

SCIENTIFIC ARTICLE

Identification and documentation of wild plant species with ornamental potentials at Mount Prau, Central Java, Indonesia

Lianah Kuswanto¹ , Noor Amalia Chusna¹ , Eko Purnomo¹ , Krisantini² , Milya Urfa Ahmad³ 

¹ Universitas Islam Negeri Walisongo Semarang, Department of Biology, Faculty of Science and Technology, Semarang, Indonesia.

² IPB University, Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor, Indonesia.

³ Universitas Sebelas Maret, Department of Biology, Faculty of Mathematics and Natural Sciences, Surakarta, Indonesia.

Abstract

Indonesia has diverse flora and fauna, and many species remain largely undiscovered. Documentation and identification of threatened wild ornamental species are increasingly difficult due to ongoing exploitation and land conversion. Mount Prau is one of the popular destinations in Central Java, Indonesia for tourism. Understanding plant biodiversity has enormous value for the economy, ecology, culture, science, and recreation. Our study is aimed to record the diversity and identify the flowering plant species in their native habitat at Mount Prau, Central Java, Indonesia. Our field surveys demonstrated that Mount Prau has abundant wild ornamental plants with wide diversity of taxa, growth habits, and forms. A total of 103 species representing 51 families and 95 genera are identified including trees, shrubs, herbs, and lianas. We also found that among the plant species found in Mount Prau, 24 have morphological characters suitable to be cultivated as ornamental flowers, and 12 as ornamental foliage, and 63 species are medicinal plants. The ornamental criteria of these species were based on the literature describing the morphological and unique characters of leaves and flowers that made them potential to be developed as ornamental plants. In this paper we have provided the current conservation status of the plant species identified and recommendations on their conservation. This study provides baseline data of species found in the Mount Prau areas, and this information could be helpful for further conservation efforts and initiatives.

Keywords: documentation, identification, Mount Prau, ornamental, wild plants.

Resumo

Identificação e documentação de espécies de plantas nativas com potencial ornamental no Monte Prau, Java Central, Indonésia

A Indonésia possui flora e fauna diversificadas e muitas espécies permanecem em grande parte desconhecidas. A documentação e a identificação de espécies ornamentais nativas ameaçadas são cada vez mais difíceis devido à exploração contínua e à conversão de terras. O Monte Prau é um dos destinos turísticos populares de Java Central, na Indonésia. Compreender a biodiversidade vegetal tem um enorme valor para a economia, ecologia, cultura, ciência e recreação. Nosso estudo tem como objetivo registrar a diversidade e identificar as espécies de plantas com flores em seu habitat nativo no Monte Prau, Java Central, Indonésia. Nossos levantamentos de campo demonstraram que o Monte Prau possui abundantes plantas ornamentais silvestres com enorme diversidade de taxa, hábitos de crescimento e formas. Um total de 103 espécies representando 51 famílias e 95 gêneros são identificados, incluindo árvores, arbustos, ervas e cipós. Também foi identificado que dentre as espécies encontradas no Monte Prau, 24 destas espécies possuem caracteres morfológicos adequados para serem cultivadas como flores ornamentais e 12 como folhagens ornamentais. Neste artigo, é apresentado o estado de conservação atual das espécies de plantas identificadas e recomendações sobre sua conservação. Este estudo fornece dados de referência de espécies encontradas nas áreas do Monte Prau, e essas informações podem ser úteis para esforços e iniciativas de conservação adicionais.

Palavras-chave: documentação, identificação, Monte Prau, ornamentais, plantas silvestres.

Introduction

The loss of natural habitat mainly occurred due to land conversion to pastures, agriculture, and commercial development (Corlett, 2016), resulting in the extinction of

various wild species of flora and fauna. Many plant species that were once abundant are now challenging to find in their natural habitat. Indonesia has the 8th largest forest area globally at 120.6 million hectares or about 63% of the country's total land area. However, forest exploitation in

* Corresponding author: lianahk58@gmail.com

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Indonesia was ranked the 3rd highest in the world in 2018 (Pratama, 2020). Since 2015, around 30% of conservation forests have been damaged due to forest encroachment by the community (Yustina et al., 2016). Deforestation has become more severe in the absence of an official assessment from the local government.

