Jurnal Biologi Tropis

Original Research Paper

The Contribution of Cibodas Botanic Garden as An *Ex-situ* Conservation Site for Tropical Mountainous Plants: The last decade

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Article history
Received: August 13th, 2019
Revised: August 28th, 2019
Accepted: September 4th, 2019
Published : September 12th, 2019

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Abstract : The threats to the plant biodiversity become more advance along with rapid degradation of the natural habitat. Plants preservation needs accompaniment between *in-situ* and *ex-situ* conservation altogether. The *ex-situ* plant conservation plays more important roles in order to help conserve threatened plant species. Cibodas Botanic Garden (CBG) is a government institution which has the main assignment on *ex-situ* plant conservation, especially tropical mountainous plants. In the last decade, CBG has conducted exploration and plants collection in order to retrieve them from the destructive pressures in their habitat. This study aimed to asses the CBG's contribution to *ex-situ* plant conservation through the addition number of planted plants and to describe the important value to conservation. The study conducted through a quantitative descriptive method, based on data inventory of the newly planted plant in the garden from 2008 to 2018. This also assessed the increasing collection of each year and descriptively explaining the background data, species variety, and their conservation status. The results described that the additional number was 473 specimens and the average increase was 43 specimens per-year. These originated from exploration and plants collection 248 specimens, donation 217 specimens, self-propagation seven specimens, and one specimen from seeds exchange. The most planted was Nepenthaceae with 84 specimens, secondly Phillantaceae with 21 specimens, and Lauraceae 15 specimens. There were 116 species (152 specimens) which have conservation status. These expected to be a comprehensive description of the CBG's plant collection and meaningful for the conservation efforts in general.

Keywords: *ex-situ* plant conservation; garden collection; Cibodas Botanic Garden (CBG)

Introduction

The conservation in plants is greatly under-resourced in examination with the conservation of animals (Havens *et al*., 2014). The plants conservation diversity has received considerably less interest than the animals conservation, perhaps because plants lack the favorite attract of many animal groups (Goettsch *et al*., 2015). Furthermore, the existence of wild plants in their ecosystem getting pressed. The extant habitats of a growing number of species are becoming less viable for their survival for a variety of reasons, including global warming, disease, drought, fragmentation, and deforestation (Braverman, 2014).

For example, thirty-eight percent of remaining forest of Sumatran tropical rainforest in 2007 was "critically endangered", "endangered" or "vulnerable" eco-floristic sectors (five million ha) but only one million ha (20%) were protected (Laumonier *et al*., 2010). It has also occurred in mountains forest since 1985-2007, in totally, 41% forest loss has occurred in South, Central and North Sumatra. Within extraordinary pressures to the existence of conservation areas, it should be carried out immediately noticeable efforts in conservation sectors.

Various efforts need to be made to minimize the threat caused by the continued reduction of tropical forests, one of which is to exert *ex-situ* conservation efforts. In order to maintain many species, an alternative habitat (or the existing one) might be (re) constructed and managed (Braverman, 2014). Moreover, *ex-situ* plant collections would help conserve threatened species (Richards *et al*., 2007), function as a source of traits for agricultural improvement (Tanksley & Mccouch, 1997; Brummer *et al*., 2011; Neale & Kremer, 2011), or has been used to propagate large numbers of individual plant for ecosystem restoration or assisted migration (Broadhurst *et al*., 2008; Vitt *et al*., 2010; Aitken & Whitlock, 2013).

Publisher
UPT Mataram University Press

Cibodas Botanic Garden (CBG) based on the Decree of the Chairman of Indonesian Institute of Sciences (*LIPI*) January 17, 1987, *No.23/KEP/ D.5./87*, CBG has the task to conduct exploration and plant conservation of tropical wet highlands. CBG has an important role to conduct exploration and research activities of tropical wet highlands plants. In the last decade, CBG has conducted of exploration and plants collection at Sumatran mountains. These collected plants were those species which threatened, has no collection in the garden or has a potential usefulness. Plants which collected from their natural habitat will be maintained and planted in the garden, *ex-situ* conservation, which will enrich plants collection of CBG. Before a plant becomes a collection of CBG, it must go through a series of data processing in order to insure the plant data.

The objectives of the study were to assess the CBG's contribution to *ex-situ* plant conservation through the addition number of planted plants from 2008 to 2018 and to describe the important value of these plants to conservation. The results were expected to be a comprehensive description of the CBG's plant collection, as an effort on *ex-situ* plant conservation, and also meaningful for the conservation efforts in general.

