



Short-Communication

Botanical Exploration and Conservation in Pasir Banteng and Pasir Pogor, Gunung Gede Pangrango National Park

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ABSTRACT

Cibodas Botanic Gardens (CBG) shall keep performing botanical exploration and *ex situ* conservation as part of the effort to rescue tropical montane rainforest plants, which tend to decrease in their natural habitat. Pasir Banteng and Pasir Pogor, Mount Gede Pangrango, were selected due to the potential threat and limited information on plants collected from these sites. The objectives of this study were to collect valuable plants, which have a conservation value and explore their potential usefulness. The study has begun by establishing a list of collectible plants. Then, the field activities were conducted by a plant collection explorative method along the hiking route, from 750 to 1,500 m asl, low-mid mountain as height as CBG, with no specific sampling point (found and collected). These plants have field treatment, were delivered to CBG, and would later be maintained in the garden. The study has obtained 31 species collected from Pasir Banteng and 20 species from Pasir Pogor. There were 35 families, with Orchidaceae being the most collectible. Some crucial findings were nine species included as least concern (LC) and a species as endangered (EN), based on their conservation status. At least six new species were identified as the garden enrichment of the CBG. In addition, at least fifteen species have potential utilization as construction materials, 29 species as ornamental plants, twelve species as medicinal plants, and some plants possessing multi-utilization. The results were significant in adding the collection's richness and enhancing the conservation value of the plants conserved by CBG. It was also contributed to describing the plant species information of these sites.

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1. Introduction

Tropical montane forest research is very crucial, especially in Asia, because this region is much mountainous compared to other tropical rainforest regions in Africa and the Amazon (Gardner et al. 2010). However, this type of forest is vulnerable to human intrusions and the destructive impact that it causes (Hughes 2017). Sodhi et al. (2010) stated that the rate of deforestation in Southeast Asia is the highest compared to other regions in the world, and it is projected that there will be a reduction in biodiversity by 13-85% by 2100.

Tropical montane rainforest ecosystems have an important role in ecology and conservation, particularly when associated with the issues of global climate change and land degradation

(Boehmer 2011). At present, this ecosystem has become a refugee area for lowland flora and fauna species whose habitat has been largely destructed (Fox et al. 2012; Lima et al. 2012). This phenomenon has also been caused by global climate change (Lucier et al. 2009; Segan et al. 2016). Furthermore, global climate change can also be a threat in preserving wet tropical montane flora (Miettinen et al. 2011; Rathore et al. 2019; Thang et al. 2020).

Conservation efforts, both *in situ* and *ex situ*, are needed to reduce the rate of degradation of plant species (Braverman 2014). Ideally, conservation efforts have to be conducted *in situ* (Braverman 2014). However, due to the high deforestation of natural forests, *ex situ* conservation is required. Based on the Presidential Regulation of the Republic of Indonesia Number 93 of 2011, botanical gardens are defined as *ex situ* plant conservation areas that have documented plant collections. It has been arranged based on taxonomic, bioregion, thematic classification patterns, or a combination of these patterns, beneficial for conservation, research, education, tourism activities, and environmental services.

Cibodas Botanic Gardens (CBG) is an *ex situ* conservation government institution under the National Research and Innovation Agency (*Badan Riset dan Inovasi Nasional*–BRIN) of the Republic of Indonesia. Based on the Presidential Regulation of the Republic of Indonesia Number 78 of 2021, CBG has a primary obligation to organize *ex situ* plant conservation, especially from the Indonesian tropical montane rainforests. Furthermore, CBG also organizes research and development, education, tourism activities, and environmental services related to the tropical montane rainforests. Therefore, it is crucial for CBG to conduct botanical exploration and conservation routinely. The purposes are to enhance the value of their plant collection based on the threatened status of the species, their potential utilization, and the increase in collection's number.