The issue of conservation has been the focus of academics, researchers, and environmentalists as the intensity of habitat exploitation has called for immediate conservation (Sharrock and Jackson, 2017). Studies on conservation so far have shown three trends. First, conservation is an effort to preserve natural resources (Saragih et al., 2019). Second, there are conservation models and approaches (Wiradimadja, 2018; Aviyana, 2016; Fa'atin and Sa'adah, 2018; Saroinsong and Kalangi, 2016); even religious and local traditions approaches have been carried out as an effort to preserve the environment (Syukur and Qodim, 2016; Maula, 2017). Third, conservation of plants for uses as medicine (Wibisono and Azham, 2017). There has not been much conservation effort of wild ornamental plants in various regions from the trend of existing studies.

The distribution of ornamental plants can be associated with colonialism and globalization (Ciftcioglu et al., 2019). Paiva et al. (2020) show that consumers of flowers and ornamental plants in Brazil can spend R\$100.00 to R\$200.00 in one year. Ornamental plants allow humans to interact and modify the environment (Ilyas et al., 2021). In the ornamental plant industry, plant breeders continuously try to do selection and conventional crossings to modify the color of leaves, flowers and the aroma of plants. Various, advanced technologies have been used to create more diverse plant features for commercialization, such as the protoplast technology such as the protoplast technology, which currently being used to transform plants and produce new cultivars; the protoplast technology is popular within the international floriculture industry to meet the demand for ornamental plants (Naing et al., 2021).

Human activities, such as agriculture, aquaculture, modification of natural systems, climate change and extreme weather, mining and renewable energy, human intrusion and disturbance, and overuse of resources, threaten the existence of the native species, leading it to scarcity and even

extinction (Cross et al., 2020). Among these activities, Cross et al. (2020) show that the most significant threats that place species at risk of extinction include urban development, agriculture, illegal hunting, and horticultural trade.

Mount Prau is a dormant volcano located in Dieng Plateau, Indonesia; it is one of the most popular hiking destinations in Central Java. Dieng itself is a popular holiday destination, with guesthouses, cafes, equipment shops, and tourist agencies. The native plants and flowers have been collected for private collections and commercial trading because of the increased tourist activities at Mount Prau (Daris and Wijaya, 2017). This condition is worsened by the occurrence of natural disasters and insufficient protection from the local government and policy makers. Extinction of species does have not only impacted the wild ornamental plants in this area, but also the other living things that depend on them.

This study aims to document the occurrence and to identify ornamental flora in various sites in Mount Prau, Indonesia. Specifically, this study was conducted to a) identify the wild plant species growing in the area, b) identify potential ornamental values of the flora of Mount Prau, and c) determine the factors that pose threats or causing the extinction of wild ornamental plants in the area. The information from this survey will complement the studies on ornamental flora conservation, particularly at the Mount Prau region. We also provided recommendations for further research on ornamental flora documentation by doing this study.

Material and Methods

Observations, records, and documentation in the form of notes and photos were taken in the forest area of Mount Prau (7°11'13"S 109°55'22"E). We conducted five traveling routes covering four districts at Mount Prau, i.e., Kendal (07° 08' 53.69892"LS, 109° 56' 20.79037"BT), Temanggung (110° 23.1104630"BT, 7° 14.73235"LS), Banjarnegara (07° 11' 12.2638631"LS, 109° 55' 04.60210"BT), Kejajar Wonosobo (07° 11' 12.97856"LS, 109° 55' 22.37948"BT) and at the top of Mount Prau (7°11'13"S, 109°55'22"E) (Figure 1).

