



Preliminary assessment of Philippine threatened plants in the Makiling Botanic Gardens, Philippines: A showcase of the gardens' ex-situ living collections

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Abstract

Conservation of threatened plants is a national and global concern. Assessment of Philippine plants listed as threatened was conducted at the Makiling Botanic Gardens (MBG) of the Mount Makiling Forest Reserve ASEAN Heritage Park. Aside from providing venue for instruction and research related to forestry and plant sciences as mandated by Republic Act (RA) No. 3523, MBG also serves as a repository of important native and endemic species. The study aimed to showcase MBG's ex-situ collections and to provide list and information on the threatened plants including status, their number and location within the area to safeguard these threatened plants and save them from possible extinction.

The list of threatened plants is based on the Department of Environment and Natural Resources (DENR) Administrative Order 2017-11 issued on 02 May 2017 pursuant to RA No. 9147, also known as the 'Wildlife Resources Conservation and Protection Law'. Results of initial inventory showed a total of 7,574 plant individuals distributed in 401 species and 75 families. Of these, only 82 species with 2,052 individuals are in the Philippine threatened plant list: eight species critically endangered (CR), 15 species endangered (EN), 39 vulnerable (VU), and 20 other threatened species (OTS). This represents only 8.3% of the total 984 species in the threatened plant list and is still way below the Global Strategy for Plant Conservation (GSPC) Target 8 of 75%. About 45% of these threatened species are endemic to the Philippines. There is a need therefore to prioritize these species for global conservation and restoration. Long-term programs on conservation and restoration of these threatened plants must be developed to at least improve their conservation status. Meanwhile, the MBG has commenced a project to increase its living collections of threatened species and develop propagation protocols to make these available for recovery and restoration programs.

Keywords: biodiversity conservation

Introduction, scope and main objectives

Conservation of threatened plants is not only a national concern but also a global concern as well. Targets 7 and 8 of the Global Strategy for Plant Conservation (GSPC) focus mainly on conserving the threatened plants through *in situ* and *ex situ* conservation. GSPC, adopted by the Convention on Biological Diversity in 2002 and updated in 2010, offers the overall framework for plant conservation at the global and national level with 16 output-oriented targets covering all aspects of conservation and sustainable use of plants.

The Philippines' response to conserve the threatened species is embodied in the National Biodiversity Strategy and Action Plan (NBSAP). NBSAP was approved in 1997 as part of the country's commitments to international conventions like the United Nations Convention on Biological Diversity (UNCBD), United Nations Framework

Convention on Climate Change (UNFCCC), and United Nations Convention to Combat Desertification (UNCCD) (PBSAP 2015-2028). NBSAP's second (2002) and third iteration (2015) is now known as the Philippine Biodiversity Strategy and Action Plan (PBSAP). PBSAP contains 206 conservation priority areas, 228 key biodiversity areas, and 20 targets towards human well-being, with PBSAP Target 1 of maintaining or improving the conservation status of threatened species. As a result, Republic Act 9147, known as Wildlife Resources Conservation and Protection Act, was issued by the state to mainly conserve and protect wildlife species and their habitats from promoting ecological balance and enhancing biological diversity. Under Section 22 of RA 9147, the Department of Environment and Natural Resources (DENR) published two administrative orders on establishing the national list of threatened Philippine plants and their categories and list of other wildlife species. The first was DAO 2007-01 with 686 threatened species, followed by DAO 2017-11 with an updated number of threatened species at 984.

With this increasing trend on threatened plants and in response to PBSAP Target 1, key biodiversity areas (KBAs) were established to prioritize conservation action and develop specific strategies to protect individual species, including their representative habitats (Edgar et al. 2008). The Mount Makiling Forest Reserve ASEAN Heritage Park (MMFR AHP) is one of the declared KBAs. MMFR AHP is known for its diverse biological resources (Pancho. 1983; Gruezo et al 1997; Bantayan et al 2008; Lapitan 2010; Fernando 2010; Castillo 2018).

The Makiling Botanic Gardens (MBG) serves as a show window, especially for those unable to go around MMFR AHP. Established on June 20, 1963, by virtue of RA 3523, MBG as mandated by law functions mainly to support instruction and research related to forestry and plant sciences and serve the public's educational, recreational, and tourism needs. MBG also serves as a repository of important native and endemic species. With the establishment of the national list of threatened species and the inclusion of MMFR to KBA, there is a great need to re-inventory the plants inside the gardens and identify the threatened species to prioritize conservation activities to save these species for possible extinction. Currently, MBG has no comprehensive plant list, especially on threatened plants.