This paper would be describing the *ex situ* plant collection and conservation activities in 2019 conducted by CBG's team. The selected locations are Pasir Banteng and Pasir Pogor, part of the Gunung Gede Pangrango National Park (GGPNP) ecosystem, Cibodas Biosphere Reserve (CBR). These areas were established based on the consideration that GGPNP is part of the CBR, has significant and strategic values in conservation efforts locally, nationally, and globally (Sudarmonowati 2019). Furthermore, the rate of deforestation in this area is allegedly concerned (Dwiyahreni et al. 2021), with many threatened plant species yet collected in CBG (Sujarwo et al. 2019). The objectives of this study were to collect valuable plants that have a conservation value, then to maintain such as *ex situ*, and explore their potential usefulness. The main priority of the collection activity was to collect threatened endemic plants or have potential utilization (e.g., as food materials in the form of fruit or tubers, ornamental plants, and medicinal plants). The results are expected to enhance the added value of the CBG plant collection not only from conservation perspectives but also beneficial for further researches, education, and community.

2. Materials and Methods

2.1. Study Site

Field exploration and plant collection were conducted from 5-19 March 2019. The study sites were located in Pasir Banteng and Pasir Pogor, Gunung Gede Pangrango National Park, West Java. Pasir Banteng has located at 06° 44' 1.4" S; 106° 54' 43.6" E, with elevation ± 1,190 masl and Pasir Pogor has located at 06° 44' 33.4" S; 106° 55' 1.8" E, with elevation ± 1,251 masl (**Fig.**

1). These locations are accessible through Cileungsi-Tapos village, Ciawi, ± 19 km to the southeast from Bogor City, or ± 46 km from Jakarta to the south. These locations are on the northern side of GGPNP.

Based on a glance observation, both locations relatively have a remains healthy configuration of the tropical montane rainforest ecosystem, both in horizontal and vertical diversity. A typical hilly mountainous topography dominates these areas. The elevation of the slopes on the trail is relatively moderate up to steep with high humidity. This condition has presumed that the configuration of the forest vegetation is dense so that the penetration of sunlight prevented it from reaching the forest floor.

