State of Nature Conservation in Malaysia 2025, 161–172
doi: 10.62613/sonc2025.v1flc14

CHAPTER 14

Conservation planning and initiatives for endemic and threatened plant species in Malaysia

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Abstract: This article presents the partial state of knowledge for endemic and threatened plants in Malaysia after 1995, several years after the first State of Nature Conservation was published. Malaysia has a prodigious diversity of Dipterocarpaceae where 72% of the world's species reside; 12.2% of the country's dipterocarps (360 species) is endemic. At least 15 new genera and 580 taxa have been described for Sabah and Sarawak while for Peninsular Malaysia, one genera and at least 122 plants have been discovered. Non-tree families with high endemism are Begoniaceae and Orchidaceae. About 38% of plant species in Malaysia has been assessed for extinction risk, of which 27.3% are threatened. The assessment rate for tree families is much higher compared to other families. In Malaysia, plant population extinctions are driven by forest loss and enhanced forest degradation arising from continued harmful anthropogenic activities, particularly mining. Additionally, inadequate mainstreaming across extractive-based sectors and timely access to sustained funding compound the predicament. To supplement the protected areas network, existing frameworks and action plans such as the Central Forest Spine (CFS) Peninsular Malaysia, Heart of Borneo (HoB), IUCN Green List of Protected and Conserved Areas, and Other Effective Area-based Conservation Measures (OECM) should be explored strategically, together with stricter enforcement of Environmental Impact Assessment (EIA) regulations. The risk assessment for families with high levels of endemism should be prioritised. Conservation initiatives for selected species are shared for in-depth awareness.

INTRODUCTION

Plant species richness, its interactions and inter-dependencies in community level assemblages are integral to ecosystem functions. In Malaysia, the vascular plant diversity is estimated at 15,300 species (Saw and Chung 2005) dispersed across a large array of habitat associations. Of this figure, about 35% are trees (BGCI 2021). Peninsular Malaysia has ca. 7,900 species of seed plants (Kiew *et al.* 2010) and no reliable estimate is available for Sabah and Sarawak although both states are known to have ca. 12,000 plant species (Saw and Chung 2005).

PARTIAL SUMMARY FOR MALAYSIAN PLANT DIVERSITY

Floristic accounts for many plant families in Malaysia are either lacking or outdated and efforts to revise and improve knowledge of poorly known families remain a significant challenge due to the paucity of taxonomists and weak support resources. The following provides data for selected families dating from 1995.

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The country has an overwhelming diversity of Dipterocarpaceae, harbouring ca. 72% of the world's species (360 species) according to the *World Checklist of Vascular Plants* (Royal Botanic Gardens, Kew 2025) dispersed across distinct geographical provinces defined by edaphic factors (Potts *et al.* 2002; Ashton 2004; Russo *et al*. 2005; Baldeck *et al*. 2013). Sarawak has the highest diversity (290 taxa; 28 endemic), followed by Sabah (182 taxa; 6 endemic; Khoo *et al.* 2022) and Peninsular Malaysia (166 taxa; 30 endemic). Apart from dipterocarps, Sabah and Sarawak are the world's hotspots for *Knema* (47%), *Horsfieldia* (~39%) (Myristicaceae; de Wilde 2000), *Madhuca* (50%), *Payena* (63%) *Palaquium* (~37%) (Sapotaceae; Chai and Yii 2002), *Polyalthia* (31%) (Annonaceae; Turner *et al.* 2014), among others. Peninsular Malaysia is a hotspot for *Barringtonia* (35%) (Lecythidaceae; Prance 2012). Sarawak has 13 hyper-endemic genera, many from the family Araceae while Sabah has six hyper-endemic genera, of which two are Orchidaceae. Peninsular Malaysia has 15 endemic genera, of which five are hyper-endemic.