Materials and Methods

The study was conducted at CBG, Cianjur, West Java. CBG is located at 107° 0' 10.476" E to 107° 0' 59.275" E and 6° 44' 6.787" S to 6° 44' 51.112" S (Figure 1). The location is mountainside of mount Gede and mount Pangrango, at an altitude of approximately 1,300-1,425 meters above sea level, with an area of 84.99 hectares (Widyatmoko *et al.*, 2010). The average temperature is 20 °C, humidity of 80.82% and an average rainfall of 2,950 mm per year (Registration Unit-CBG, 2018a). CBG is *ex-situ* plants conservation with various types of plants that mostly originated from Indonesia, more than 60% (Registration Unit-CBG, 2018b), especially from tropical wet highland, and other foreign countries.

In this study, plants collection enrichment was only assessed from three sources of plants acceptance: (1) exploration, (2) donation, (3) self-propagation effort by CBG staff, and (4) seeds exchange (if any). Plant seeds exchange is one of the botanic gardens business in order to develop the conservation value of the garden (Davis, 2008; BGCI, 2012). Nonetheless, along with the increasingly strict regulations in Indonesia (such as *Peraturan Pemerintah Republik Indonesia Nomor 7 Tahun 1999* and *Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor P.106/MENLHK/SETJEN/ KUM.1/12/2018*), then this effort is restricted by CBG.

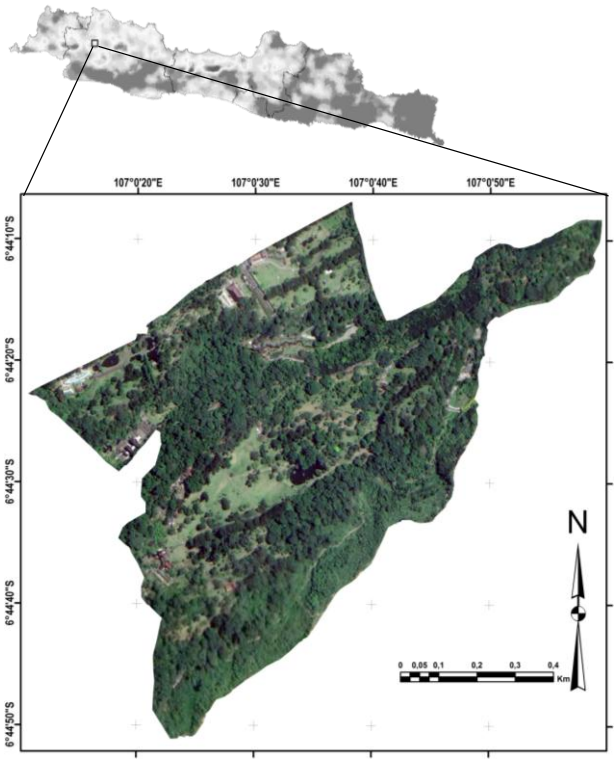

Figure 1. Study area at Cibodas Botanic Garden.

A plant can be referred to as enrichment of garden collection if it has been through a series of the registration process and finally determined as the addition of garden collection. The number of plants enrichment was assessed from 2008 to 2018. In each year, will be analyzed the number of enrichment, the sources of acceptance and plants species were dominated planted in the garden. Then, statistically will be analyzed the addition of each year. The trend of adding number of the collections was done through a simple regression analysis by formula: $y_i = a + bx_i$.

Moreover, it will be explained plants species which have a high conservation value, such as a threatened or vulnerable, etc., based on International Union for the Conservation of Nature (IUCN) status and/or has no collection in the garden. This is expected to give an explanation of CBG contribution efforts in *ex-situ* plants conservation, and for further research and education purposes.

Results and Discussion

The number of addition and the sources of the plant

Based on 2008 to 2018 data, plants collection addition of CBG was experienced increased (Table 1). In totally, plants collection resulted from exploration were dominated as much as 248 specimens, donation 217

specimens, self-propagation seven specimens, and one specimen from seeds exchange. The specimen is *Acacia caffra* (Leguminosae) that accepted from Johannesburg Botanic Garden, South Africa in 2002 and planted in 2014 (Registration Unit-CBG, 2018b). Because of the increasingly strict regulations in Indonesia about flora and fauna transfer materials, then this source would not be further explained.

