiling, pteridophytes

INTRODUCTION

Mt. Makiling is one of the best known biological areas and one of the 18 centers for plant diversity in the Philippines (Lapitan et al. 2010). The different physical types of vegetation is similar to those natural on many, if not most, mountain peaks rising from the lowlands in moist tropical regions. According to Fernando et al. (2004) there are four types of vegetation recognized in the mountain based on altitude: upper montane rain forest (>1000 m asl.), lower montane forest (>750 m asl.), lowland evergreen forest (100-500 m asl.), and parang vegetation (< 100 m asl.). Ferns and their allies are one of the important understory vegetation in many forest communities. Ferns can be used as food and ornamentals (Zamora and Co 1986; Buot 1999; Banaticla and Buot 2008; Delos Angeles and Buot 2012). It also has medicinal value found in this plant (Amoroso 1987b; Zamora and Co 1986; Delos Angeles and Buot 2012). Fern species are spore-bearing plants growing in moist shaded habitat although some can grow under strong sunlight in very dry environment.

Few studies on the pteridophyte flora of Philippine mountains have been carried out. There are approximately 1,100 species, with 144 genera and 39 families of Pteridophytes

reported to be present in the Philippines (Barcelona 2002; Banaticla and Buot 2008; Pelser et al. 2011; Delos Angeles and Buot 2012; Amoroso et al. 2016). It was reported that 899 species of ferns in the Philippines are endemic in the Philippines (Delos Angeles and Buot 2012; Zamora 2007). In Mindanao, Amoroso et al. (1996) studied the diversity, status and ecology of pteridophytes in three forests, i.e. Mt. Kitanglad has 275 species; Mt. Apulang and Marilog forest has 249 species and 183 species, respectively. In Mt. Pangasugan, Baybay Leyte, a total of 93 species of pteridophytes belonging to 24 families and 55 genera were collected and found at 5 to 400 masl (Belonias and Bañoc 1994). The study of Barcelona (2003) on the pteridophyte flora of Mt. Iraya, Batan Island, Batanes revealed that the area caters 89 species in 47 genera and 25 families. Tolentino (1988) worked on the fern flora of Mt. Santo Tomas, Benguet and documented 100 species. In Mt. Makiling, a total of 27 species under 18 genera and 14 families were identified (Delos Angeles and Buot 2015). Pteridophytes are excellent bioindicators in recognizing the altitudinal zonation of tropical mountains (Frahm and Gradstein 1991).

In a study conducted by Delos Angeles and Buot (2018) in Mt. Makiling, three zones were identified using dendrogram by average clustering. These zones were: (i) *Bolbitis*-

Lindsaea zone, (ii) *Lygodium-Christella* zone; and (iii) *Sphaerostephanos-Selaginella* zone. Fern species may also be used as bioindicators for different land use types. The study was conducted to: (i) identify and document fern species found in various land use types across the north-eastern slope of Mt. Makiling and; (ii) to determine the distribution and current conservation status of the identified fern species through the use of published literature.

MATERIALS AND METHODS

Study area

The study was conducted during the wet season of June 2018 at Mt. Makiling, Los Baños, Laguna, Philippines (Figure 1). The mountain is an important training laboratory for the conservation and development of forests and associated ecosystems. Mt. Makiling (1,090 m asl.) is surrounded by regions with sharply alternating wet and dry seasons, so its immediate vicinity has a mild climate. In terms of soil type, Mt. Makiling soils are classified as clay-loam type, which were derived from volcanic ash (Brown 1919).

A field reconnaissance survey was conducted in the study area as a confirmatory step to verify the presence of ferns in a different land use types in Mt. Makiling. The different land use types identified were: i) Mahogany (341 m asl.); (ii) Agriculture (355 m asl.); (iii) Buffer zone (365 m asl.); (iv) Agroforest (368 m asl.); (v) Roadside (455 m asl.), and (vi) Forest (482 m asl.). A Global Positioning

System (GPS) was used to record the coordinates of the identified land use type.

Establishment of plots

The plot technique was employed using a 20 x 20 m² quadrat to inventory the different fern species observed. Within the established quadrat, three (3) 5 x 2 meter sub quadrats were randomly distributed. Three sub quadrats were established per land use type. In each sub quadrat, all observed ferns were considered samples. The number of individuals per species of fern found within the area was noted and recorded. Sample specimens were collected for herbarium use. The number of individuals of ferns per unit area was used as a measure of dominance.