Numerous new plant genera and taxa has been described from Malaysia since 1995. The number of species described for Sabah, Sarawak and Borneo in general is notably higher compared to Peninsular Malaysia. At least two new orchid genera, i.e., *Jejewoodia* (Orchidaceae; Szlach. 1995) and *Kipandiorchis* (Orchidaceae; P.O'Byrne and Gokusing 2015) are hyper-endemic to Sabah. More than twelve genera of Araceae (Wong and Boyce 2010; Low *et al.* 2018) and *Sleumeria* (Icacinaceae; Utteridge *et al.* 2005) were ascertained for Borneo. A partial list of new species endemic to Sabah and Sarawak are 212 species of orchids (Royal Botanic Gardens, Kew 2025), 168 species of *Begonia* (Begoniaceae; Kiew *et al*. 2015, 2016; Rimi *et al*. 2015; Royal Botanic Gardens, Kew 2025), 49 species of *Timonius* (Chen and Wong (2023) and ten species of *Polyosma* (Escalloniaceae; Saw 2020). Nineteen and 12 new species of Anacardiaceae (Kochummen 1996) and Burseraceae (Kochummen 1994), respectively, have been discovered for Sabah and Sarawak. More than a hundred species of Araceae (Low *et al.* 2018; IPNI 2025), 48 species of *Bulbophyllum* (Orchidaceae; Royal Botanic Gardens, Kew 2025), 25 species of *Dendrobium* (Orchidaceae; Royal Botanic Gardens, Kew 2025), 15 species of *Coelogyne* (Orchidaceae; Chase *et al.* 2021) and 12 species of *Calamus* (Palmae; Baker 2015; Henderson 2020) have since been added to Borneo's diversity. Genera whose species number have increased in significant proportion include *Lithocarpus* (Fagaceae; Sang and Soepadmo 1998) and *Thottea* (Aristolochiaceae; Yao 2013). Given Borneo's immense diversity, many new species remain to be discovered, as anticipated by Joppa *et al.* (2011) and Gatti *et al.* (2022).

As for Peninsular Malaysia, since 1995, at least one genera *Bayabusua* (Cucurbitaceae; de Wilde and Duyfjes 1999) and more than 122 seed plant species have been discovered. Of these, 47 and 14 are orchids and *Begonias,* respectively (Royal Botanic Gardens, Kew 2025). In due time, when the projects "*Tree Flora of Sabah & Sarawak*" and "*Flora of Peninsular Malaysia*" and floristic accounts of herbaceous families such as Araceae and Zingiberaceae and other poorly known families are near completion, the often-quoted estimate of Malaysia's plant diversity may need to be revised to provide a more accurate figure.

In terms of endemism, Borneo and the Malay Peninsula (comprising Peninsular Thailand, Peninsular Malaysia and Singapore) have 65 and 12 endemic plant genera, respectively (Neo *et al.* 2020; IPNI 2025). Malaysia has 9.2% (5,422 species) of the world's tree diversity—of this number, 1,616 (29.8%) are endemic (BGCI 2021). Sabah and Sarawak has a much higher level of endemism compared to Peninsular Malaysia. For example, 69.3% of the Malaysian Begoniaceae and 32% of Malaysian Orchidaceae are endemic to both states. The high level of endemism, especially for Sarawak (Ashton 1972), is related to a high diversity of geological and geomorphological formations that had occurred since early Paleozoic (Raes 2009; Wong 2011; de Bruyn *et al.* 2014) and exemplified by a lack of adequate inventories, sampling and recent floristic accounts for Kalimantan and Brunei.

To date, an estimated 38% of the plant species in Malaysia has been assessed for extinction risk according to the IUCN Red List of Threatened Species. Of the 5,922 taxa assessed, 3.6% are Critically Endangered (CR), 7.7% are Endangered (EN) and 16% are Vulnerable (VU), bringing the total of threatened species to 27.3%. The assessment rate in Malaysia varies between families and genera and the rate is higher for trees compared with non-trees. The most complete is undoubtedly the Dipterocarpaceae. Nationwide, this family has 64.9% threatened taxa—11.5% are CR, 24.1% are EN and the remaining 29.3% are VU, with only 1.4% being Data Deficient (DD). The genus with the highest number of CR taxa is *Rubroshorea* (13 taxa) and *Vatica* (eight taxa).

For the native tree flora as a whole, 52.5% of the species has been assessed (BGCI 2021)—of this percentage, 24% is currently threatened. For herbaceous groups, the country's current estimate for Zingiberaceae is 400 taxa (Sam Y.Y., pers. comm.), where 75.5% has been assessed—of this, 49% are threatened and all the CR taxa, with the exception of one taxa, occur in a single locality. In Orchidaceae, 47.3% of *Paphiopedilum* species are CR—all are hyper-endemic to Sabah and Sarawak. By phytogeographical region, Sabah and Sarawak consistently outnumbered Peninsular Malaysia in each of the threatened category.