The study aimed to showcase MBG's *ex situ* collections and to provide list and information on the threatened plants including status, their number and location within the area to safeguard these threatened plants and save them from possible extinction as part of the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development - Department of Science and Technology's funded program entitled "*Ex-situ Conservation of Threatened Philippine Plants: Restoring Philippines' Plant Resources and Environment*". The results can significantly help as this will complement the conservation efforts in target species, habitats, ecosystems, and priority areas in MBG.

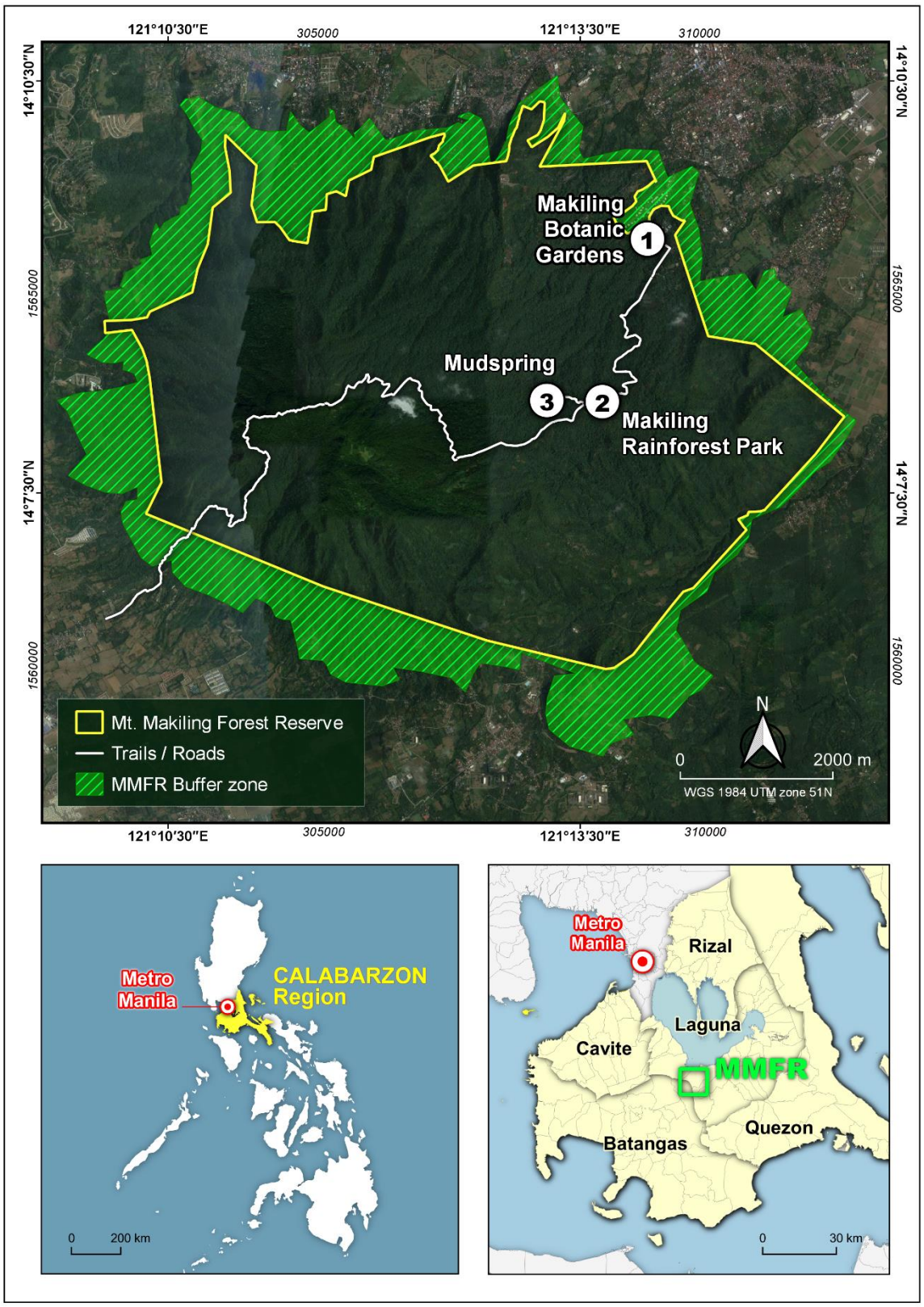
Methodology

1-Location of the study

The study is located at MBG, which occupies 300 hectares of natural and re-growth forests on the northeastern slope of MMFR AHP, including other MMFR's points of interest such as Mudsprings and Makiling Rainforest Park (Fig. 1). The inventory covered 6.9 has which is about 2.3% of the whole MBG.