Fern identification

The collected fern samples were re-examined at the Plant Systematics Laboratory, Plant Biology Division, Institute of Biological Sciences (IBS), College of Arts and Sciences (CAS), University of the Philippines Los Baños (UPLB), using a dissecting (20x) and compound microscope (40x). The unknown species were identified using the herbarium specimens at the Plant Biology Division Herbarium (PBDH), Plant Systematics Laboratory, IBS, CAS, UPLB, and the Philippine National Herbarium, National Museum in Manila. Fern specialists were also consulted for the identification of unknown specimens. The morphology and diagnostic characters of ferns were used for classification. Identified specimens were deposited to the Plant Biology Division Herbarium (PBDH).

Figure 1. Location of the study site indicating the different land use types at the northeastern slope of Mt. Makiling, Los Baños, Philippines

RESULTS AND DISCUSSION

Fern species composition across land use types of Mt. Makiling

Six (6) land use types were identified from Mt. Makiling. These land use types were: i) Mahogany (341 m asl.); (ii) Agriculture (355 m asl.); (iii) Buffer zone (365 m asl.); (iv) Agroforest (368 m asl.); (v) Roadside (455 m asl.), and (vi) Forest (482 m asl.) (Figure 2). Forest areas were represented by the growth of dipterocarps and plantations, including the tropical rain-forest park. Agroforestry areas are those where annual crops and fruit trees along with woody species are grown. Brush lands, grasslands and coconut plantations areas are also categorized as part of the agroforestry areas. Buffer zone is those areas designed to protect and intensify the conservation benefit of ecologically valuable areas (Soriano et al. 2019).

A total of 28 fern species with 22 genera from 14 families were found across the identified land use types (Table 1). Based on its important values, the pteridophyte flora of Mount Makiling across land use types was dominated by the following fern families: Thelypteridaceae (5 spp), Dryopteridaceae (3 spp), Polypodiaceae (3 spp) and Pteridaceae (3 spp). The families Aspleniaceae, Dennstaedtiaceae, Selaginellaceae, and Tectariaceae are comprised of two (2) species each. Marattiaceae,

Davalliaceae, Schizaeaceae, Lindsaeaceae, and Nephrolepidaceae consist of one (1) species only.

Dominant fern species in each land use type

Dominant fern species for each land use type was determined. The Mahogany land use type can be found at an elevation of 341 m asl. It is a 60-year plantation heavily dominated by *Swietenia macrophylla* King (Lee, et al. 2010). This land use type harbors the lowest number of observed species with 6 fern species. *Pneumatopteris nitidula* (C. Presl) Holttum dominated this land use type. This particular fern species is utilized by the community as food, especially the crozier. It is enjoyed by the locals and is usually prepared as a salad.

The agricultural land use type is found at an elevation of 355 m asl. It refers to areas in the mountain with clearings by farmers for the plantation of crops (Buot and Osumi, 2011). Similar to the Mahogany land use type, the dominant fern species was *Pneumatopteris nitidula* (C. Presl) Holttum. This fern species is capable of colonizing areas with high anthropogenic activity such as agricultural areas. The fern species *Sphaerostephanos unitus* (L.) Holttum was only recorded in plots established in this particular land use type. It can be considered as an indicator species for agricultural land use types. *Sphaerostephanos unitus* (L.) Holttum can be found in degraded habitats generally, along waterways, and is very common at low to medium elevation (Pelsner et al. 2011).

Figure 2. Identified different land use types in Mt. Makiling, Los Baños, Laguna, Philippines. Note: A. Buffer zone; B. Agroforest; C. Agriculture; D. Roadside; E. Primary forest, and F. Mahogany.