CHALLENGES

The main threat causing plant and population extinction in Malaysia is the loss of forest cover and enhanced regression of forest degradation arising from continued harmful anthropogenic activities. Between 1973 and 2015, Sabah and Sarawak lost 31.9% and 25.9% of its forest cover respectively. Based on 2015 data, these states had only 28.2% and 19% of intact forest, respectively, while the remaining forests had been selectively logged (Gaveau *et al.* 2016). As for the protected areas in Sabah and Sarawak, 92% and 97% of the land, respectively, had experienced various degrees of degradation by 2009 (Bryan *et al.* 2013). During the same period, Peninsular Malaysia had lost 30.5% of the natural forest cover (FAO 1973; FDPM 2016). Undisputed, the major factor that caused deforestation during that period was land conversion for industrial plantations; currently although deforestation continues to occur sporadically, the rate has reduced substantially (FAO 2025) after the country imposes in 2019 a limit of 6.5 million ha of oil palm areas under cultivation (Bernama 2019). As for forest plantations, the increasing extant replacing natural forests is a growing concern but verified data for the attributes of increment is not publicly available.

At present, in Peninsular Malaysia, fragmented forests are being further isolated and degraded by mining for underground and limestone minerals (Ministry of Natural Resources and Environment 2009, Ministry of Energy and Natural Resources 2021, Ministry of Natural Resources and Environmental Sustainability 2024; Lamb *et al.* 2024). Hughes (2017) reported Malaysia as being one of the top five global exporters of cement, which is derived from limestone quarrying. Although mining, with the exception of limestone quarrying, generally occur in areas that are degraded, several locations were in forest reserves that had to be degazetted for the purpose. The disperse distribution of potential mining sites (Ministry of Energy and Natural Resources 2021) poses substantial risks and challenges to forest and biodiversity conservation as it obstructs ecological connectivity that enables natural forest dynamics to rebound. Mining sites are notoriously slow to recover back to its productive ecological capacity (Cristescu *et al.* 2012; Majer 2014). Because of harsher and extended exposure to edge effects (Garate-Quispe *et al.* 2023), and the detrimental impacts accumulated from facilities such as roads and processing plants, adjacent forest fragments tend to suffer among others from increased tree death, death of canopy-dependent species, loss of above-ground biomass (Garate-Quispe *et al.* 2024, Yang *et al.* 2025), invasion of pioneer

plant species including climbers (Chambi-Legoas *et al.* 2021) that overwhelm and suppress the establishment of native species. How continued degradation influences the disturbances, stresses, resilience and potential recovery of natural forest fragments is not understood due to the lack of temporal-refined monitoring activities.

One of Malaysia's key challenges to ecosystem, species and genetic conservation is the lack of adequate mainstreaming across the various sectors that use the components of biodiversity (IPBES 2018, 2022) such as agriculture, fisheries and extractive-based industries, and the weak accounting of externalities, and the potential trade-offs and opportunity costs that a particular sectoral plan may have on existing plans. Timely access to sustained funds by local conservation actors is another key implementation challenge whereby fund disbursement process is bureaucratic and lengthy and projects often face unrealistic time-bound limitations.

IPBES (2022) has succinctly described how the loss of biodiversity rapidly degrades ecological services such as climate regulations, livelihood dependence, food security and human well-being. In Malaysia, we do not adequately understand the impacts to resilience of plant community assemblages due to the lack of adequately-timed monitoring programmes. When ecological damage is not addressed quickly with effective mainstreaming across sectors, such as specifically designed restoration or rehabilitation initiatives that are long-term in approach, the potential ecosystem recovery from the damage and consequently, the measure of success of the initiatives are placed at high risk.

OPPORTUNITIES AND RECOMMENDATIONS

Malaysia's vast diversity is a natural heritage we are proud of and an invaluable asset that we are bound responsibly to protect, especially so when the diversity intricately determines the quality of ecosystem services that are critical to the country's socioeconomic prosperity and public well-being.

Conservation planning begins with species risk assessment that appraises the risks, drivers of threats and extinction proximity (Rodrigues *et al.* 2006). Following the IUCN Red List Categories and Criteria guidelines, inferences from landscape-level data, evidence -based species data and expert knowledge (Rodríguez *et al.* 2007) are widely used in Malaysia since the spatial and species-level data for a large number of native plant species are scarce. Approximately 64% that were assessed are tree species, indicating a pronounced tree-biased taxonomic research. The neglect faced by herbaceous families such as Begoniaceae, Orchidaceae, Palmae and Zingiberacae should be addressed since all have record high levels of diversity and endemism. Initiatives that copy the framework of the "*Tree Flora of Sabah and Sarawak*" and "*Flora of Peninsular Malaysia*" projects can be undertaken at smaller scales for non-trees plant families. Families having high endemism such as Begoniaceae are in urgent need of risk assessment, as the first step towards conservation planning and implementation.