2-Tree Inventory

The inventory of plants, including vines, shrubs, palms, orchids, and trees, was conducted in August 2019 – September 2020. Following the MMFR's GAME Model Inventory System, all trees with a minimum diameter at breast height of 5.0cm were measured and recorded, including total and merchantable heights. Vines and orchids were counted and noted. The relative location of each plant was also determined. Voucher specimens were also collected for reference.



source

Fig. 1: Location of the study area

3-Categorization of threatened species

From the inventory data, identified threatened species were categorized based on DAO 2017-11. The study used DAO 2017-11 as the primary reference since this is the country's own national red list. IUCN encourages countries to develop their own national red list following IUCN's guidelines and criteria (Villanueva and Buot, 2015).

These threatened plants are classified into the following categories as defined by Fernando et al. (2008) and DAO 2017-11:

- (1) Critically Endangered (CR) - refers to a species, subspecies, varieties, or other infraspecific categories facing an extremely high risk of extinction in the wild in the immediate future.
- (2) Endangered (EN) - refers to species, subspecies, varieties, or forma that is not critically endangered but whose survival in the wild is unlikely if the causal factors continue operating.
- (3) Vulnerable (VU) refers to a species or subspecies, varieties, formae or other infraspecific categories of plants that are not critically endangered or endangered but under threat from adverse factors throughout its range and is likely to move to the endangered category in the future. This shall include varieties, formae or other infraspecific categories; and,
- (4) Other Threatened Species (OTS) - refers to a species, subspecies, varieties, or other infraspecific categories that are not critically endangered, endangered, nor vulnerable but is under threat from adverse factors, such as over-collection throughout its range and is likely to move to the vulnerable category in the near future;

Results

1. Distribution and Status of Threatened Plants

Results of the initial inventory showed a diverse collection of threatened species. A total of 7,574 plant individuals distributed into 401 species and 75 families were inventoried. Of these, 82 species with 2,052 individuals are in the Philippine threatened plant list: eight species in the CR category, 15 species EN, 39 VU, and 20 OTS. Such 82 species represent about 8.3% of 984 species in the DAO 2017-11 threatened plant list and are still way below the GSPC Target 8 of 75% (Table 1). About 45% of these threatened species are endemic to the Philippines.

Table 1: Number of species per threat category

CATEGORIES	No. of Species (DAO 2017-11)	No. of Species (This Study)	Percentage (%)
CR	179	8	4.47
EN	254	15	5.90
VU	406	39	9.61
OTS	146	20	13.70
TOTAL	984	82	8.33

For threat categories, data showed that the vulnerable category is among the most present in MBG in terms of the number of individuals, species, and families (Table 2).

Table 2: Number of individuals, species and families per threat category

CATEGORIES	No. of Individuals	No. of Species	No. of Families
CR	199	8	4
EN	224	15	9
VU	1,280	39	17
OTS	349	20	16
TOTAL	2,052	82	29

Meanwhile, in terms of plant habits, the study listed 65 trees, 8 palms, 1 vine and 4 orchids and 4 epiphytes (Fig. 2). The distribution reflects the dominance of trees since about 90% of MBG’s natural landscape is forest, and more trees are being planted since they have the most and readily available planting materials in the area.