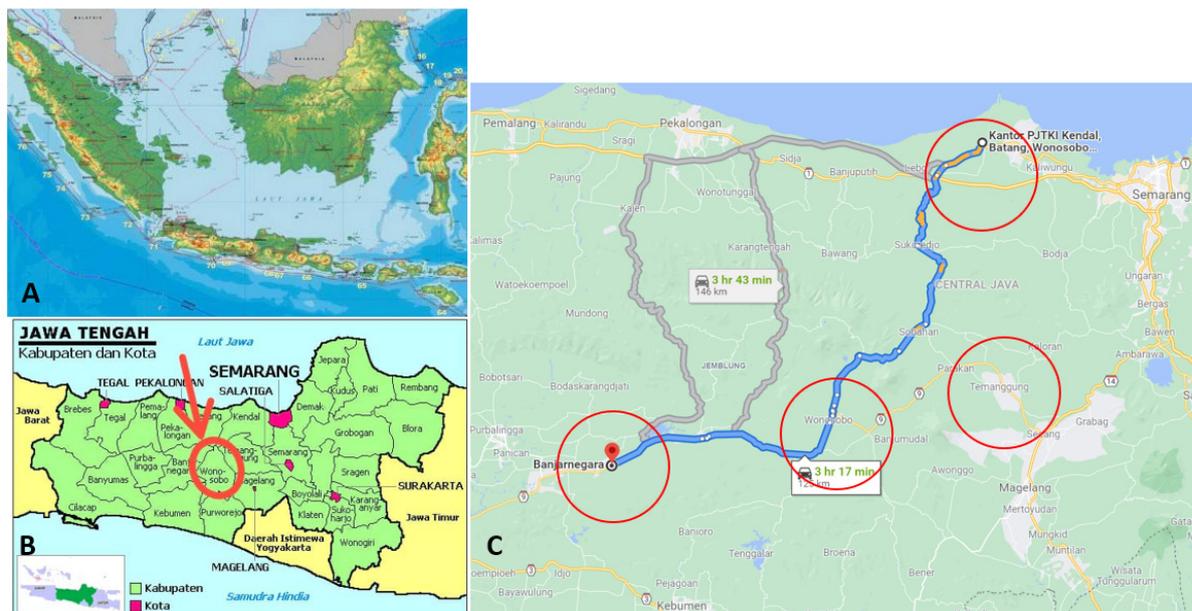


Figure 1. Research site map showing (A) Indonesian map; (B) Central Java location map; (C) Map of research locations Kendal, Temanggung, Banjarnegara and Kejajar Wonosobo

The total area of study covered 16.5 km² with altitudes ranging from 900-2500 m above the sea level (a.s.l.). The climate is type hot and humid, with a dry season with rather severe drought between February and July, and a rainy season between October and December (BMKG, 2020). The average annual temperature is 27.1°C, with annual rainfall of 1,442 mm and annual average relative humidity of 76% (BMKG, 2020).

All specimen samples were photographed and collected, then identified for their ornamental values and potential use as flowering potted plants, ornamental foliage, and small trees. The ornamental values are based on the plants' unique

and attractive color, texture, shape, pattern of the leaf, flower, and stem described in Table 1 (Stumpf et al., 2009; Sousa and Versieux, 2020). Mature leaves were selected for morphological evaluation. Flower characteristics were selected from plants that have flowered at the full bloom stage. Based on morphological data, identification was conducted according to the description in the flora of Indo-China, British India, China, and the Malay Peninsula, and scientific publications, and confirmed by a taxonomist from Herbarium Bogoriense for the identification of the specimens. The collected specimens that have not been recorded in the Herbarium were reported.

Table 1. Morphological and type of growth evaluation of the ornamental species of Mount Prau, Central Java, Indonesia, with the potential use in ornamental flower industry*

PARAMETER	CHARACTERS
Growth habit	Tree, shrub, herbs, vines, epiphytic
Life cycle	Annuals, perennials
Plant shape	Vertical (height > canopy diameter), horizontal (canopy > height), balanced (diameter of canopy similar to plant height), others.
Symmetry of the branches	Symmetrical, asymmetrical (i.e. branches grow in random directions).
Colour of leaf, flower, capsule, bark	Visual determination
Texture of leaf, flower, capsule, stem	Smooth/rough, hairy/glabrous
Other distinct and unique physical characters	Visual and spot determination

*Adapted from Stumpf et al., 2009; Sousa and Versieux, 2020

Results and Discussion

Diversity of plant species at Mount Prau

Field exploration of wild vegetation in Mount Prau has demonstrated a wide floristic diversity. A total of 112 individuals representing 103 species and consisting of 51 families and 95 genera of flowering and non-flowering plants were identified. The plant families with ornamental values include Asteraceae (19 species), Lamiaceae (5 species), Achantaceae (5 species), Solanaceae (5 species), Euphorbiaceae (2 species) (Figure 2), and Pteridophytes (12 species). Based on the morphological characters of these species (described by Stumpf et al., 2009; Sousa and Versieux, 2020;