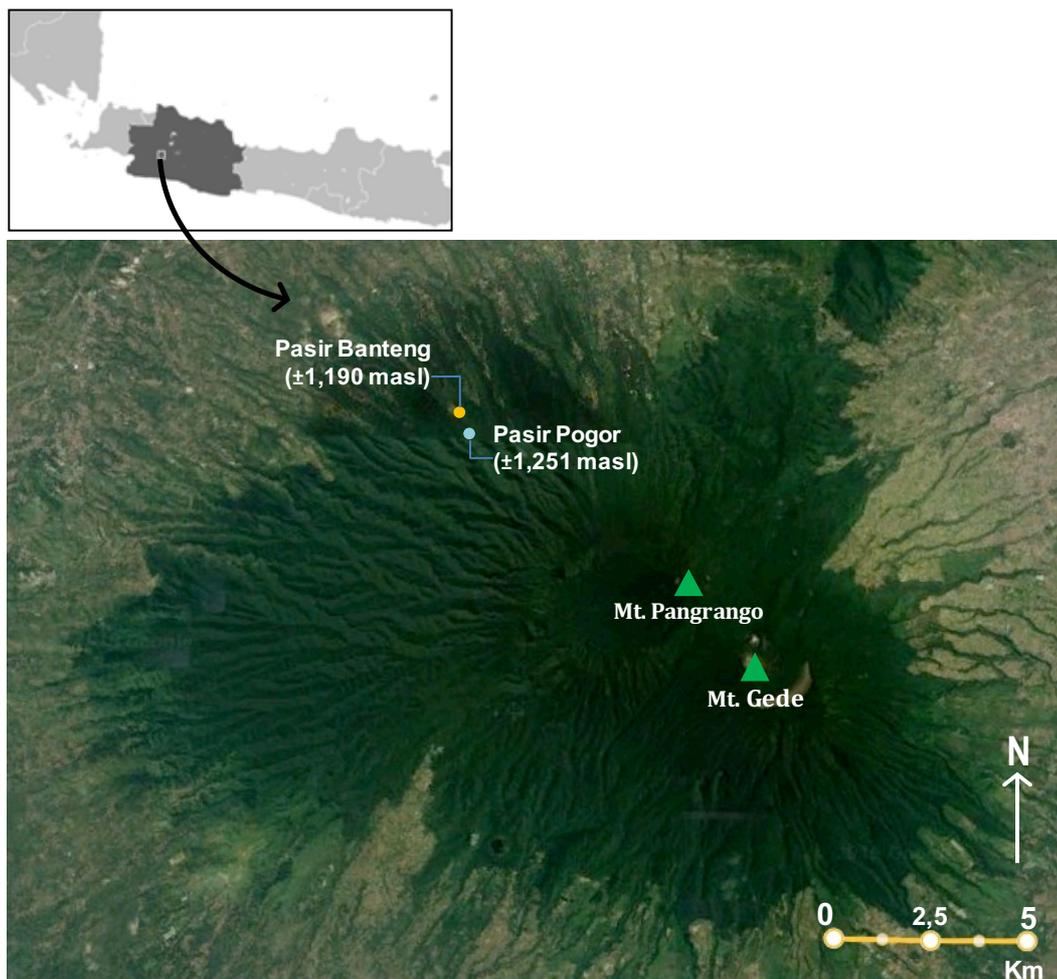


Fig. 1. The locations of the study site: Pasir Banteng and Pasir Pogor, GGPNP (Source: Google Earth, accessed: 12 April 2019).

2.2. Field Exploration, Plants Collection, and Data Acquisition

Firstly, the CBG team was listed priority plants to be collected in the field through a literature study. Some considerations to establish this list are the plant has a crucial value of conservation (threatened in their habitat because of degradation, endemic, or requires habitat-specific), owning a potential used (food material, medicinal substance, ornamental, or multi utilization), and to enrich the CBG plants stock. Furthermore, this list is registered for recommendation approval to the Research Center of Biology and the Ministry of Environment and Forestry. These produced recommendations will be used by the CBG team when proposing permits at the sampling location and guidance in collecting plant species.

Plants collection was conducted using the exploration method by exploring the study area to collect plant information (Partomihardjo and Rahajoe 2004). The exploring method is tracing the forest through existing pathways or hiking routes. Plants collection is an activity to collect plant material(s), in the forms of seedlings, cuttings, or seeds, in their natural habitat and later propagated in CBG. The points for collecting plants are random, along with the hiking or exploration route (Hidayat et al. 2017). If a spot point overgrown with large numbers of priority plants was found, observation, search, and plant collection were expanded to within a radius of approximately 5 m surrounding that spot. The plant collection was started from 750 to 1,500 masl, which the lower-mid mountain as height as CBG altitude. This was conducted based on the assumption that the microclimate conditions are relatively similar. Therefore, it has expected to increase the success of the acclimatization process at CBG. The details of the plant collection sampling are graphically described in Fig. 2.

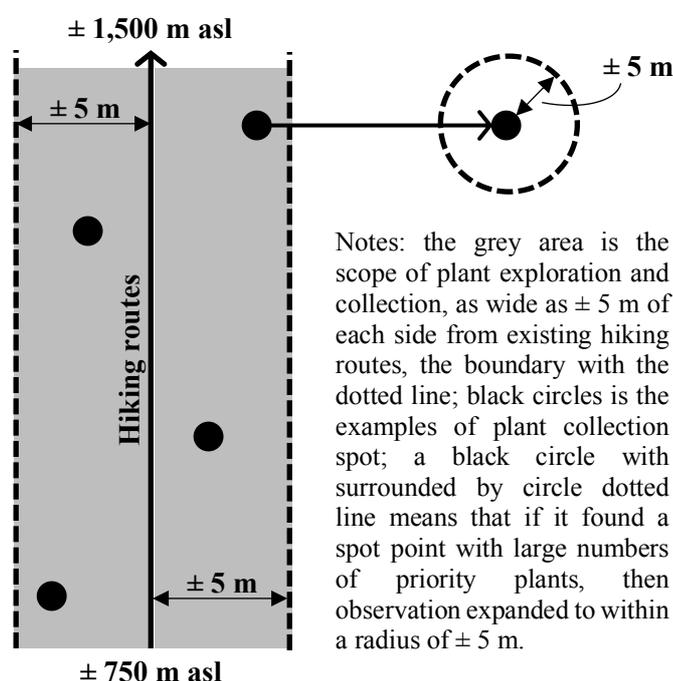


Fig. 2. The graphical explanation of the plant collection sampling.

There was no specific quantitative analysis related to plant populations in this study. Instead, population conditions were analyzed descriptively on their encounters in the field. In addition, determination of the altitude (Mueller-Dombois and Ellenbergh 2016), habitus, and the type of material were also recorded for each collected plant.