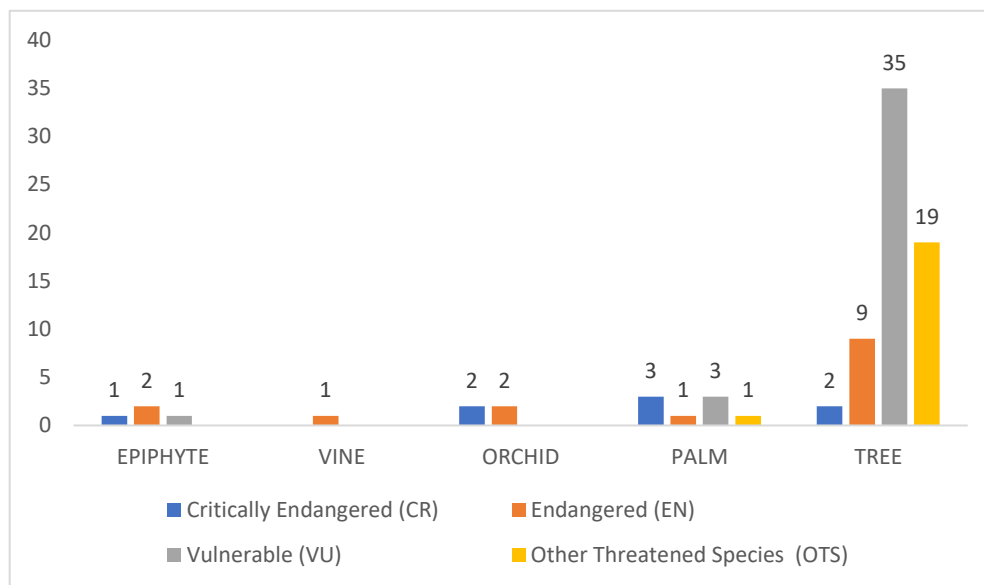


Fig. 2. Number of threatened plants per plant habit

4-List and Spatial Distribution of threatened species in MBG

Figure 3 and Table 3 show the spatial distribution and complete list of threatened plants within the MBG zone. The map shows that the most significant number of threatened species are found in MBG main area since the main site is the central repository of threatened species. It was followed by Mudspring and then the Makiling Rainforest Park. Being the most accessible among the MMFR’s three points of interest, the MBG main area is most frequented by people for education and recreation, hence focusing on plant conservation.

The critically endangered species are represented chiefly by endemic species and mostly palms. Notable species under this category are endemic species such as *Heterospathe califrons* Fernando, *Heterospathe scitula* Fernando, *Pinanga bicolorana* Fernando, *Hopea malibato* Foxw., *Hopea philippinensis* Dyer, and *Vanda sanderiana* Rchb.f. MBG uses the critically endangered species *Medinilla magnifica* Lindl. as its logo since the species was first described on Mount Makiling in 1850. Most of these critically endangered species are found within the MBG recreation and nursery areas and Dipterocarp arboretum.

Fifteen species are listed under the endangered category. Like the critically endangered category, most species under this category are mostly endemic (78%). Notable are native and endemic rare hardwood species such as *Dipterocarpus kerrii* King, *Hopea acuminata* Merr, *Azelia rhomboidea* (Blanco) S.Vidal, *Sindora supa* Merr., *Tectona philippinensis* Benth. & Hook, *Vitex parviflora* Juss., and *Madhuca betis* (Blanco) Macbr. & Merr. Most of these endangered species are found within MBG and at higher elevations such as Makiling Rainforest Park and Mudsprings

Most of the threatened plants in MBG belong to vulnerable category. Notable species include endemic species such as *Ardisia squamulosa* Elmer, *Areca ipot* Becc., *Cryptocarya ampla* Merr., *Cycas riuminiana* Porte ex Regel, *Dillenia luzoniensis* (S.Vidal) Merr., *Diospyros ferrea* (Willd.) Bakh., *Diospyros pilosanthera* Blanco, *Kingiodendron alternifolium* (Elmer) Merr. & Rolfe, *Medinilla cumingii* Naudin, *Palaquium luzoniense* (Fern.-Vill.) S.Vidal, *Palaquium philippense* (Perr.) C.B.Rob., *Reutealis trisperma* (Blanco) Airy Shaw. Most of these species are found inside the MBG, but some thrive in Musprings and Makiling Rainforest Park.

The Other Threatened Species also represent several species. Under this category are endemic species such as *Alangium longiflorum* Merr., *Artocarpus rubrovenius* Warb., *Canarium luzonicum* (Blume) A.Gray, *Canarium ovatum* Engl., *Cinnamomum mercadoi* S.Vidal, *Mitrephora lanotan* (Blanco) Merr., *Myristica philippinensis* Lam., *Ziziphus talanai* (Blanco) Merr. These OTS species are found in MBG, Makiling Rainforest Park and Mudsprings.