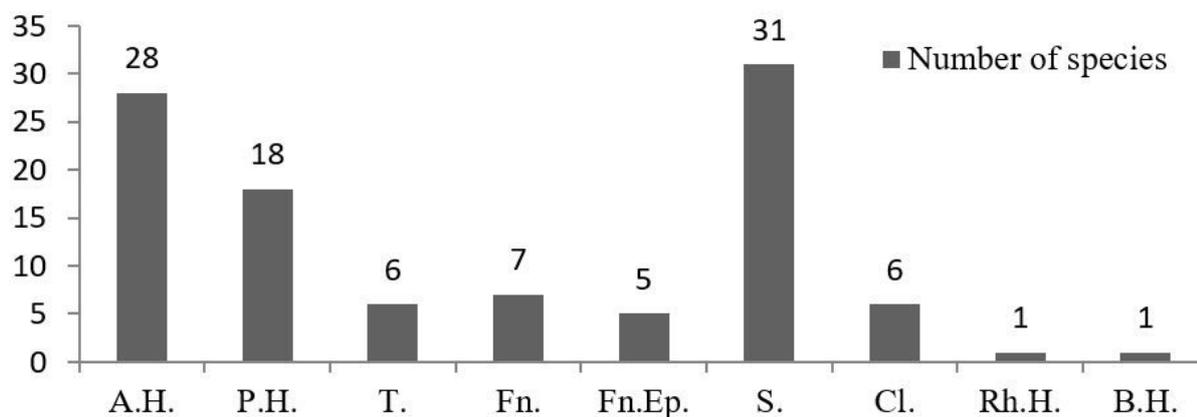
Table 1), 12 species have potentials to be developed as ornamental foliage (Table 2), and 24 species as flowering ornamentals (Table 3). Additionally, three endemic and rare species were found, *Anaphalis javanica* (Javanese edelweiss, Figure 3 B and Figure 4) (Whitten et al., 1992), *Dodonaea viscosa* (Figure 5), and *Tetrastigma glabratum* (Figure 6) (Lianah, 2014). The species in our study have different growth habits, i.e., herbs, shrubs, trees, creeping and climbing lianas, and epiphytes (Table 2 and 3). Twenty-eight species are annual herbs (A.H.), 18 are perennial herbs (P.H.), 6 are tree (T.), 7 are ferns (Fn.), and, 5 are fern epiphytes (Fn.Ep.), 31 are shrubs (S/shrub), six each are climber (Cl.) and 2 are rhizome herb (Rh.H.) and bulb herb (B.H.), respectively (Figure 2).

Table 2. Species that have potentials to be domesticated as foliage ornamentals

NO	BOTANICAL NAME	FAMILY	Notes
1	<i>Alocasia portei</i> Schott	Araceae	Herbaceous perennial; attractive leaf shape
2	<i>Alpinia zerumbet</i> B.L.Burt and R.M.Sm	Zingiberaceae	Perennials; attractive leaf color pattern
3	<i>Begonia rubra</i> Blume Presl.	Begoniaceae	Herbaceous perennial; unique spotted leaves
4	<i>Davallia solida</i> G. Forst	Davalliaceae	Epiphytic fern; attractive leaf shape; also useful as medicinal plant
5	<i>Dracaena fragrans</i> (L.) Ker Gawl.	Asparagaceae	Perennials; attractive leaf color pattern
6	<i>Hemigraphis colorata</i> W. Bull	Acanthaceae	Climbers; deep-purple color leaves
7	<i>Monophyllaea horsfieldii</i> R. Brown	Gesneriaceae	Shrubs; unique plant and leaf shape; the plant only has one large deep-vein leaf
8	<i>Nephrolepis cordifolia</i> (L.) C.	Devalliaceae	Fern; attractive leaf shape
9	<i>Pilea cadierei</i> Gagnep. & Guillaumin	Urticaceae	Herbaceous annuals; attractive leaf color pattern
10	<i>Pteris vittate</i> L.	Pteridaceae	Fern; attractive leaf shape
11	<i>Schismatoglottis acuminatissima</i> Schott	Araceae	Herbaceous annuals; attractive leaf color pattern
12	<i>Senecio cineraria</i> L.	Asteraceae	Herbaceous annuals; attractive color, succulent

Table 3. Species that have potentials to be domesticated as flowering ornamentals.