Tabel 1. The additions of CBG's plants collection based on the sources of the acceptance from 2008 to 2018.

Year	Sources of the plants acceptance			
	Explo-ration	Dona-tion	Self propagation	Seed exchange
2008	8	1	0	0
2009	24	20	1	0
2010	21	20	1	0
2011	33	16	2	0
2012	5	1	1	0
2013	6	30	0	0
2014	37	91	1	1
2015	15	8	0	0
2016	15	5	0	0
2017	50	17	1	0
2018	34	8	0	0
Total	**248**	**217**	**7**	**1**

Plants collection in exploration activity was an act of taking plant materials both seedlings, cuttings or seeds of plant, from the original habitat, which would later be re-planted and breed at CBG. List of priority plants that would be collected from the field, previously conducted through literature study, inventory and recommendations from the nursery and registration unit of CBG, consultation with the Research Center of Biology-*LIPI*, and the recommendations of the Ministry of Environment and Forestry. Nevertheless, it was possible to be done a plants collection outer of the list that meets the requirements of priority plants (e.g. unique or endangered, or had a high potential value of economic, ethno-botany, ornamental, development of the science, or other values).

Based on Figure 2, the addition of plants collection was significantly rising each year. The most addition was occured in 2014, with totally as much as 130 specimens (Registration Unit-CBG, 2018b). These planted plants were related to the number of availability of plants stock. The more plants stock are ready for planting, then the more of planting can be conducted.

More than 50% of enrichment in the last decade came from exploration effort. In each exploration trip, they can collect an average 300 to 400 of live plant specimens in the form of seedlings, seeds or cuttings. After maintenance and with an average survival rate above 60%, each year CBG has sufficient plant stock in the framework of the collection enrichment, besides from other sources. Nevertheless, in 2014, 2015 and 2016 the contribution of exploration result has decreased in enriching the garden collection than a donation (Figure 2). This was due to the plants from the exploration from 2014 to 2016 still many in the maintenance phase, and not ready to be set as ready to be planted.

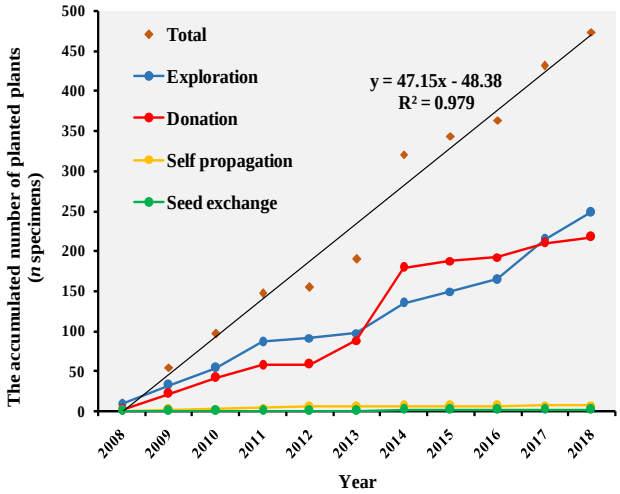

Figure 2. The trend of planted plants to be the garden collections at CBG.

Based on source, plants from exploration originated from Sumatran mountains as much as 163 specimens and Javan mountains 62 specimens (Table 2). Plants from Sumatran mountains were dominated because since 2006 CBG has routinely conducted exploration activities and plants collection, as part of *ex-situ* conservation, with a focus on plants of the mountains in Sumatra.

Table 2. Originated plants from exploration effort.

No.	Area of exploration	The number of plants (*n*- specimens)
1.	Sumatra	163
2.	Java	62
3.	Papua	11
4.	Unidentified*)	7
5.	East Nusa Tenggara	3
6.	Sulawesi	2

Note: unidentified occurred because recorded data may only show the origin of "Indonesia" in general. *Source*: Registration Unit-CBG, 2018b.

The activities were conducted once or twice a year depends on institution budget. These efforts were expected to help conserve threatened species in their natural habitat and as a part of *ex-situ* conservation (Richards *et al*., 2007). The few explorations location that conducted in Sumatra is mount Ledang, mount Sago Malintang, mount Singgalang, mount Marapi (West Sumatra), mount Dempo (South Sumatra), Mount Leuser National Park (Aceh), Kerinci Seblat National Park (Jambi), mount Patah (Bengkulu) and mount Tanggamus and mount Pesagi (Lampung). The Java exploration conducted in mount Slamet, mount Kemulan-Dieng (Central Java), Mount Salak Halimun National Park, Mount Gede Pangrango National Park, Mount Ciremai National Park (West Java). CBG has also conducted exploration in mount Pampunami, mount Kapit Atosambun, mount Simbiedip (Manokwari-Papua), mount Wanggameti (East Nusa Tenggara) and mount Rantemario (South Sulawesi).