Spatial Distribution of Threatened Plant Species in the Makiling Botanic Gardens (MBG), Makiling Rainforest Park, and Mudspring

- Critically endangered
- Endangered species
- Vulnerable species
- Other threatened species
- Non-threatened species

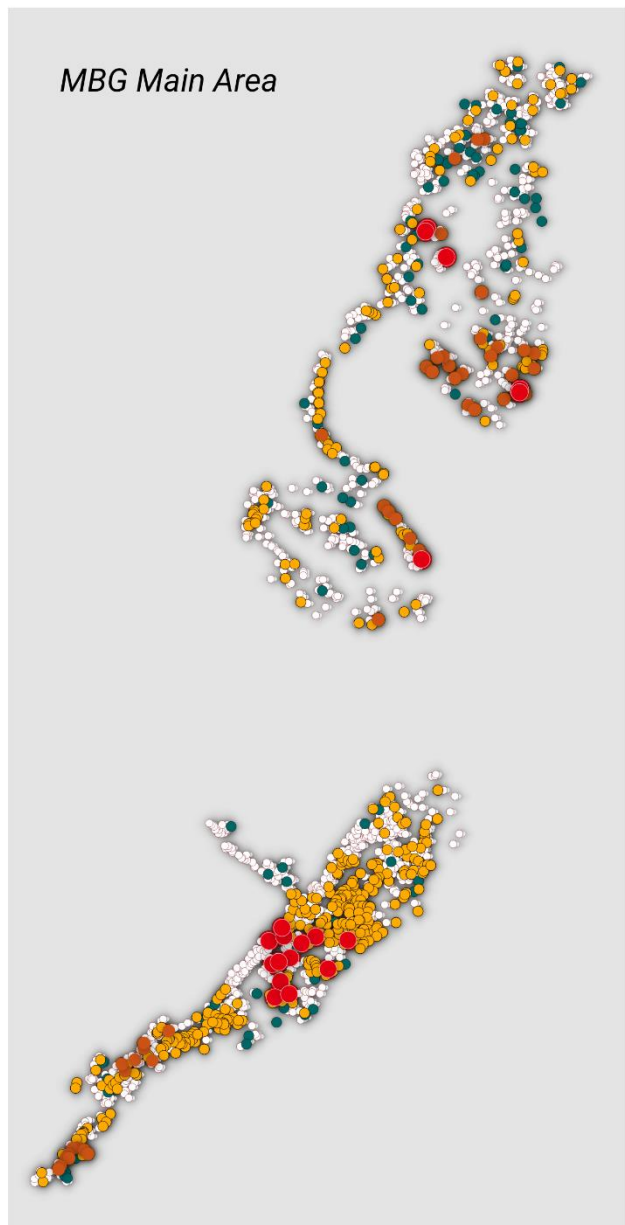


Fig. 3. Spatial distribution of threatened plants in MBG zone

Table 3. List of threatened plants in the Makiling Botanic Gardens

CRITICALLY ENDANGERED SPECIES

FAMILY	SCIENTIFIC NAME	COMMON NAME
ARECACEAE	<i>Heterospathe califrons</i> Fernando	Yanisi
	<i>Heterospathe scitula</i> Fernando	Malasanakti
	<i>Pinanga bicolorana</i> Fernando	Bicol abiki
DIPTEROCARPACEAE	<i>Hopea malibato</i> Foxw.	Yakal kaliot
	<i>Hopea philippinensis</i> Dyer	Gisok-gisok
MELASTOMATACEAE	<i>Medinilla magnifica</i> Lindl.	Kapa-kapa
ORCHIDACEAE	<i>Grammatophyllum speciosum</i> Blume	Comely marked orchid
	<i>Vanda sanderiana</i> Rchb.f.	Waling-waling