NO	BOTANICAL NAME	FAMILY	Notes
1	<i>Aechmea caudate</i> Lindm.	Bromeliaceae	Herbaceous perennial
2	<i>Callistephus chinensis</i> L. Nees	Asteraceae	Annual herbaceous
3	<i>Calliandra tetragona</i> Benth.	Leguminosae	Shrub
4	<i>Cestrum nocturnum</i> L.	Solanaceae	Shrubs, night flowering, scented
5	<i>Chrysanthemum</i> sp. L.	Asteraceae	Annual herbaceous
6	<i>Chrysanthemum indicum</i> L.	Asteraceae	Annual herbaceous
7	<i>Crinum latifolium</i> L.	Amaryllidaceae	Bulbous herbs
8	<i>Gomphrena globosa</i> L.	Amaranthaceae	Annuals; also used as medicinal plant by the local community
9	<i>Hibiscus</i> sp. L.	Malvaceae	Shrubs
10	<i>Ixora javanica</i> (Blume) DC.	Rubiaceae	Shrubs
11	<i>Kalanchoe laciniata</i> (L) DC.	Crassulaceae	Herbaceous perennial
12	<i>Neomarica longifolia</i>	Iridaceae	Rhizomatous herbaceous
13	<i>Pachystachys coccinea</i> Nees	Acanthaceae	Shrubs
14	<i>Rheum officinale</i> L.	Polygonaceae	Annual Herb
15	<i>Rhodendron</i> sp. L.	Ericaceae	Shrubs
16	<i>Rhododendron javanicum</i> L.	Eriaceae	Shrubs, endemic species
17	<i>Rosa chinensis</i> Jacq.	Rosaceae	Shrubs
18	<i>Ruellia tuberosa</i> L.	Achantaceae	Shrubs, also used as medicinal plant by the local community
19	<i>Salvia coccinea</i> L.	Lamiaceae	Perennial herbaceous
20	<i>Stachytarpheta cayennensis</i> (Rich.) Vahl	Verbenaceae	Shrub
21	<i>Symphotrichum ericoides</i> L. (G.L. Nesom)	Asteraceae	Shrubs, also used as medicinal plant by the local community
22	<i>Torenia fournieri</i> Linden ex E. Fourn.	Linderniaceae	Annual herbaceous
23	<i>Tibouchina semidecandra</i> Cong	Melastomataceae	Shrubs
24	<i>Vinca rosea</i> L.	Apocynaceae	Herbaceous perennial

**Figure 2.** Distribution of species based on their growth habit: annuals (A.H.), perennials (P.H.), tree (T.), fern (Fn.), fern epiphyte (Fn.Ep.), shrubs (S), climber (Cl.), rhizome (Rh. H.) and bulb (B.H.)

The Rare Species Found in Mount Prau

Figure 3 shows the endemic plants of Mount Prau at an altitude of 2.500 m.a.s.l. i.e. *Passiflora coccinea* (Figure 3A), *Anaphalis javanica* (Figure 3B and 4), *Vaccinium varingiaefolium* (Figure 3C), *Allmania nodiflora* (Figure 3D), *Rhododendron javanicum* (Figure 3E), *Hypericum*

leschenaultia (Figure 3F), *Sedum album* (Figure 3G), and *Quisqualis indica* (Figure 3H). These species have bright, showy colors in their flowers, making them potential candidates to be domesticated as ornamental plants. Among these, tourists frequently hunt for *A. javanica* (Figure 3B and 4).