Table 1. Frequency of pteridophytes (sensu PPG 2016) across land use types in Mt. Makiling Forest Reserve, Laguna, Philippines

Class, Order	Family	Scientific name	Land use types						
			B	AF	A	R	F	M	
Lycopodiopsida									
Selaginellales	Selaginellaceae	<i>Selaginella</i> sp. 1	9	5	0	0	2	0	
		<i>Selaginella cupressina</i> (Willd.) Spring	5	0	0	5	0	0	
Polypodiopsida									
Marattiales	Marattiaceae	<i>Angiopteris evecta</i> (Forst.) Hoffm.	10	1	0	6	7	1	
Schizaeales	Schizaeaceae	<i>Lygodium circinatum</i> (Burm. f.) Sw.	0	1	0	0	0	0	
Lindsaeineae	Lindsaeaceae	<i>Lindsaea fissa</i> Copel.	0	0	0	0	1	0	
Pteridineae	Pteridaceae	<i>Adiantum diaphanum</i> Blume	0	0	3	0	1	0	
		<i>Pteris blumeana</i> C. Agardh	2	0	0	0	0	0	
		<i>Pteris longipinnula</i> Wall. ex J. Agardh	1	0	0	0	2	1	
Dennstaedtiineae	Dennstaedtiaceae	<i>Dennstaedtia philippinensis</i> Copel.	0	2	0	0	0	0	
		<i>Microlepia</i> sp.	0	1	0	0	0	0	
Aspleniineae (Eupolypods II)	Aspleniaceae	<i>Asplenium</i> sp.	0	0	0	0	6	1	
		<i>Asplenium tenerum</i> G. Forst.	0	0	0	0	4	0	
Polypodiineae (Eupolypods I)	Thelypteridaceae	<i>Christella</i> sp.	0	0	0	0	38	0	
		<i>Cyclosorus terminans</i> (J. Sm. ex Hook.) K.H. Shing	0	163	3	11	0	0	
		<i>Sphaerostephanos hirsutus</i> Holttum	0	0	13	9	0	0	
		<i>Sphaerostephanos unitus</i> (L.) Holttum	0	0	32	0	0	0	
	Dryopteridaceae	<i>Pneumatopteris nitidula</i> (C. Presl) Holttum	2	2	28	0	0	38	
		<i>Bolbitis heteroclita</i> (C. Presl) Ching	0	0	0	18	0	0	
		<i>Bolbitis sinuata</i> Hennisman	1	0	0	0	2	0	
		<i>Pleocnemia macrodonta</i> Holttum	19	2	1	3	9	0	
		Nephrolepidaceae	<i>Nephrolepis cordifolia</i> (L.) C. Presl	0	0	0	0	1	0
			Tectariaceae	<i>Tectaria crenata</i> Cav.	3	0	0	0	0
	<i>Tectaria siifolia</i> (Willd.) Copel.	0		1	0	14	0	0	
	Davalliaceae	<i>Davallia hymenophylloides</i> (Blume) Kuhn	0	57	0	0	0	9	
	Polypodiaceae	<i>Microsorium longissimum</i> Fée	0	2	0	0	4	0	
		<i>Phymatosorus membranifolium</i> (R. Br.) S.G. Lu	0	0	0	6	0	0	
		<i>Phymatosorus scolopendria</i> (Burm.f.) Pic. Serm.	0	0	0	0	2	1	
		Total	52	237	80	72	79	51	

Note: Values are the number of individuals found in the study plots. Note: B: Buffer, AF: Agroforest, A: Agriculture, R: Roadside, F: Forest, and M: Mahogany

The buffer land use type is a forested area in between the forest edge and the undisturbed forest (Buot and Osumi, 2011). The buffer zone is found at an elevation of 365 m asl. The dominant fern species was *Angiopteris evecta* (Forst.) Hoffm. It is commonly known as the king fern with heights reaching up to 7 meters and fronds that can reach up to 5 to 6 meters (Christenhusz, M., Toivonen, J.M., and Tuuli, K., 2008). In a study conducted by Magtoto and Austria (2017), *Angiopteris evecta* (Forst.) Hoffm can be observed in slopes and in inner forests. The fern species *Pteris blumeana* Agardh and *Tectaria crenata* Cav. are recorded only in plots established in the buffer land use type and are indicator species for this particular land use type.

The agro-forest land use type is found at an altitude of 368 m asl. It refers to open areas of the mountain where trees and shrubs are grown in association with economically important crops. The agroforest land use types were recorded to have 10 fern species. Despite being an anthropogenic ecosystem, agroforests can still harbor a

higher number of species resulting in a higher number of fern species among the land use types. Ferns have strategies which allow them to adapt to more frequent disturbance and invest in rapid gametophyte growth and recruitment (Watkins, et al. 2007). The dominating fern species was *Davallia hymenophylloides* (Blume) Kuhn. *Dennstaedtia philippinensis* Copel., *Lygodium circinnatum* (Burm. F.) Sw., and *Microlepia* sp. can be considered as indicator species since they can only be found thriving in this particular land use type. *Lygodium circinnatum* (Burm. F.) Sw. are common in brush and open sites as well as in disturbed lowland forests (Pelser et al. 2011).