ENDANGERED

FAMILY	SCIENTIFIC NAME	COMMON NAME
ARECACEAE	<i>Areca camarinensis</i> Becc.	Mono
DIPTEROCARPACEAE	<i>Dipterocarpus kerrii</i> King	Malapanau
	<i>Hopea acuminata</i> Merr.	Manggachapui
FABACEAE	<i>Afzelia rhomboidea</i> (Blanco) S.Vidal	Tindalo
	<i>Sindora supa</i> Merr.	Supa
	<i>Strongylodon macrobotrys</i> A.Gray	Jade vine
LAMIACEAE	<i>Tectona philippinensis</i> Benth. & Hook.f.	Philippine Teak
	<i>Vitex parviflora</i> Juss.	Molave
LAURACEAE	<i>Litsea leytensis</i> Merr.	Batikuling
MELASTOMATACEAE	<i>Medinilla miniata</i> Merr.	Miniata
	<i>Medinilla pendula</i> Merr.	Baladu
ORCHIDACEAE	<i>Phalaenopsis amabilis</i> (L.) Blume	Mariposa
	<i>Phalaenopsis schilleriana</i> Rchb.f.	Tiger orchid
SAPINDACEAE	<i>Cubilia cubili</i> (Blanco) Adelb.	Kubili
SAPOTACEAE	<i>Madhuca betis</i> (Blanco) Macbr. & Merr.	Betis

VULNERABLE

FAMILY	SCIENTIFIC NAME	COMMON NAME
ANACARDIACEAE	<i>Dracontomelon dao</i> (Blanco) Merr.	Dao
ARAUCARIACEAE	<i>Agathis philippinensis</i> Warb.	Almaciga
ARECACEAE	<i>Adonidia merrillii</i> (Becc.) Becc.	Manila palm
	<i>Areca ipot</i> Becc.	Bungang ipod
	<i>Licuala spinosa</i> Wurbm.	Balatbat
CYCADACEAE	<i>Cycas riuminiana</i> Porte ex Regel	Pitogo
DILLENIACEAE	<i>Dillenia luzoniensis</i> (S.Vidal) Merr.	Malakatmon
DIPTEROCARPACEAE	<i>Dipterocarpus alatus</i> Roxb. G.Don	Hairy-leaf Apitong
	<i>Dipterocarpus caudatus</i> Foxw.	Tailed-leaf apitong
	<i>Dipterocarpus gracilis</i> Blume	Panau
	<i>Dipterocarpus grandiflorus</i> (Blanco) Blanco	Apitong
	<i>Dipterocarpus kunstleri</i> King	Broad-winged apitong
	<i>Hopea plagata</i> (Blanco) S.Vidal	Saplungan
	<i>Shorea almon</i> Foxw.	Almon
	<i>Shorea contorta</i> S.Vidal	White lauan
	<i>Shorea negrosensis</i> Foxw.	Red lauan
	<i>Shorea polysperma</i> (Blanco) Merr.	Tanguile

FAMILY	SCIENTIFIC NAME	COMMON NAME
EBENACEAE	<i>Diospyros discolor</i> Willd.	Kamagong
	<i>Diospyros ferrea</i> (Willd.) Bakh.	Ebony
	<i>Diospyros pilosanthera</i> Blanco	Bolong-eta
	<i>Diospyros pyrrocarpa</i> Miq.	Anang
EUPHORBIACEAE	<i>Balakata luzonica</i> (S.Vidal) Esser	Balakat gubat
	<i>Reutealis trisperma</i> (Blanco) Airy Shaw	Baguilumbang
FABACEAE	<i>Intsia bijuga</i> (Colebr.) Kuntze	Ipil
	<i>Kingiodendron alternifolium</i> (Elmer) Merr. & Rolfe	Batete
	<i>Pterocarpus indicus</i> Willd. forma <i>echinatus</i> (Pers.) Rojo	Prickly Narra
	<i>Pterocarpus indicus</i> Willd. forma <i>indicus</i>	Smooth Narra
	<i>Wallaceodendron celebicum</i> Koord.	Banuyo
LAURACEAE	<i>Cryptocarya ampla</i> Merr.	Bagarilau
MELASTOMATACEAE	<i>Medinilla cumingii</i> Naudin	Cumingi
MELIACEAE	<i>Toona calantas</i> Merr. & Rolfe	Kalantas
MYRSINACEAE	<i>Ardisia squamulosa</i> Elmer	Tagpo
MYRTACEAE	<i>Syzygium nitidum</i> Benth.	Makaasim
SAPINDACEAE	<i>Glenniea philippinensis</i> (Radlk.) Leenh.	Mamoko
	<i>Litchi chinensis</i> Sonn. subsp. <i>philippinensis</i> (Radlk.) Leenh.	Alupag
	<i>Nephelium ramboutan-ake</i> (Labill.) Leenh.	Kapulasan
SAPOTACEAE	<i>Palaquium luzoniense</i> (Fer.-Vill.) S.Vidal	Nato
	<i>Palaquium philippense</i> (Perr.) C.B.Rob.	Malak-malak
THEACEAE	<i>Camellia lanceolata</i> (Blume) Seem.	Haikan