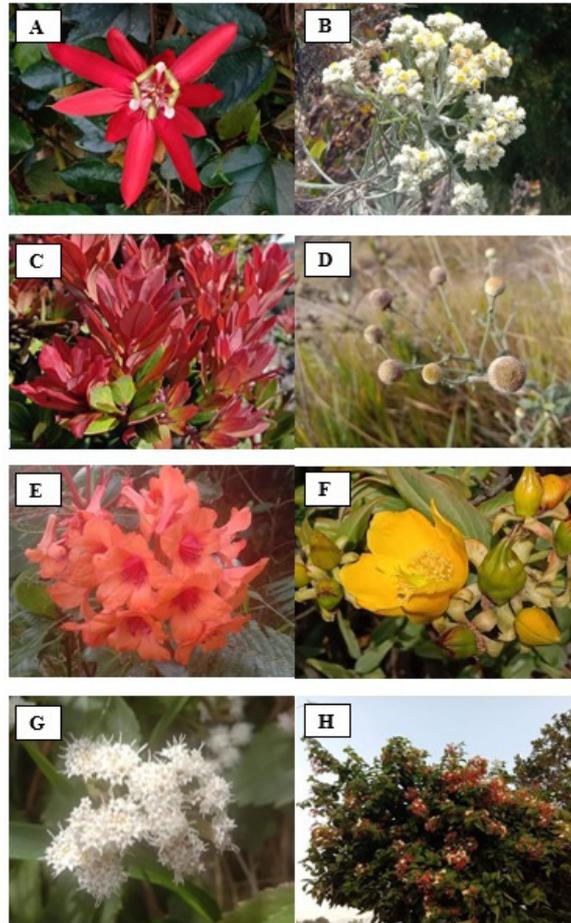


Figure 3. Endemic plants of Mount Prau. (A) *Passiflora coccinea*; (B) *Anaphalis javanica*; (C) *Vaccinium varingiaefolium*; (D) *Almanicanodiflora*; (E) *Rhododendron javanicum*; (F) *Hypericumleschenaultii*; (G) *Sedum album*; and (H) *Quisqualis indica*.



Figure 4. Flower (A) and leaf morphology of *Anaphalis javanica* (Reinw. ex Bl.) Sch. Bip (Javanese Edelweiss).

Anaphalis javanica is a flowering species endemic to Indonesia and known as 'Javanese edelweiss.' Whitens et al. (1992) reported that *A. javanica* had been found to grow in the mountainous regions of Java, Sumatra, Sulawesi, and Lombok. *Anaphalis javanica* that we found at Mount Prau are generally ± 1 meters in height at an altitude of 2,000 m.a.s.l. *Allmania nodiflora* (Figure 3D) are also known as eternal flowers because their petals are long-lasting and can last up to 10 years. The long lasting flowers of *A. nodiflora* and *A. javanica* is an important character for potential use as cut flowers. The flowers have been frequently collected as a souvenir by the people climbing Mount Prau. According to Setiyo and Haddy (2019), *Anaphalis javanica* has important roles in the mountain ecosystem; it is one of the essential food sources for insects, plant host for *Myophonus glaucinus* or the Javan whistling thrush, and

growing in groups they can prevent landslides and erosion. *Anaphalis javanica* is a pioneer species in young volcanic soil and can maintain its survival on barren earth by forming mycorrhizae, thereby expanding the area of root coverage to look for nutrients (Ade et al., 2019).

Anaphalis javanica usually bears flowers between April and August. Currently, there is an existing cultivation group responsible for propagating this species. *Anaphalis javanica* has been protected in the Regulation of the Minister of Environment and Forestry Number P.92 (2018) on Protected Types of Plants and Animals. However, in the Mount Prau area, this plant is not being propagated yet. In Indonesia, collecting native plants from their natural habitat is commonly done; therefore, conservation of this species is urgent in this location. It is also necessary to issue local and regional regulations to protect this species.