After taking the plants from their natural habitat, the next phase is maintenance. The maintenance phase plays a very important role, as it provides ready-to-plant plant stock. Based on Bradi & Well (2014), a good growth medium has four main functions, there are nutrients suppliers and roots medium, provides water and water catchment, provides air circulation for roots respiration, and for the medium of plants development. Hartmann *et al.* (2010), a good medium has several requirements, which are the ability to preserve humidity, good aeration and drainage, low salinity and clear from pests and diseases.

In the maintenance phase, each plant specimen was grown in different medium to adapt their natural habitat in the wild (Hartmann *et al.*, 2010). Growth medium has previously given *Furadan* at a dose of 7.5 to 10 g per sack sized 40-50 kg, in order to prevent disruption of worms and termites (Abd-El-Khair *et al.*, 2019). Plants seedling and terrestrial orchids were grown in forest compost medium and paddy husks with a ratio of 1:1. Epiphyte orchids were grown by using growth medium in the form of chopped ferns, and Rhododendrons were grown in the growth medium of a mashed root of *Kadaka* (Haryati & Siampa, 2018; Sari *et al*., 2018). Growth medium as maturate place of roots organ is an environmental factor which influences the seedling growth of plants.

The next source that enriches the collection was the donation. The donation can be originated from institution, corporation or private. Along 2008 to 2018, there were 217 specimens originated from donation. The number of local donation is 189 specimens and 28 specimens came from foreign donation. The foreign institutions that donate were Kunming Botanical Garden and Xishuangbanna Tropical Botanical Garden (China), Botanischer Garten der Universitat Tubingen and Botanischer Garten der Martin-Luther-Deutschland (Germany), University of Athens (Greece).

The number of planted plants from foreign donation is described in Figure 3. Furthermore, the local institutions have also contributed the donation. They were Tahura Juanda (Bandung), Komatsu Project (P3HKA) - Department of Forestry (Bogor), Kuningan Botanic Garden (Kuningan), *Hutan Adat* Tau Taa Wana (Central Sulawesi), mount Halimun Salak National Park (Bogor), etc.

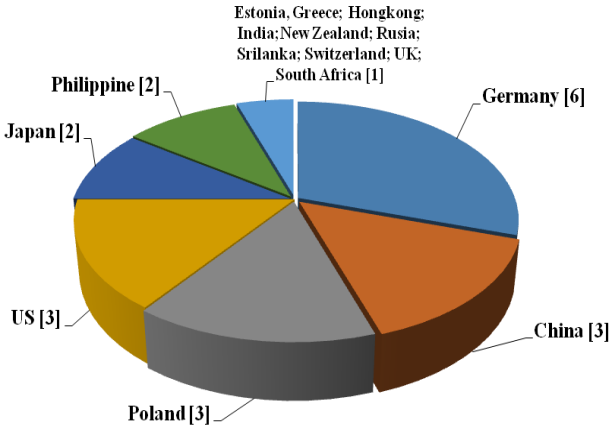

Figure 3. The donation from foreign institutions and the number of its planted plants.

Some corporations and privates, both foreign and local, have also contributed to donate some plants to CBG. Some of them are PT EISAI (Sukabumi), PT Kimia Farma (Bandung), Linggarjati Indah (Kuningan), PT Indo-Pacific (Jakarta), Mustika Ratu (Bogor), etc., and some researchers from local and foreign (the identity of private contributors were not displayed in order to keep the privacy).

Next, in order to develop the number of the garden plants, it also conducted self-propagation by staff of CBG. The seven plants that propagated (Table 1) because the number is limited. The details of the plants were described in Table 3.

Table 3. The plant species that self propagated by CBG's staff.