OTHER THREATENED SPECIES

FAMILY	SCIENTIFIC NAME	COMMON NAME
ANACARDIACEAE	<i>Koordersiodendron pinnatum</i> (Blanco) Merr.	Amugis
ANNONACEAE	<i>Mitrephora lanotan</i> (Blanco) Merr.	Lanutan
ARECACEAE	<i>Saribus rotundifolius</i> (Lam.) Blume	Anahau
BURSERACEAE	<i>Canarium luzonicum</i> (Blume) A. Gray	Piling liitan
	<i>Canarium ovatum</i> Engl.	Pili
CORNACEAE	<i>Alangium longiflorum</i> Merr.	Malatapai
FABACEAE	<i>Adenanthera intermedia</i> Merr.	Tanglin
LAMIACEAE	<i>Premna odorata</i> Blanco	Alagau
LAURACEAE	<i>Cinnamomum mercadoi</i> S.Vidal	Kalingag
	<i>Eusideroxylon zwageri</i> Teijm. & Binn.	Tambulian
	<i>Angiopteris evecta</i> (G.Forst.) Hoffm.	Salaguisog
MARATTIACEAE	<i>Aglaia edulis</i> (Roxb.) Wall.	Malasaging
	<i>Aglaia rimosa</i> (Blanco) Merr.	Bayanti
	<i>Aphanamixis polystachya</i> (Wall.) R.Parker	Kangko
MORACEAE	<i>Artocarpus rubrovenius</i> Warb.	Kalulut
MYRISTICACEAE	<i>Myristica philippinensis</i> Lam.	Duguan
PODOCARPACEAE	<i>Nageia wallichiana</i> (C.Presl) Kuntze	Malaalmaciga
PUTRANJIVACEAE	<i>Drypetes falcata</i> (Merr.) Pax & K.Hoffm	Gakakan
RHAMNACEAE	<i>Ziziphus talanai</i> (Blanco) Merr.	Balakat
RHIZOPHORACEAE	<i>Carallia brachiata</i> (Lour.) Merr.	Bakauan gubat

Discussion

The number of threatened species in MBG can be accounted to the series of improving the gardens' natural landscape, including the establishment of theme gardens for living collections, nursery and plantation development, and natural regenerations in most parts of MBG as part of its in situ and ex situ conservation programs. In addition, infrastructure development in MBG took place from 1965 to 1967 including plant nurseries and foot trail construction. Collections of seeds and seedlings of important endemic trees also commenced during this period. Immediately thereafter, dipterocarp, palmetum and leguminous blocks were developed and intensive research activities focusing on the germination and growth of endemic and native tree species were also undertaken.

MBG's in situ and ex situ conservation programs have been instrumental in the presence of these threatened plants. Since the establishment of MBG in 1963, a series of germplasm collections have been conducted within and outside the MMFR. Its most extensive collection outside of the MMFR was in 1997 when the Department of Tourism provided financial assistance in collecting plant species to improve and establish its living collections. Families of Dipterocarpaceae and Arecaceae have the most significant number of threatened species since the living collections comprising these families are among the very first established in MBG. Also, the existence of Dipterocarp Forest at about 600m elevation of the mountain (Brown 1919) and the Dipterocarp mix-montane forest zone (Gruezo 1997) in MMFR provided an excellent and accessible venue for germplasm collection.

The threatened species now form part of the natural landscape showcasing MBG's ex situ living collections. They are used for appreciation and communication, education, and public awareness in line with the MBG's function as a training laboratory for instruction, research, and extension and PBSAP's & GSPC's plant conservation targets. In this way, MBG is restoring these crucial species and increasing awareness not only to the UPLB community but to all MBG local and international visitors and plant enthusiasts on the importance of conserving these threatened species for restoration and recovery.

Conclusions

This initiative will enhance MBG's living collections of threatened species, promote awareness and advocacy on conservation of threatened species, and develop propagation methods and protocols that enable these species to be used for future degraded land recovery and restoration programs. The project recommends development of long-term programs on the conservation and restoration of these threatened plants such as regular assessment of threatened plants, establishment of long-term ecological research plots, conservation biology of selected threatened species, biodiversity education and advocacy, and other significant programs that will regularly monitor and update the conservation status of these priceless plant species.

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