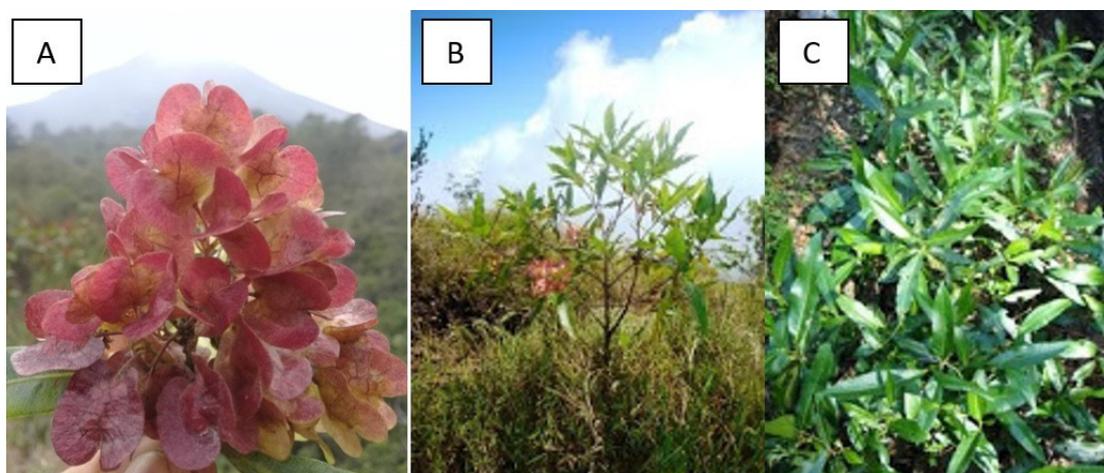


Figure 5. Morphology of *Dodonaea viscosa* (A) Capsules; (B) Tree; (C) Leaves.

Another unique endemic plant in Mount Prau is *Dodonaea viscosa* (Figures 5A, B, C), locally known as 'tengsek tree' or 'dolu'. *Dodonaea viscosa* is found at an altitude of 1,300 m.a.s.l. *Dodonaea viscosa* flowers are inconspicuous and have no petals, the colorful parts are actually capsules. Fertilized capsules can take up to 11 months to mature, and over this time, the capsules will change color from a green or cream color to a brilliant red (Hidayat and Suhendri, 2020). The soft color of the capsules (Figure 5A) makes them suitable as flowering shrubs or small trees for landscapes. People consider *D. viscosa* as lucky trees, making it frequently hunted. *Dodonaea viscosa* is a woody perennial, and most of the plant population that we discovered at Mount Prau is 1-7 m in height. The local people used *Dodonaea viscosa* stem as a material for making the sheath of the keris, a traditional Javanese weapon with unique shapes. The leaves are single-spreading, slightly variable, oval to lancet, green, pinnate leaf bone (Pongtiku, 2016) with a thin, supple, shiny, or oily look. Dolu leaves are commonly used in traditional medicine and raw materials to make keris by the local people so they are increasingly hard to find, while no cultivation

or propagation has been conducted to preserve them. It is imperative to propagate this species either *in-situ* or *ex-situ* and to be protected from illegal collection.

In addition to *Dodonaea viscosa*, two endemic species in Mount Prau have been identified, *Tetrastigma glabratum* (Figure 6A) and *Symphytotrichum ericoides* (Figure 6B and C), also known as daisy or aster. *Tetrastigma glabratum* (local name: oyod gang, walikadep) is a liana found climbing on tall trees in the Mount Prau forest at an altitude of 1300 m.a.s.l. *Tetrastigma glabratum* grows wild at Mount Prau and the surrounding areas, especially in Blumah Village (Lianah, 2014). The local people at the villages around the area have been using the liquid exudates from *T. glabratum* to children's appetite, to treat coughing and to maintain health in general (Lianah, 2014). The parts of the plants that have been collected are the stems with large diameters, i.e., from the older trees. *Tetrastigma glabratum* is a host for *Rafflesia*, the largest flowering species in the world. Therefore, to conserve both the host and *Rafflesia*, there is an urgent need to propagate them either *in-situ* or *ex-situ*. *Tetrastigma glabratum* also needs to be protected legally.