Year	Species	Familia
2009	*Allocasuarina paludosa*	Casuarinaceae
2010	*Pilocarpus selloanus*	Rutaceae
2011	*Cinchona calisaya*	Rubiaceae
2011	*Xanthorrhoea presii*	Xanthorrhoeaceae
2012	*Retrophyllum vitiense*	Podocarpaceae
2014	*Enterolobium cyclocarpum*	Leguminosae
2017	*Anigozanthos manglesii*	Haemodoraceae

The diversity of the plants and the importance value to conservation

Furthermore, based on the data, species which planted as collection were dominated by the family of Nepenthaceae 84 specimens, Phyllantaceae 21 specimens, Lauraceae 15 specimens, Annonaceae and Leguminosae 14 specimens, Rosaceae and Rutaceae 12 specimens, Rubiaceae 11 specimens, Araliaceae and Malvaceae were 10 specimens (Figure 4a).

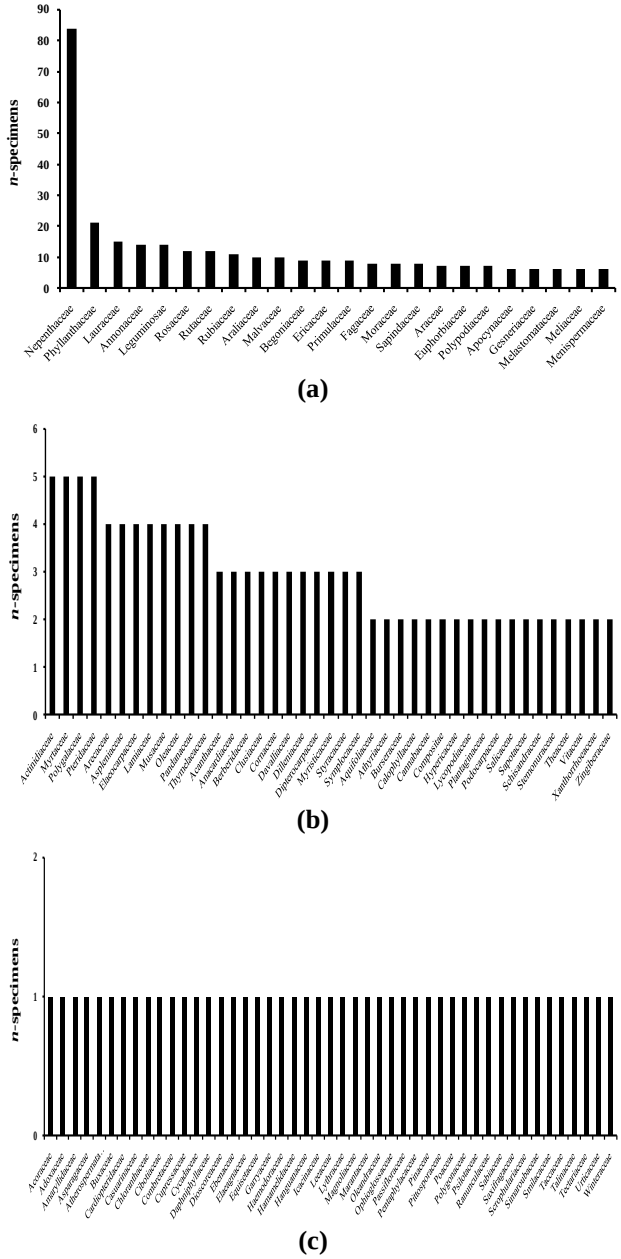

Figure 4. The number of planted plants based on familia: (a) the most planted to six specimens; (b) five to two specimens; (c) only one specimen.

Van Steenis (2006) claimed that some families such as Arecaceae, Araucariaceae, Clethraceae, Cunoniaceae, Ericaceae, Fagaceae, Lauraceae, Myrtaceae, Pentaphylaceae, Podocarpaceae, Symplocaceae and Theaceae were a better presence in medium and high elevation than in the lowlands. Each plant has an adaptation mechanism which enables to life adjacent to the surrounding environment. Environment parameters are determining ecological habitat in most of the plants. The interacted factors with a physiological mechanism of plants are temperature, lighting duration, wind, and humidity.

CBG with an altitude of approximately 1,200 to 1,425 meters above sea level and the number of wet months more than dry months, between seven to eight months per year (Widyatmoko *et al.*, 2010), is a suitable location for the breeding of typical of tropical mountainous plants. In addition, besides typical plants of the tropical mountainous, planted specimens in CBG had also come from various species of lowland plants, such as the family of Dipterocarpaceae and Myristicaceae.

In a conservation term, it is important to use the justification restriction for traditional and also the conservation introductions. It needs a well understanding that some species have threats within their range that may cause extinction, therefore the existing reintroduction guidelines excuse conservation introductions only if there are no viable sites within a species range.