The roadside refers to vegetated area beside a road. The plot was established at an altitude of 455 m asl. A total of 8 fern species were observed in the area. The dominant fern species was *Cyclosorus terminans* (J. Sm. Ex Hook) K.H. Shing which is common in thickets on hillsides and in valleys at low and medium elevation (Pelser et al. 2011). It can be noted that ferns in the established plots for this land use type were thriving on rocks as well as along slopes. A

rocky substrate provides a good substrate for ferns to root upon (delos Angeles and Buot 2018). *Bolbitis heteroclita* (C. Presl) Ching, and *Phymatosorus membranifolium* (R. Br.) S.G. Lu were limited to this land use type and thus can be considered as indicator species.

The primary forest can be found starting at an altitude of 482 m asl. It is a pristine forest with very little human encroachment. Forests are richer in species as compared to disturbed areas of the mountain. It was recorded to have the most number of observed species with 13 fern species. The dominant fern is *Christella* sp. Indicator species for this land use type are *Asplenium tenerum*, *Christella* sp., *Nephrolepis cordifolia*, and *Lindsaea fissa* Copel.

Distribution and conservation status of fern species

The climate in Mt. Pangasugan was Type IV which is characterized by frequent rainfall that is evenly distributed throughout the year (Polinar and Muuss, 2010). This climate is similar to that of Mt. Makiling. On the other hand, Mt. Iraya has unfavorable climatic conditions due to frequent strong winds and remoteness from mainland Luzon (Barcelona, 2003). Mt. Banahaw mountain complex is one of the 12 centers of plant diversity and endemism in the Philippines as recognized by the World Wildlife Fund/International Union for the Conservation of Nature (WWF/IUCN) (Mittermeier et al. 1997).

Some fern species recorded in Mt. Makiling were similar to that of Mt. Pangasugan, Mt. Iraya and Mt. Banahaw (Table 2). *Angiopteris evecta* (Forst.) is a fern

species similar to both Mt. Pangasugan and Mt. Iraya only. It was noted that *Pleocnemia macrodonta* Holttum species were similar only with Mt. Pangasugan. The fern species similar only with Mt. Banahaw were *Bolbitis sinuata* Hennisman and *Phymatosorus membranifolium* (R. Br.) Ching. Only *Bolbitis heteroclita* (C. Presl) Ching and *Christella* sp. are the fern species similar to Mt. Iraya.

The existence of various microenvironment, as a result of stratified vegetation of the secondary forest, which allows niche variation for the pteridophytes. The tree ferns formed the lowest canopy layer with forest tree seedlings and large shrubs. Terrestrial ferns and clubmosses are very prominent components of the ground layer, especially along trails. Tree branches, fallen tree trunks, tree stumps and rock crevices in a various land use types is a very large array of epiphytic ferns and lycopsids. The moist and wet conditions are favorable for pteridophyte growth and reproduction (Banaticla and Buot 2004, Koptur and Lee 1993). The species success in occupying a particular area is determined by several biological and physical factors. The most conducive environmental conditions and the absence of other plant competitors would greatly favor species growth and reproduction. Species with wider tolerance range, climbing habit (Russel et al. 1998) and ability to reproduce asexually have more advantage than the others. However, the combined cover values of many different species occupying their own niches in a stratified forest community can equal or even surpass the combined cover values of a few species dominating an exposed grassland.

Figure 3. Dominant fern species found in various land use types in Mt. Makiling, Los Baños, Laguna, Philippines: A. Mahogany: *Pneumatopteris nitidula* (C. Presl) Holttum -sterile frond; B. Agriculture: *Pneumatopteris nitidula* (C. Presl) Holttum -fertile frond; C. Buffer: *Angiopteris evecta* (Forst.) Hoffm.; D. Agroforest: *Davallia hymenophylloides* (Blume) Kuhn; E. Roadside: *Cyclosorus terminans* (J. Sm. Ex Hook) K. H. Shing; F. Forest: *Christella* sp.