Conservation planning for threatened species and ecosystems is guided by three national policies on biological diversity, i.e., National Policy on Biological Diversity 1998, National Policy on Biological Diversity 2016–2025 and National Policy on Biological Diversity 2022–2030, in addition to the Kunming-Montreal Global Biodiversity Framework under the Convention on Biological Diversity (CBD 2022) and Sarawak Biodiversity Master Plan 2023–2030. Since 1998, more than 900,000 ha of forested areas in Sabah, 300,000 ha in Sarawak and over one million ha in Peninsular Malaysia have been declared as Protected Areas (PAs) (UNEP-WCMC and IUCN 2021). Currently, approximately 12.6% of the country is conserved in the network of 472 PAs. There are several other strategic frameworks and action plans available for in-situ conservation—among the most important are the

Central Forest Spine Peninsular Malaysia 2022 (PLANMalaysia 2022; Ministry of Natural Resources, Environment and Climate Change 2022), Heart of Borneo (HoB) (Forest Department Sarawak 2025), IUCN Green List of Protected and Conserved Areas (IUCN 2025a), Other Effective Area-based Conservation Measures OECMs (IUCN 2025b). At present, CFS, Green Lists and OECMs sites such as Important Bird Areas (IBAs), Key Biodiversity Areas (KBAs), UNESCO GeoParks, and Indigenous and Community Conserved Areas (ICCAs) contribute a very small percentage. These frameworks are major complements to PAs and consolidated implementation of these frameworks, as well as stricter enforcement of Environmental Impact Assessment (EIA) regulations, can be further strengthened by Malaysia, recognising that these approaches ultimately reduce population loss, conserve species richness and habitat diversity, and directly reduce the number of threatened plant species.

A SELECTION OF SPECIES-BASED CONSERVATION INITIATIVES IN MALAYSIA

I. Peninsular Malaysia

Dipterocarps (*Vatica flavida*, *Shorea macrantha*, *S. hemsleyana*) and agarwood (*Aquilaria malaccensis*).

Assess. These species were discovered in the forest of Universiti Teknologi PETRONAS (UTP) in Perak between 2006 – 2011. *Vatica flavida* is CR because it is a very rare species endemic confined to a single location in Perak. *Shorea macrantha* is also CR due to the conversion of its mixed peat swamp habitats. *Shorea hemsleyana* and *Aquilaria malaccensis* are VU threatened by habitat conversion and illegal harvesting respectively.

Plan and Act. A report on the "*Zonation of forest areas at UTP for the purpose of conservation based on the density of rare tree species*" was produced through an MoU and conservation grant generously provided by UTP. The aims were to conserve forested habitats and populations of threatened species and assist in maintaining ecosystem services to meet UTP's vision and mission. Priority areas for conservation were identified and zoned with explicit details of population demographics and spatial features.

Network and Communicate. Numerous dialogues and knowledge sharing sessions were held between UTP and the Forest Research Institute Malaysia (FRIM). In 2024, a 950-m Warisan Hijau Nature Trail featuring the freshwater swamp forest and these species is opened to the public to educate and inspire environmental conservation and strengthening environmental education.



Figure 1. Freshwater swamp forest in UTP. Photo courtesy of Siti Fariezza bt Thaw.

II. Sarawak

Rubroshorea praestans (Dipterocarpaceae)

Assess. *Rubroshorea praestans* is CR A4cd because it is endemic, occurs in four small populations in highly fragmented forests outside Totally Protected Areas, severely threatened by forest conversion, illegal encroachment and unauthorised harvesting.

Plan and Act. Population demography have been sampled for Sungai Sebatang and Bukit Tiban in Bintulu, Kenyana in Mukah and Ulu Bawan in 2011 – 2013. Phenological observations in Kenyana, Sungai Sebatang and Ulu Bawan are on-going. Fruits from several sites were collected between 2012 and 2013, grown in the nursery of the Botanical Research Centre (BRC) and subsequently planted and conserved at Landeh in Semengoh Nature Reserve, a Totally Protected Area. Efforts by Sarawak Forestry Corporation (SFC) to list *R. praestans* in the Wild Life Protection Ordinance, 1998 is on-going as part of the overall attempt to include endemic CR species into the list of Protected Plants of Sarawak.