2.3. Plants Collection Treatment

The plants have been collected from the field were treated to ensure the vigor of the plants. A vigor plant is referred to the strength and healthy growth of a plant to keep surviving under undesirable conditions, such as drought, low temperature, or lack of nutrients (Lazarova et al. 2016). First, collected plants in the form of seedling and cutting, their roots or at the end of the bottom were soaked in a roots growing solution for three to five minutes (Mudiana et al. 2020). Next, the handling has conducted by wrapping the plant's roots with forest humus or moss, moistened with water. The leaves and branches have also been cut off to be fewer to reduce the

transpiration process, and the primary rod was only preserved less than 150 centimeters and then wrapped in perforated plastic.

All plants are then packed in 100 L plastic container boxes to facilitate transportation for approval from the national park office and then delivered to CBG (Efendi et al. 2020). When the box arrived at CBG, all plants were taken out and immediately treated according to the type. When the box arrived at CBG, all plants were taken out and immediately treated according to the type. Seedling and cutting materials were grown using forest humus media: raw husk in a ratio of 1:1, while orchids are used the chopped medium of fern roots (Nurlaeni et al. 2017). All plants were stored in a paranet house with a density of 75%. In this acclimatization stage, fertilizing, watering, pest control, and vitamin allocation were performed regularly, either daily or weekly.

3. Results and Discussion

3.1. General Conditions

Pasir Banteng and Pasir Pogor, Cileungsi-Tapos are included in the working area of the PTN Tapos Resort Section, Area III, Gunung Gede Pangrango National Park, Ministry of Environment and Forestry. Both locations have mountainous forests in well-natural conditions that have expected to function as conservation areas, ecosystems protection, species breeding, and germplasm bank. Therefore, these locations may be included in a zone characterized by tropical montane rainforest that the number of rainy months is more than drought months. The type is C to B, or less wet to wet, based on Schmidt-Ferguson classification. It also could be included in tropically rainy climates or wet tropics 'Af' based on Koppen (Corlett 2014).

However, these locations are directly adjacent to other use areas (such as pine grove area, tourism site, or grazing area), utilization areas (such as agriculture, mixed garden, livestock, fishpond, or other cultivation activities), and populated villages (Dewi 2019; Sawitri and Bismark 2013). Then, it might cause the intensity of contact between humans and the natural environment at moderate to high levels. Therefore, it is necessary to perform supervision and control from the management, so there is no violation, abuse of resources, or land use/ cover changes caused by human intrusions (Setiawan et al. 2016).

The easiest way to reach the Pasir Banteng access is to cross the entrance portal of a cattle and goat farming company, PT. Rejo Sari Bumi Unit Tapos. Next, we would cross a footpath surrounded by a relatively open area which is broad other use areas of GGPNP (Fig. 3a). The topography of this area is dominated by slopes and valleys, from less to steep. During exploration, the density of vegetation found along the hiking route is relatively moderate to very dense, so that the penetration of sunlight may still penetrate to the forest floor even though in some dense areas, radiation is lacking (Fig. 3b).

Pasir Pogor access could be reached through a dirt road passing the Tapos Lbc tourist area. This route is commonly used by residents for crossings transporting grass for their livestock. Unlike Pasir Banteng, this access is surrounded by the dominance of tree stands (Fig. 4a). Regarding vegetation cover configuration, the characteristics exhibited in this access are not much different from Pasir Bogor, a low-mid tropical montane rainforest (Fig. 4b).



Fig. 3. (a) Entrance of Pasir Banteng access; (b) vegetation cover characteristic, dominated by dense trees and high shrubs, along with field exploration in Pasir Banteng (Photos: Fitri Kurniawati).



Fig. 4. (a) Passing road to Pasir Pogor; (b) the entrance of Pasir Pogor access (Photos: Fitri Kurniawati).

3.2. Collected Plant Species Variety

The collected plants were not describing their structure, abundance, or any other indicators of plants composer of these locations. However, these are solely collected to enrich the CBG plant collection. Therefore, the team was careful to select the plants to be collected in these activities, following the plant's list established before. As a result, 31 species were successfully collected from Pasir Banteng and 20 species from Pasir Pogor (**Table 1**). The total of plant's families was 35, with Orchidaceae being the most collected with six species. Begoniaceae and Annonaceae with three species. Then, these followed by Acanthaceae, Elaeocarpaceae, Phyllanthaceae, Primulaceae, Rubiaceae, and Rutaceae were fewer with two species. The rest were only one species each. Each species was collected its seedlings from two to five specimens.