Table 2. Pteridophytes from Mt. Makiling compared to other mountain areas

Family	Scientific name	Mt. Pangasugan ¹⁾	Mt. Iraya ²⁾	Mt. Banahaw ³⁾
Selaginellaceae	<i>Selaginella</i> 1	-	-	-
	<i>Selaginella cupressina</i> (Willd.) Spring		+	+
Marattiaceae	<i>Angiopteris evecta</i> (Forst.) Hoffm.	+	+	+
Schizaeaceae	<i>Lygodium circinatum</i> (Burm. f.) Sw.	+	+	-
Lindsaeaceae	<i>Lindsaea fissa</i> Copel.	-	-	-
Pteridaceae	<i>Adiantum diaphanum</i> Blume	-	-	-
	<i>Pteris blumeana</i> C. Agardh	-	-	-
	<i>Pteris longipinnula</i> Wall. ex J. Agardh	-	-	-
Dennstaedtiaceae	<i>Dennstaedtia philippinensis</i> Copel.	-	-	-
	<i>Microlepia</i> sp.	-	-	-
Aspleniaceae	<i>Asplenium</i> sp.	-	-	-
	<i>Asplenium tenerum</i> G. Forst.	-	-	-
Thelypteridaceae	<i>Christella</i> sp.	-	+	-
	<i>Cyclosorus terminans</i> (J. Sm. ex Hook.) K.H. Shing	-	-	-
	<i>Sphaerostephanos hirsutus</i> Holttum	-	+	+
	<i>Sphaerostephanos unitus</i> (L.) Holttum	-	-	-
	<i>Pneumatopteris nitidula</i> (C. Presl) Holttum	-	-	+
Dryopteridaceae	<i>Bolbitis heteroclita</i> (C. Presl) Ching	-	+	-
	<i>Bolbitis sinuata</i> Hennipman	-	-	+
	<i>Pleocnemia macrodonta</i> Holttum	+	-	-
Nephrolepidaceae	<i>Nephrolepis cordifolia</i> (L.) C. Presl	+	-	+
Tectariaceae	<i>Tectaria crenata</i> Cav.	-	-	-
	<i>Tectaria siifolia</i> (Willd.) Copel.	-	-	-
Davalliaceae	<i>Davallia hymenophylloides</i> (Blume) Kuhn	-	-	-
Polypodiaceae	<i>Microsorium longissimum</i> Fée	-	-	-
	<i>Phymatosorus membranifolium</i> (R. Br.) S.G. Lu	-	-	+
	<i>Phymatosorus scolopendria</i> (Burm.f.) Pic. Serm.	-	-	-

Note: (-) = absent (+) = present. ¹⁾ Belonias and Bañoc (1994), ²⁾ Barcelona (2003); ³⁾ Banaticla and Buot (2004)

Identified fern species were found to be distributed over large biogeographical regions (Table 3). These species are *Adiantum diaphanum* Blume, *Angiopteris evecta* (Forst.) Hoffm., *Asplenium tenerum* G. Forst., *Bolbitis heteroclita* (C. Presl) Ching, *Bolbitis sinuata* Hennipman, *Davallia hymenophylloides* (Blume) Kuhn, *Dennstaedtia philippinensis* Copel., *Lygodium circinnatum* (Burm. f.) Sw., *Nephrolepis cordifolia* (L.) C. Presl, *Phymatosorus membranifolium* (R. Br.) S.G. Lu. Ferns tend to have wider geographical ranges due to their effective dispersal via spores (Kessler 2010).

Some endemic Philippine fern species are: *Phymatosorus scolopendria* (Burm.f.) Pic. Serm., *Pteris longipinnula* Wall. ex J. Agardh, *Tectaria crenata* Cav. and *Tectaria siifolia* (Willd.) Copel. The fern species *Cyclosorus terminans* (J. Sm. ex Hook.) K.H. Shing is

native to the Philippines while *Pneumatopteris nitidula* (C. Presl) Holttum is endemic to the Philippines. Despite opportunities for long-distance dispersal, some ferns have localized ranges as a result of low frequency of long-distance dispersal, habitat specialization, geographical isolation, and competitive interactions between species (Kessler 2010).

There is a need to document fern species along with its population across land use types in order to utilize ferns as plant indicators due to their vulnerability to changes in environmental conditions. These results can shed light on the appropriate strategy for the conservation and management of ferns. Hopefully, data sets gathered in this study can result to the creation of effective forest conservation measures to pteridophyte flora of Mt. Makiling.