Network and Communicate. Various engagements and dialogues with relevant stakeholders (e.g., Forest Management Units, Sarawak Timber Association) on threatened dipterocarps were carried out. In 2024, a series of workshops and training was organised with stakeholders from the relevant agencies. At present, SFC is working with the State Attorney-General's office on the proposed amendment, and this will be followed with a proposal for consideration at *Majlis Kerajaan Negeri*.

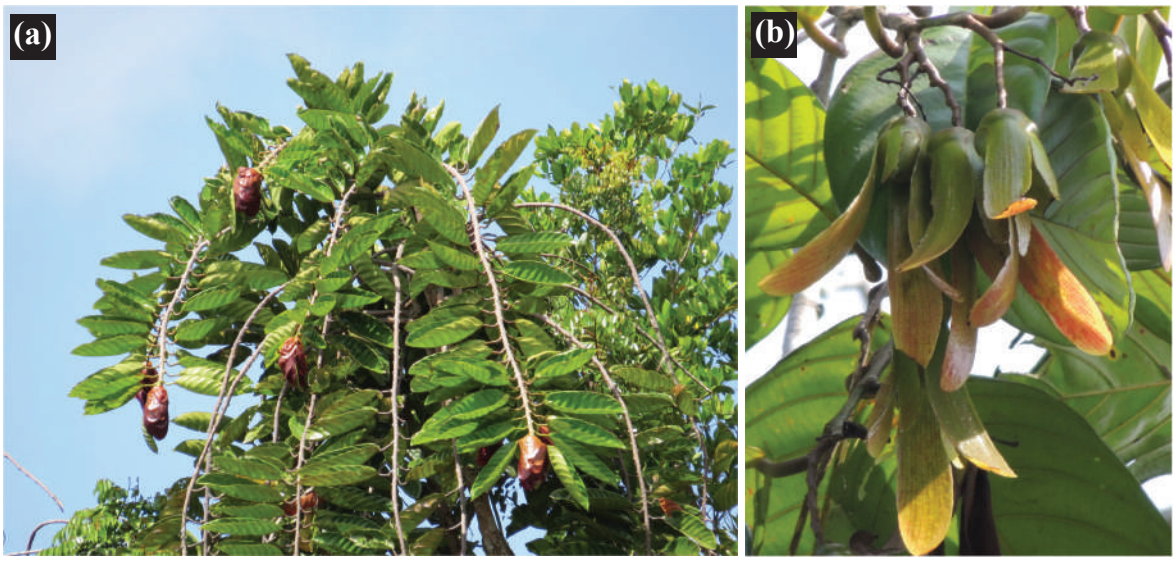

Figure 3. (a) Branches and **(b)** developing fruits of *Rubroshorea praestans*. Photos courtesy of Julia S.

Begonia belagaensis, *B. bengohensis* (Begoniaceae)

Assess. Only selected species have been provisionally assessed using the IUCN Red List of Categories & Criteria although approximately 80% are known to be hyper-endemic or restricted to a single locality (Julia and Kiew 2014). Current efforts are focused at describing numerous new species.

Plan and Act. The species are grown in BRC Garden and Murum Conservation Garden. Native Begonias are generally very difficult to grow and maintain under *ex situ* conditions and the lack of long-term commitment and sustained funding compound the struggle to sustain living collections.

Communicate. *A Guide to Begonia of Borneo* (Kiew *et al.* 2015) seeks to address the challenges associated with the identification of Bornean Begonias. It provides brief morphological descriptions, habitat information, geographical distribution, as well as notes on the potential ethnobotanical and horticultural uses. Species images constitute a major component of the book, with 134 known species represented to facilitate accurate recognition and comparison. Since then, 71 new species have been described from Sabah and Sarawak (Peng *et al.* 2015; Ling and Julia 2023).



Figure 4. (a) Begonias propagated at Botanical Research Centre (BRC) and **(b)** *B. bengohensis* rescued from Bengoh Dam and planted at BRC Garden. Photos courtesy of Julia S.