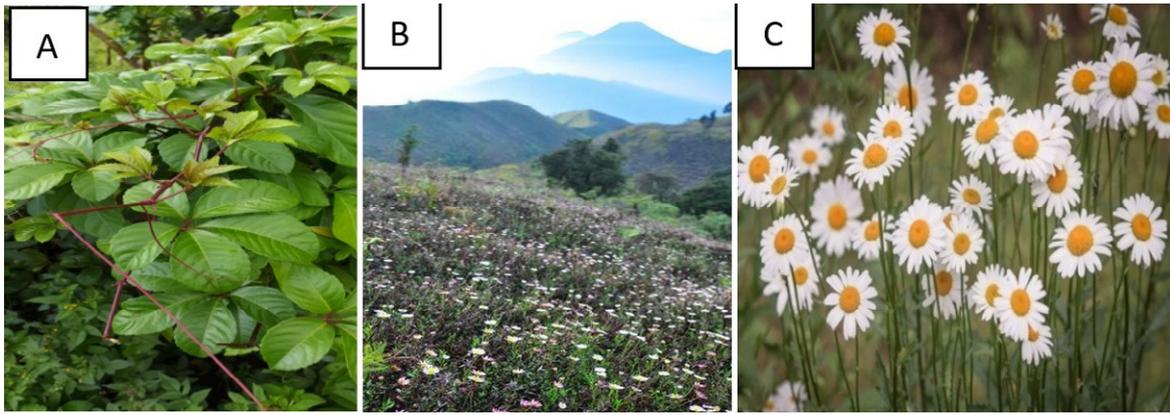


Figure 6. Other unique endemic plants in Mount Prau. (A) *Tetrastigma glabratum* Blume. Planch; (B) and (C) *Symphyotrichum ericoides* L. (G.L. Nesom)

At the time of our exploration, *S. ericoides* were abundant in Mount Prau; they were found to grow on dry and rocky soils. The survey was conducted during the dry season, and there was no rain for about 3 months (BMKG, 2020). *Symphyotrichum ericoides* is widely known as heath aster. *Symphyotrichum ericoides* are perennials, and most of the plants that we found are 50-70cm tall. Their flowers are composite with white ray flowers in contrast to their yellow disk flowers at the centers. The inflorescence diameter is about 10 mm across. In our opinion, for now, there is no urgent need to call for the legal protection of this species. Additionally, it is not over-exploited in the area. Being widely distributed in the area, this makes these daisies better suited for domestication.

The dynamic floriculture industry is constantly looking for new products with more diverse physical appearances, textures, and patterns (Krisantini et al., 2014). Therefore, new species with unique shapes, colors, and patterns of flowers, leaves, or stems are always wanted to be introduced to the floricultural market. Propagation and domestication of unique and beautiful species need integrated research and development efforts and require strong collaboration between research institutions, universities, and the local government. In developing new hybrids, it is vital to have a vast collection of species (Ghimiray and Vernooy, 2017). Therefore, it is very important to protect the species diversity in their natural habit. The floriculture industry and landscaping business in Indonesia has been the source of income for the locals, and there has been increasing awareness to build environmentally friendly human habitats. The flowering species that we have found in our study could be helpful for the local people and add new products to the Indonesian flower and ornamental plant market.

Conservation efforts should be carried out considering specific and contextual driving factors, including integration of nature conservation and forest management (Henri et al., 2018). In line with that, to assist in formulating conservation planning both *in-situ* and *ex-situ*, a priority list of species is needed. This priority list can further help

achieve the Global Strategy for Plant Conservation 2011-2020 (Cahyaningsih et al., 2021).

Factors threatening the extinction of ornamental wild plants

We recorded that natural disasters are unavoidable conditions that cause environmental damage, thereby affecting various rare plant species that live naturally. Mount Prau is vulnerable to natural disasters such as heavy rain, landslide, volcano eruption, making its natural vegetation prone to destruction. Ignorance of plant uses and other benefits make humans exploit rare species to extinction; tourist visits to Mount Prau had disrupted the natural growth of wild species. Illegal and indiscriminate harvesting of plants has broken the chain of native plant growth. During the pandemic in 2020, the number of visitors to Mount Prau has been limited to only 1,500 people per day.

Worldwide, deforestation and forest degradation affect biodiversity and practices and become a driving factor for biodiversity loss caused by exploitation practices (Tsujino et al., 2016). In the Mount Prau region, the main threat is the overexploitation of native plants by visitors, climbers and tourists. The impact of the extinction of a species will result in the extinction of species relying on them. It will harm the balance of the ecosystem and eventually on humans.

Conclusions

Wild plant species in Mount Prau should receive more protection from various threats of extinction, and the high intensity of tourist visits to Mount Prau is one of the main factors that need to be managed. The wild plant species with potential ornamental values are *Anaphylis javanica*, *Dodonaea viscosa*, and *Symphyotrichum ericoides*. We strongly suggest the local government enforce the regulations to protect these species from extinction. Future research efforts should be directed into studying reproductive biology, propagation, and optimal culture of these species and develop their potentials as ornamental plants.

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Author Contribution

LK: research orientation, survey and monitoring the entire activities, preparation of the manuscript; **NAC.:** survey, suggestions, recording, documentation; **EP:** survey, suggestions, documentation; **K:** idea, research orientation, method development, preparation of the manuscript; **MUA:** survey, preparation of the manuscript.

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