Table 1. The profile of plant collection from Pasir Banteng and Pasir Pogor

Location	Family	Species	Altitude (masl)	
Pasir Banteng	Acanthaceae	<i>Strobilanthes paniculata</i> (Nees) Miq.	1,255	
	Annonaceae	<i>Goniothalamus macrophyllus</i> (Blume) Zoll.	1,224	
		<i>Polyalthia subcordata</i> (Blume) Blume	1,255	
	Araceae	<i>Alocasia</i> sp.	1,255	
		<i>Amorphophallus</i> sp.	1,332	
	Begoniaceae	<i>Begonia muricata</i> Blume	1,239	
		<i>Begonia isoptera</i> Dryand. ex Sm.	1,485	
	Daphniphyllaceae	<i>Daphniphyllum glaucescens</i> Blume	1,175	
	Elaeocarpaceae	<i>Elaeocarpus petiolatus</i> (Jack) Wall.	1,190	
	Escalloniaceae	<i>Polyosma ilicifolia</i> Blume	1,261	
	Gentianaceae	<i>Fagraea elliptica</i> Roxb.	1,103	
	Leguminosae	<i>Ormosia penangensis</i> Ridl.	1,261	
	Oleaceae	<i>Jasminum multiflorum</i> (Burm.f.) Andrews	1,103	
	Orchidaceae	<i>Calanthe</i> sp.	1,332	
		<i>Cryptostylis arachnites</i> (Blume) Hassk.	1,261	
		<i>Cymbidium lancifolium</i> Hook.	1,103	
		<i>Plocoglottis javanica</i> Blume	1,187	
		<i>Bulbophyllum</i> sp.	1,485	
		Phyllanthaceae	<i>Breynia microphylla</i> (Kurz ex Teijsm. & Binn.) Müll.Arg.	1,203
		Primulaceae	<i>Ardisia villosa</i> Roxb.	1,203
	<i>Myrsine avenis</i> (Blume) A.DC.		1,261	
	Rhizophoraceae	<i>Carallia brachiata</i> (Lour.) Merr.	1,485	
	Rubiaceae	<i>Mussaenda frondosa</i> L.	1,261	
		<i>Urophyllum</i> sp.	1,103	
	Rutaceae	<i>Acronychia trifoliolata</i> Zoll. & Moritzi	1,175	
		<i>Luvunga sarmentosa</i> Kurz	1,301	
	Staphyleaceae	<i>Turpinia montana</i> (Blume) Kurz	1,190	
	Theaceae	<i>Schima wallichii</i> (DC.) Korth.	1,187	
	Thymelaeaceae	<i>Eriosolena composita</i> (L.f.) Tiegh.	1,272	
	Xanthorrhoeaceae	<i>Dianella ensifolia</i> (L.) Redouté	1,255	
	Zingiberaceae	<i>Hedychium roxburghii</i> Blume	1,485	
	Pasir Pogor	Acanthaceae	<i>Strobilanthes involucrata</i> Blume	1,251
		Adoxaceae	<i>Viburnum sambucinum</i> Reinw. ex Blume	1,237
Annonaceae		<i>Artabotrys</i> sp.	1,373	
Begoniaceae		<i>Begonia longifolia</i> Blume	748	
Chloranthaceae		<i>Chloranthus elatior</i> Link	748	
Clusiaceae		<i>Calophyllum</i> sp.	1,382	
Compositae		<i>Strobocalyx arborea</i> (Buch.-Ham.) Sch.Bip.	1,318	
Dichapetalaceae		<i>Dichapetalum</i> sp.	1,377	
Dioscoreaceae		<i>Tacca chantrieri</i> André	1,251	
Elaeocarpaceae		<i>Elaeocarpus</i> sp.	1,382	
Lauraceae		<i>Cryptocarya</i> sp.	1,340	
Melastomataceae		<i>Medinilla speciosa</i> Blume	1,377	
Myrtaceae		<i>Rhodamnia cinerea</i> Jack	1,225	
Orchidaceae		<i>Apostasia wallichii</i> R.Br.	1,289	
Pentaphragmaceae		<i>Eurya acuminata</i> DC.	1,380	
Phyllanthaceae		<i>Antidesma tetrandrum</i> Blume	1,373	
Proteaceae		<i>Helicia serrata</i> (R.Br.) Blume	1,259	
Rosaceae		<i>Rubus alceifolius</i> Poir.	1,259	
Stemonuraceae		<i>Gomphandra javanica</i> (Blume) Valetton	1,238	
Symplocaceae		<i>Symplocos</i> sp.	1,259	