Table 3. List of fern species (sensu PPG 2016) found in Mt. Makiling with its corresponding distribution and conservation status

Class, Order	Family	Scientific name	Distribution	Reference	Status	Conserv- ation status	Exsiccata
Lycopodiopsida Selaginellales	Selaginellaceae	<i>Selaginella</i> 1	-		-	NA	-
		<i>Selaginella cupressina</i> (Willd.) Spring	Moluccas, Java, Sulawesi, Borneo, Philippines. Widespread.	http://portal.cybertaxonomy.org/Leaflet. Données issues de l'INPN 23/07/2019	-	NA	6896
Polypodiopsida Marattiales	Marattiaceae	<i>Angiopteris evecta</i> (Forst.) Hoffm.	Occurs in far N.E. India-in Arunachal Pradesh and adjacent Assam-and right through from Myanmar and S.E. Asia to the Philippines.	Boonkerd et al. Thai For. Bull. (Bot.) 32: 9. 2004	-	OTS	6897
Schizaeales	Schizaeaceae	<i>Lygodium circinnatum</i> (Burm. f.) Sw.	Sri Lanka and India to S China, across Malesia to the Solomons. Throughout the Philippines	Merr.-in Philip. J. Sc. 1921: 336 Sw.-in Bull. Bur. For. Philip. 1920: pl. IV	-	NA	6898-6900
Lindsaeineae	Lindsaeaceae	<i>Lindsaea fissa</i> Copel.	Asia Tropical: Malesia: Philippines	Copeland-in Fern Fl. Philip. 1958: 105	Endemic	NA	6936-6937
Pteridinae	Pteridaceae	<i>Adiantum diaphanum</i> Blume	Native to China (Fujian, Guangdong, Hainan, Jiangxi), Taiwan, Indonesia, Malaysia, Vietnam, Australia, New Zealand and the Pacific islands	Bostock, P.D. 1998: Adiantaceae. Flora of Australia 48: 248-263	-	NA	6902-6904
		<i>Pteris blumeana</i> C. Agardh	India, Laos, Cambodia, S. Vietnam and Malesia.	Tardieu & C.Chr., Fl. Indo-Chine 7 (2): 157. 1940	-	LC	-
		<i>Pteris longipinnula</i> Wall. ex J. Agardh	Widespread; S India, Malesia	Boonkerd & Pollawatn, Pterid. Thailand: 129. 2000	Endemic	NA	6908-6909
Dennstaedtiinae	Dennstaedtiaceae	<i>Dennstaedtia philippinensis</i> Copel.	native to Asia-Tropical, Africa, Pacific, Southern America, Northern America, Australasia and Asia-Temperate	Leaflet. Philipp. Bot. 9: 3107 1920	Endemic	NA	-
		<i>Microlepia</i> sp.	-	-	-	NA	6910
Aspleniinae	Aspleniaceae	<i>Asplenium</i> sp.	-	-	-	NA	6914
(Eupolypods II)		<i>Asplenium tenerum</i> G. Forst.	Australia, Bonin Isls, Borneo, Cambodia, China, India, Japan, Java, Lesser Sunda Isls, Micronesia, Moluccas, Myanmar, New Guinea, Nicobar Isls, Pacific, Peninsular Malaysia, Ryukyu Isls, Sauballae, Singapore, Solomon Isls, South Korea	Handb. Ferns Brit. India: 147, f. 74. 1883	-	NA	6911-6913