Based on the data, the most planted plants dominated by *Nepenthes* spp. (Figure 4). There were as much as 84 specimens of Nepenthes has planted at CBG in the last decade. Nepenthes has an importance value to conservation because over half of these carnivorous plant species assessed by the IUCN are listed as threatened (i.e., vulnerable, endangered, or critically endangered).

There presently are around 600 described species of these plants from 17 genera (Ellison & Gotelli, 2009), with new species frequently being described (Cheek & Jebb, 2009; Mann, 2007). There have been many studies regarding carnivorous plant conservation threats, and the threats as a group are also frequently represented (Schnell, 2002).

Of the 122 Nepenthes species that have been evaluated by the IUCN, ten are listed as critically endangered, 14 are listed as endangered, and 21 are listed as vulnerable (IUCN, 2019). Consequently, of these IUCN-evaluated species, 37% is considered a threatened. The threats to carnivorous plants have not formerly been quantified in any systematic method. These also often have complex interactions with animals aside from receiving nutrients from them For these threats, then CBG considers the need for immediate conservation efforts. The planted plants list and the conservation status of this species can be described in Table 4.

Table 4. Species from *Nepenthes* spp. planted in CBG from 2008 to 2018.

No.	Species	The number of plants (*n*-specimens)	Conservation status*)
1.	*Nepenthes maxima*	7	LC
2.	*Nepenthes rafflesiana*	4	LC
3.	*Nepenthes spathulata*	4	LC
4.	*Nepenthes tobaica*	4	LC
5.	*Nepenthes adnata*	3	EN
6.	*Nepenthes eustachys*	3	No data and/ or unthreatened
7.	*Nepenthes mirabilis*	3	LC
8.	*Nepenthes veitchii*	3	LC
9.	*N. albomarginata, N. ampullaria, N. beccariana, N. gracilis, N. gymnamphora, N. hirsuta, N. jacquelineae, N. pectinata, N. stenophylla, N. tomoriana, N. truncata*	2	Mostly LC (except *N. beccariana* and *N. jacquelineae* are no data and/ or unthreatened); EN (*N. truncata*)
10.	*N. alata, N. aristolochioides, N. bicalcarata, N. clipeata, N. distillatoria, N. dubia, N. fusca, N. glabratus, N. inermis, N. izumiae, N. jamban, N. kerrii, N. khasiana, N. longifolia, N. lowii, N. macfarlanei, N. merrilliana, N. murudensis, N. naga, N. neoguineensis, N. northiana, N. petiolata, N. ramispina, N. reinwardtiana, N. sanguinea, N. singalana, N. smilesii, N. spectabilis, N. talangensis, N. tentaculata, N. thorelii*	1	DD (*N. thorelii*); Mostly LC (except *N. glabratus* and *N. jamban* are no data and/ or unthreatened); VU (*N. bicalcarata, N. distillatoria, N. lowii, N. merrilliana, N. naga, N. northiana, N. petiolata, N. ramispina, N. spectabilis*); EN (*N. khasiana, N. talangensis*) to CR (*N. aristolochioides, N. clipeata, N. dubia*)

Note: *) IUCN conservation status [accessed: July 7th 2019], DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered.

Based on planted Nepenthes, of sixteen species (19 specimens) were included a threatened species (IUCN, 2019), with totally 50 species were planted (Table 4). *N. aristolochioides, N. clipeata,* and *N. dubia* are the most threatened with the status of "critically endangered" (IUCN, 2019). In order to minimize the possible damages and to maximize the maintenance, the collections were maintained in the greenhouse.

Beside *Nepenthes* spp., the importance value of the planted plants in CBG from 2008 to 2018 has come from diverse species. These species have not only enriched the garden collection but also has the important value to conservation. There are 71 different species included need to be conserved (Table 5). Of these species, there are 12 species being threatened in nature (IUCN, 2019).

Furthermore, *Dipterocarpus cornutus* (Dipt.), *Hibiscus storckii* (Malv.) and *Psilotum nudum* (Psil.) are the most threatened species with status "critically endangered" (CR). The secondly are *Cycas riuminiana* (Cycad.), *Sequoia sempervirens* (Cupr.), *Shorea javanica* and *Shorea platyclados* (Dipt.) with status "endangered" (EN). Next, *Aquilaria filaria* (Thym.), *Horsfieldia glabra* (Myrist.), *Khaya anthotheca* (Meliac.), *Macropanax concinnus* (Aral.) and *Saurauia lanceolata* (Actin.) are also included threatened with status "vulnerable" (VU) (Table 5).