These families are commonly found in the lower mountain zone (sub-montane) and the upper mountain zone (montane). According to [Kartawinata et al. \(2013\)](#), the families found in mountain forests, such as Annonaceae, Fagaceae, Lauraceae, Meliaceae, Myrtaceae, Rubiaceae, and Sterculiaceae. It is also following the research of [Efendi et al. \(2016\)](#) on Mount Pesagi, the highest mountain in Lampung, that the Myrtaceae, Clusiaceae, and Lauraceae are the three families with the highest number of plant species found in the sub-montane zone.

At least six new species were potentially enriching the CBG's plants collection, according to the collection list of [Sujarwo et al. \(2019\)](#). They are *Begonia isoptera*, *Begonia longifolia*, *Myrsine avenis*, *Polyosma ilicifolia*, *Strobilanthes paniculata*, and *Strobilanthes involucrata*. The other species are collected as stock to the collection at CBG, especially classified as critical in the garden. Critically in the garden means only one specimen displayed, and there is no stock seedling in the propagation unit ([Efendi et al. 2020](#); [Mudiana et al. 2020](#)). These species are *Eurya acuminata*, *Fagraea elliptica*, *Polyalthia subcordata*, and *Tacca chantrieri*.

Almost all of the plants collected had habitus in the form of trees or woody shrubs. It is related to the abundance of this type in the forest. Except for orchids, epiphyte or terrestrial, *Begonia* spp., and *Hedychium roxburghii* are herbs, and *Jasminum multiflorum* is a woody climber. Another reason is to facilitate maintaining and propagating these wooden materials. Herbs are a type of plant material that is difficult to move and propagated to a new place. Based on [Nurlaeni et al. \(2017\)](#) study, the low survivorship level of herbs from Mount Seblat exploration may be caused by the material collection, field handling, delivery, and maintenance processes at CBG. Besides, herbs are high in water content ([Haba 2015](#); [Xu and Chang 2017](#)) which is often not resistant to heat during the field, and the time-consuming delivery to CBG.

In this exploration, the field plant selection is directly at uncollected species by CBG. Therefore, the number of collected species and specimens was less than the previous activities, which could reach more than two hundred specimens ([Efendi et al. 2020](#)). Most of these specimens have been identified to the species level. However, there are still ten species identified at the level of genera due to limited generative characteristics. This botanical exploration results showed that the diversity of plants found in the sub-montane forest of GGPNP is still relatively high in various species, genera, and plant families found in it. Besides, the collected plants are endemic species typical of Mount Gede Pangrango ([Rozak et al. 2016](#); [Susiarti et al. 2018](#)).

The objective of the altitude selection in this study was to facilitate the acclimatization process of the collected plants with the new location (CBG). The CBG elevation is between \pm 1,100 to 1,400 m asl ([Sujarwo et al. 2019](#)), with a tropical montane rainforest microclimate that is approximately similar to the study site. The species collected focused on plants with high conservation status (endemic, rare, and protected) and potential utilization. Therefore, the results of this exploration were unable to describe the entire vegetation along with the exploration route. However, as a comparison, there were five families successfully collected from both sites, i.e., Acanthaceae, Annonaceae, Begoniaceae, Elaeocarpaceae, Orchidaceae, and Phyllanthaceae.