		<i>Cyclosorus terminans</i> (J. Sm. ex Hook.) K.H. Shing	Native	Racib.-in Fl. Btzig. 1898: 183 Copel., Fern Fl. Philip. 1960: 361 Holtum-in Blumea. 1977: 207	Native	NA	6915
		<i>Sphaerostephanos hirsutus</i> Holtum	Sulawesi, Philippines.	v.A.v.R., Handb. 1908: 214 Hook.-in Sp. Fil. 1862: p.p. & t. 240B.	-	NA	6916-6917
		<i>Sphaerostephanos unitus</i> (L.) Holtum	Sri Lanka, S India, across Malesia. Throughout the Philippines	Holtum-in Rev. Fl. Mal. 1955: f. 147	-	NA	6918-6920
		<i>Pneumatopteris nitidula</i> (C. Presl) Holtum		www.iucnredlist.org/details/194150/0	Endemic	LC	-
Polypodiinae (Eupolypods I)	Dryopteridaceae	<i>Bolbitis heteroclita</i> (C. Presl) Ching	E. India to S. Japan, Formosa, and Indo-China; in Malesia: throughout, except for the Lesser Sunda Is.; also in Micronesia (Caroline Is.) and Melanesia (Solomon Is.).	Copel., Fern Fl. Philip. 1960: 257	-	NA	-
		<i>Bolbitis sinuata</i> Hennipman	India (Nicobar Is.) and Peninsular Thailand; in Malesia: Sumatra, Malay Peninsula, W. Java, Borneo, Philippines, New Guinea	Blumea 18: 148. 1970	-	NA	6921
		<i>Pleocnemia macrodonta</i> Holtum	Malesia: Borneo (Sarawak), Philippines (Luzon, Sibuyan, Mindoro), E New Guinea, Admiralty Is., New Britain.	http://portal.cybertaxonomy.org/flora-malesiana/cdm_dataportal/taxon	-	NA	6922-6927
	Nephrolepidaceae	<i>Nephrolepis cordifolia</i> (L.) C. Presl	introduced into Bermuda, French Polynesia, New Zealand, and the United States; native in north-eastern Australia, and is considered naturalized on the central east coast of New South Wales	Holtum-in Revis. Fl. Malaya, 2nd ed. 1968: 379	-	NA	6928
	Tectariaceae	<i>Tectaria crenata</i> Cav.	Malesia: Java (?), Lesser Sunda Islands (Flores, Sumbawa), Philippines, NE Celebes, Moluccas, New Guinea; Marianas, Solomons, New Hebrides, Rotuma Is., probably Fiji.	Alderw., Malayan Ferns. 1917: 196 Copel., Fern Fl. Philipp. 1960: 314	Endemic	NA	-
		<i>Tectaria siifolia</i> (Willd.) Copel.	Asia-Tropical: Malesia: throughout, but local in occurrence.	Copel., Fern Fl. Philipp. 1960: 314	Endemic	NA	6929-6931
	Davalliaceae	<i>Davallia hymenophylloides</i> (Blume) Kuhn	Africa: Asia-Tropical; Australasia; Tropical and southern Africa: continental Asia	Schkuhr-in Deutschl. Krypt. Gew. 1809: t. 127	-	NA	6932
	Polypodiaceae	<i>Microsorium longissimum</i> Fée	Asia-Tropical: , Borneo (Sarawak); Philippines (Philippines)	Ching-in Acta Phytotax. Sinica. 1963	-	NA	-
		<i>Phymatosorus membranifolium</i> (R. Br.) S.G. Lu	India, Sri Lanka to Indochina, China. In Malesia: Sumatra, Peninsular Malaysia, Java, Lesser Sunda Islands, Borneo, Philippines, Sulawesi, Moluccas, New Guinea (including New Ireland). Pacific Solomon Islands, Fiji, Society Is., Marquesas	Noot.-in Blumea. 1997: 339	-	LC	6934-6935
		<i>Phymatosorus scolopendria</i> (Burm.f.) Pic. Serm.	Philippines (Luzon), Palawan; introduced in Hawaii	W.C. Shieh-in Fl. Taiwan. 1994: 504	Endemic	VU	6933

Note: *Conservation status is based from DENR list of threatened species (DAO No. 2007-01, also found in Fernando, et al. 2008). LC = Least Concern; NA = Not Assessed; OTS = Other Threatened Species

Recommendation

All ferns identified should be conserved and several measures should be developed to prevent their extinction. Some of these measures should include: (i) information dissemination, (ii) active participation in environmental improvement, and (iii) implementation of strict rules and regulations towards the protection of ferns to increase awareness and fern conservation. The generated information from this study, such as fern indicators, can be utilized as reference for biodiversity monitoring programs in Mt. Makiling in the future. The list of species encountered in this study can serve as baseline data for future pteridophytes research and can be enriched by further studies in the said area.

The preference of many pteridophyte species for microenvironments that can be found along the altitudinal gradient makes them vulnerable to the slightest change in environmental conditions brought by natural and man-made disturbances. Effective forest conservation measures are essential to the survival and diversity not only of the pteridophytes but also the rest of the flora and fauna of Mt. Makiling. Furthermore, it is recommended that the fern diversity and composition of the Northeastern and Southeastern portions of Mt. Makiling be compared to this study. Moreover, these could be compared to other similar forest reserves in the Philippines having the same land use types.

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