In general, the plant materials which taken from their natural habitat, especially from exploration effort, wherever possible has similar climatic and environmental conditions to their introduction site (Maschinski & Albrecht, 2017), in this case, CBG. This recommendation is supported by studies that show plant community and habitat type matching of the source material to the re-introduction site is often more important than other factors (e.g., geographic distance) for long-term survival of rare plant reintroductions (Noel *et.al*., 2011).

Therefore, the selection and prioritization of threatened species of CBG for *ex-situ* management continue to be a serious challenge. These decisions are guided by a variety of criteria, including the level of threat; legislative and institutional responsibilities; the probability of successful storage and reintroduction; cost-effectiveness; relevant social, political, and economic issues; and curatorial preferences (Havens *et al.*, 2006).

Tabel 5. The diversity of the planted plants in CBG that has conservation value*), from 2008 to 2018.

No.	Species	Familia	Conservation status	The number of plants (*n*-specimens)
1.	*Cinnamomum heyneanum*	Lauraceae	DD	1
2.	*Pandanus tectorius*	Pandanaceae	DD	1
3.	*Acorus calamus*	Acoraceae	LC	1
4.	*Adinandra dumosa*	Pentaphylacaceae	LC	1
5.	*Aglaia tomentosa*	Meliaceae	LC	1
6.	*Aidia racemosa*	Rubiaceae	LC	1
7.	*Alangium javanicum*	Cornaceae	LC	1
8.	*Aleurites moluccanus*	Euphorbiaceae	LC	2
9.	*Antidesma bunius*	Phyllanthaceae	LC	1
10.	*Antidesma montanum*	Phyllanthaceae	LC	1
11.	*Aralia dasyphylla*	Araliaceae	LC	1
12.	*Cinchona calisaya*	Rubiaceae	LC	1
13.	*Cleistanthus oblongifolius*	Phyllanthaceae	LC	1
14.	*Coffea canephora*	Rubiaceae	LC	2
15.	*Cyathocalyx sumatranus*	Annonaceae	LC	1
16.	*Debregeasia longifolia*	Urticaceae	LC	1
17.	*Dillenia reticulata*	Dilleniaceae	LC	1
18.	*Diplazium esculentum*	Athyriaceae	LC	1
19.	*Elaeagnus conferta*	Elaeagnaceae	LC	1
20.	*Elaeocarpus petiolatus*	Elaeocarpaceae	LC	1
21.	*Enterolobium cyclocarpum*	Leguminosae	LC	1
22.	*Equisetum ramosissimum*	Equisetaceae	LC	1
23.	*Etlingera megalocheilos*	Zingiberaceae	LC	1
24.	*Ficus grossularioides*	Moraceae	LC	1
25.	*Ficus subulata*	Moraceae	LC	1
26.	*Garcinia burkillii*	Clusiaceae	LC	1
27.	*Garcinia dulcis*	Clusiaceae	LC	1
28.	*Guazuma ulmifolia*	Malvaceae	LC	1
29.	*Hanguana malayana*	Hanguanaceae	LC	1
30.	*Harpullia arborea*	Sapindaceae	LC	1
31.	*Ilex cymosa*	Aquifoliaceae	LC	1
32.	*Ilex micrococca*	Aquifoliaceae	LC	1
33.	*Macaranga tanarius*	Euphorbiaceae	LC	1
34.	*Maesa ramentacea*	Primulaceae	LC	1
35.	*Magnolia ovata*	Magnoliaceae	LC	1
36.	*Mallotus paniculatus*	Euphorbiaceae	LC	1
37.	*Mangifera foetida*	Anacardiaceae	LC	1
38.	*Maniltoa grandiflora*	Leguminosae	LC	1
39.	*Musa acuminata*	Musaceae	LC	1
40.	*Musa zebrina*	Musaceae	LC	1
41.	*Ophioglossum reticulatum*	Ophioglossaceae	LC	1
42.	*Osmanthus fragrans*	Oleaceae	LC	2
43.	*Photinia integrifolia*	Rosaceae	LC	1

continued...