Some of these collected species also have a crucial value for plant conservation. Based on [IUCN \(2021\)](#), there are ten species included as threatened species, one species is endangered (EN), and nine as least concern (LC) (**Table 2**). The threatened species is *Hedychium roxburghii*, having a status of endangered (EN) ([Olander 2019](#)). This species is native to the lower up to the montane zone rainforest of Java and Bali. Their population is severely fragmented and tends to decline their mature individuals. In addition, the annual and perennial non-timber crops and logging have threatened their natural habitat ([IUCN 2021](#)). The least concerned species are *Acronychia*

trifoliolata, *Breynia microphylla*, *Elaeocarpus petiolatus*, *Eriosolena composita*, *Rhodamnia cinerea*, *Schima wallichii*, *Strobocalyx arborea*, *Turpinia montana*, and *Viburnum sambucinum*. The population of these species was threatened by severely fragmented in their natural and continuing decline of their mature individuals. The other issues are continuing decline in area, extent, and quality of their natural habitat. *S. wallichii* is widely distributed from Bhutan, Nepal, southern China, the Malayan Peninsula to Indonesia and has been widely cultivated and utilized as construction materials, medicine-human and veterinary, and fuels (IUCN 2021). These utilizations are also recognizable on *Strobocalyx arborea* (IUCN and BGCI 2021). However, these species are regarded as generic and able to develop if their degraded areas are protected. Moreover, *Viburnum sambucinum* is commonly used and traded as a cultivated ornamental plant (Oldfield 2020). Therefore, this wild type is often hunted as broodstock.

Table 2. The conservation status of the collected plant species*

Species	Conservation Status	References
<i>Hedychium roxburghii</i>	Endangered (EN)	Olander (2019)
<i>Acronychia trifoliolata</i>	Least Concern (LC)	BGCI and IUCN (2018a)
<i>Breynia microphylla</i>	Least Concern (LC)	IUCN and BGCI (2019)
<i>Elaeocarpus petiolatus</i>	Least Concern (LC)	Zhao et al. (2019)
<i>Eriosolena composita</i>	Least Concern (LC)	Ye et al. (2019a)
<i>Rhodamnia cinerea</i>	Least Concern (LC)	BGCI and IUCN (2018b)
<i>Schima wallichii</i>	Least Concern (LC)	Oldfield (2018)
<i>Strobocalyx arborea</i>	Least Concern (LC)	IUCN and BGCI (2021)
<i>Turpinia montana</i>	Least Concern (LC)	Ye et al. (2019b)
<i>Viburnum sambucinum</i>	Least Concern (LC)	Oldfield (2020)

Note: * Based on the IUCN Red List of Threatened Species (IUCN 2021).

3.3. Potential Utilization

This study focused on collecting plants with a conservation value to enrich the CBG collection and identify the potential utilization and economical addition of these species. These potential utilizations have been divided into three categories, i.e., construction materials, ornamental plants, and medicinal or food ingredients.

3.3.1. Construction materials

Plant species, especially trees, are a significant source of wood, as reviewed by Sosef et al. (1998). Based on their study, tree species such as *Antidesma* spp., *Elaeocarpus* spp., *Helicia* spp., *Ormosia* spp., medang (*Persea* spp.), ki sabun (*Polyosma ilicifolia*), brown mallet wood (*Rhodamnia* sp.), and puspa (*Schima wallichii*) have been utilized for their wood in a few local communities. These species are lesser-known timbers (Sosef et al. 1998). Families from Lauraceae and Myrtaceae are commonly has developed as construction materials (Efendi et al. 2020).

Tree species, such as *Cryptocarya* spp. and *Fagraea* spp., are also known locally as limited commercial woods (Lemmens et al. 1995). It is due to these species being commonly have utilized as materials in house building. Besides, species such as bintangur (*Calophyllum* sp.), *Daphne* spp., *Dichapetalum* spp., *Gomphandra* spp., and *Strobocalyx arborea* also potentially have to be utilized as construction materials (Muhaimin et al. 2016; Slik 2009).

3.3.2. Ornamental plants

The aesthetical aspect of a plant does not only come from the flowers. It also could be seen from its uniqueness and the color of other parts, such as leaves, stems, or branches. In this study, collectible species potentially developed as ornamental plants such as *Ardisia villosa*, *Begonia* spp., *Breynia microphylla*, *Calophyllum* sp., *Chloranthus elatior*, *Cryptocarya densiflora*, *Daphniphyllum glaucescens*, *Dianella ensifolia*, *Eurya acuminata*, *Hedychium roxburghii*, *Medinilla speciosa*, *Myrsine avenis*, *Ormosia penangensis*, *Plocoglottis javanica*, *Rubus alceifolius*, *Urophyllum* sp., and *Viburnum sambucinum* (Muhaimin et al. 2016, 2018; Siregar et al. 2018; Slik 2009). These species have potentially developed as ornamental plants due to their uniqueness of the leaves, color, shape, or texture.