III. Sabah

Elaeocarpus pinosukii and *E. inopinatus* (Elaeocarpaceae), *Ilex mesilauensis* (Aquifoliaceae), *Melastoma maraiparaiense* (Melastomataceae), *Phyllanthus rufuschaneyi* (Phyllanthaceae), *Saurauia leopoldii* (Actinidiaceae), *Timonius clementis* (Rubiaceae), *Urophyllum lineatum* (Rubiaceae), *Symplocos trichomarginalis* (Symplocaceae), *Hedyotis protrusa* (Rubiaceae) and *Nepenthes pongoides* (Nepenthaceae)

Assess. *Elaeocarpus pinosukii* is CR and known only from a single collection from Pinosuk Plateau, outside of PA. *Elaeocarpus inopinatus* is VU; *Ilex mesilauensis* is DD; *Melastoma maraiparaiense* is VU; *Phyllanthus rufuschaneyi* is EN; *Saurauia leopoldii* is VU; *Timonius clementis* is VU and *Urophyllum lineatum* is VU.

Plan and Act. *In situ* monitoring and *ex situ* collections are established for *Phyllanthus rufuschaneyi*. Search efforts for the critically endangered *Elaeocarpus pinosukii* and data deficient *Ilex mesilauensis*, both present in single localities which have undergone significant habitat degradation, were unsuccessful, potentially heightening their extinction risks. Population surveys have been conducted for seven hyper-endemic species at Marai Parai, western Kinabalu Park and the hyper-endemic *Nepenthes pongoides* in Meliau Range.



Figure 5. (a) Vegetation at Marai Parai and **(b)** *ex situ* collection of *Phyllanthus rufuschaneyi* in the nursery at Kinabalu Park. Photos courtesy of A. Damit.

Rhododendron monkoboense and *R. tuhanense* (Ericaceae)

Assess. *Rhododendron monkoboense* is VU and restricted to the lower montane ultramafic forest. *Rhododendron tuhanensis* is also VU and restricted to the upper montane vegetation at Lipson, Mount Kinabalu, on exposed steep slope. Risks of climate change, forest fires and landslide are serious threats to both species, although their habitats are protected.

Plan and Act. The management and protection for *R. monkoboense* is outlined in the *Rhododendron monkoboense* Conservation Plan (2022–2031). Population demography and spatial distribution for both species are now known while wildings and cuttings established at the Park's nursery have been planted out at the Mount Kinabalu Botanical Garden.

Network and Communicate. This initiative was a collaboration between Sabah Forestry Department and Sabah Parks.

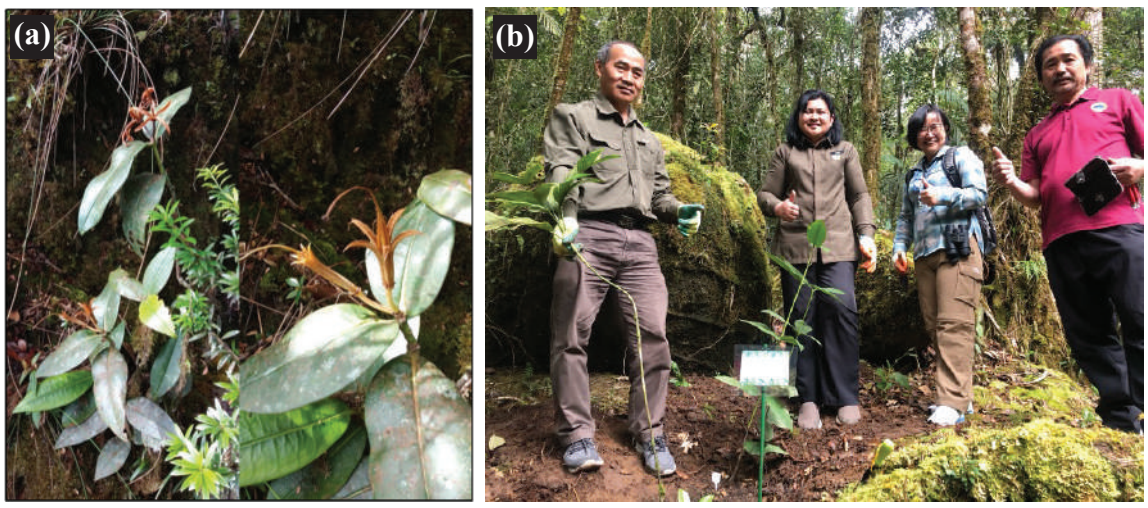

Figure 6. (a) *Rhododendron monkoboense* and **(b)** saplings planted at the Mount Kinabalu Botanical Garden. Photos courtesy of A. Damit.

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