44.	*Phyllocladus hypophyllus*	Podocarpaceae	LC	1
45.	*Pinus pinea*	Pinaceae	LC	1
46.	*Planchonella duclitan*	Sapotaceae	LC	1
47.	*Quercus pubescens*	Fagaceae	LC	1
48.	*Retrophyllum vitiense*	Podocarpaceae	LC	1
49.	*Sambucus nigra*	Adoxaceae	LC	1
50.	*Sandoricum koetjape*	Meliaceae	LC	1
51.	*Saurauia tristyla*	Actinidiaceae	LC	2
52.	*Schima wallichii*	Theaceae	LC	1
53.	*Sesbania sesban*	Leguminosae	LC	1
54.	*Sorbus corymbifera*	Rosaceae	LC	1
55.	*Tetradium daniellii*	Rutaceae	LC	1
56.	*Tipuana tipu*	Leguminosae	LC	1
57.	*Trevesia palmata*	Araliaceae	LC	1
58.	*Aglaia leptantha*	Meliaceae	NT	1
59.	*Aglaia silvestris*	Meliaceae	NT	1
60.	*Aquilaria filaria*	Thymelaeaceae	VU	1
61.	*Horsfieldia glabra*	Myristicaceae	VU	3
62.	*Khaya anthotheca*	Meliaceae	VU	1
63.	*Macropanax concinnus*	Araliaceae	VU	1
64.	*Saurauia lanceolata*	Actinidiaceae	VU	1
65.	*Cycas riuminiana*	Cycadaceae	EN	1
66.	*Sequoia sempervirens*	Cupressaceae	EN	1
67.	*Shorea javanica*	Dipterocarpaceae	EN	1
68.	*Shorea platyclados*	Dipterocarpaceae	EN	1
69.	*Dipterocarpus cornutus*	Dipterocarpaceae	CR	1
70.	*Hibiscus storckii*	Malvaceae	CR	1
71.	*Psilotum nudum*	Psilotaceae	CR	1

Noted: The list arranged alphabetically of each category of conservation status and started from the lowest to the most threatened. *) IUCN conservation status [accessed: July 7th 2019], DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered.

Whenever possible, target species for *ex-situ* management should be identified before they experience catastrophic declines, because the chances of successful recovery and reintroduction can be severely reduced when sampling genetically depauperate populations (Maunder *et al.*, 1999), and because sampling numerically small populations has a proportionally greater impact on population viability (Menges *et al.*, 2004).

In order to maintain the survivorship, CBG conducted some efforts to alleviate the threats or eliminated prior to introduction. Nursery area at CBG is set into a desirable site which has biological and physical features (community composition, topography, soil type, microclimate, etc.) similar to those of plants. Plant conditions monitored daily by paying attention to the condition of planting media, fertilizing, watering and doing the pest and disease management, as well as the ability of the growth and development.

CBG as an *ex-situ* conservation area also conducts an edu-ecotourism effort. The plants were planted by following the taxa-relationship and considering the proportion design of the comfortable view. Although the advantages of the green space are intangible, however, the vegetation is of substantial value to providing the community with a social communal area. This emphasizes the existence of CBG as an important conservation area for the environment and surrounding communities.

Based on the addition, it was expected to provide the added value to the efforts of *ex-situ* plants conservation, and roles in the development of research and education. The collection addition is only a part of the conservation efforts conducted by CBG. Existing plants conservation efforts are not only limited to the enrichment, but also how CBGs can disseminate them to the wider community. This intended that the efforts are more leverage and able to generate public awareness.

Conclusions

In the last decade, CBG has tended to increase the addition of plants collection of the garden. More than half of the addition acquired from exploration and plants collection that organized to help conserve threatened plant species. This effort is still continuously conducted by CBG as a part of *ex-situ* plants conservation. As much as 32.6% of preserved specimens have an important value to the plants conservation, and almost half of the specimens (49.3%) were *Nepenthes* spp. and the rest are from Angiosperms. *N. aristolochioides*, *N. clipeata*, *N. dubia* (Nepenthes), and *H. storckii* and *P. nudum* (Angiosperms) are the most threatened species. These collection addition and the background efforts to achieve it were only half part of the conservation efforts conducted by CBG. The existing plant conservation efforts are not only limited to enrich the garden collection but also how CBGs can disseminate them at once to generate the awareness to the wider community.

Acknowledgements

Our grateful towards all staff of CBGs' Registration Unit, Didi Rasidi, Habibulloh, Puji Soepriati, Yudi Suhendri, and Agus Darmawan for cooperation in data compilation. This paper expected to be our small contribution in disseminating the information and knowledge about CBG towards the scientific community and the public.

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