Collectible species with unique or elegant flowers are *Artabotrys* sp., *Gomphandra javanica*, *Goniothalamus macrophyllus*, *Mussaenda frondosa*, *Polyalthia subcordata*, *Strobilanthes paniculata*, *Strobilanthes involucrata*, and *Tacca chantrieri* (Muhaimin et al. 2016, 2018). *Artabotrys* sp. and *Polyalthia subcordata* have fragrant flowers, *Gomphandra javanica* has unique yellowish flowers, and *Mussaenda frondosa* has flowers in the middle of the stem. *Strobilanthes paniculata* has white flowers, *Strobilanthes involucrata*, and *Tacca chantrieri* have blackish flowers.

3.3.3. Medicinal and food ingredients

Based on the literature study, some of these collectible species have the potential value to be developed as medicinal plants and food ingredients. For example, empag or kalibanban (*Acronychia trifoliata*) may produce essential oil and aromatic leaf plants (Sujarwo and Arinasa 2014; Tirta and Wibawa 2017). This essential oil has been used regularly in traditional medicine in Bali and Nusa Tenggara. The leaves of kakatukan (*Breynia microphylla*) and *Symplocos* sp. are commonly have been cooked to accelerate post-pregnancy healing (Susiarti et al. 2018). Buah kanis (*Carallia brachiata*) can be utilized as antimicrobial, antifungal, and antidiabetic (Junejo et al. 2020; Neeharika et al. 2012). *Chloranthus elatior* produces essential oil used in various therapy and healing practices (Thang et al. 2016).

Furthermore, *Jasminum multiflorum* contains chemical constituents for antioxidants (Khidzir et al. 2015; Kumaresan et al. 2019). *Luvunga sarmentosa* also contained active methanol as an antioxidant and post-pregnancy healing (Nashrul and Rizki 2020; Wardah and Sundari 2019). Nona leuweung (*Polyalthia subcordata*) also contains chemical constituents traditionally used for anti-itching and potentially developed for drug cancer (Arbiastutie et al. 2017). *Rubus alceifolius* has potentially been using as edible fruit, the tastes sweet and a little sour (Surya et al. 2018). Puspa (*Schima wallichii*) traditionally has been used for ache healing (Susiarti et al. 2018). The flowers are commonly crushed, mixed with coconut oil, and applied to the foot. These flowers also have been utilized for aromatic therapy (Sujarwo and Arinasa 2014). *Strobocalyx arborea* or *Vernonia arborea* (synonym) is a potential plant used as an anti-inflammatory and anticancer (Sridharan et al. 2016; Valkute et al. 2018). *Turpinia montana* is a common plant used in Thailand as an anti-diarrheal medication (Grosvenor et al. 1995).

Based on those explanations, *ex situ* plant conservation efforts conducted by CBG are crucial to keeping forward. These have been done to reduce the pressure load of natural habitat that tends to be degraded continuously. Besides, to uncover plant diversity of the Indonesian tropical montane rainforest and research their utilization for the community. Various opportunities and

challenges will come along with efforts to conserve threatened plants. Therefore, it requires good cooperation between the government, stakeholders, and the community to establish an integrated conservation action, especially in Indonesia.

4. Conclusions

This study has clearly described the *ex situ* plant exploration and conservation in Pasir Banteng and Pasir Pogor, GGPNP, conducted by CBG's team. Hundreds of tropical montane rainforest specimen plants are successfully collectible. Those plants are significant to enrich the seedling's stock of the CBG and also possess a crucial value for conservation. Some of those are a new plant collection for the garden. The findings also explained that ten species identified as threatened in their natural habitat. Nine species are least concerned, and one species is endangered. Therefore, propagation and maintenance efforts need to conduct immediately. Almost all of these collectible plants have potential utilization, and some of these have multi-use. Then, it needs to establish further research to exhibit these potentials and benefits to the community. CBG needs to continuously organize the other botanical exploration and plant conservation with other stakeholders to establish an integrated conservation effort towards a greater chance of success.

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