

Establishing a long-term permanent plot in remnant forest of Cibodas Botanic Garden, West Java

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ABSTRACT

Mutaqien Z, Zuhri M (2011) *Establishing a long-term permanent plot in remnant forest of Cibodas Botanic Garden, West Java. Biodiversitas 12: 218-224.* Cibodas Botanic Garden (CBG) has unique characters; almost 10% of which is forested area adjacent to the natural forest of Mt. Gede Pangrango National Park. The area is a transition between natural forest and artificial habitat which mostly consists of exotic plant species. The permanent plot in CBG was established in 2007-2009. Two hundred and eighty four units of 10x10 square meters sub-plot were established in four locations, i.e. Wornojiwo, Kompos, Jalan Akar, and Lumut forest. Vegetation analyses were conducted for trees, saplings, shrubs, and herb species. The inventory found 137 species plants consisting of 74 tree species dominated by *Villebrunea rubescens* (Bl.) Bl. and *Ostodes paniculata* Bl., 30 shrub species dominated by *Strobilanthes hamiltoniana* (Steud.), 24 herb species dominated by *Cyrtandra picta* Bl., 6 fern species mainly consisted of *Diplazium pallidum* Moore, and 3 climber species dominated by *Calamus reinwardtii* Mart. In comparison with the natural forest of Mt. Gede Pangrango National Park, the CBG permanent plot showed a good representative of the vegetation of lower montane forest. A regular monitoring during the successive years is needed to maintain diversity, monitor forest dynamics and anticipate the spread of invasive plant from CBG.

Key words: Cibodas Botanic Garden, permanent plots, remnant forest.

INTRODUCTION

Cibodas Botanic Garden (CBG) was used as an experimental plot for the introduction of *Cinchona* to Indonesia. When it was stated as a biological station and forest reserve, the area was extended up to 1,200 ha covering from Cibodas to the summit of Mount Gede and Pangrango (Dakkus 1945; van Leeuwen 1945; Soerohaldoko et al. 2006). It was a well-known area for classical spot of botanical investigation. More than 8,000 studies were conducted in this area. Some of them were conducted by famous botanist such as; Reinwardt, Blume, Junghuhn, Treub, Zollinger, Teysmann, Koorders, Backer, Bakhuizen van den Brink Jr., von Faber, van Leeuwen and van Steenis (Meijer 1959; van Steenis 1972; Arrijani 2008).

CBG is managed by the Indonesian Institute of Sciences (LIPI) at present. It conserves about 6,764 individual plants from 1,270 species and 204 families. Ten percent of CBG is a forested area. It consists of fragmented forest and border forest adjacent to the natural forest of Mount Gede Pangrango National Park. The forested area is important to maintain genetic diversity which uncovered by the small number of plant collection of botanic garden (Hurka et al. 2004). Remnant forest of CBG also played important role as buffer zone between the garden and Mount Gede-Pangrango National Park to restrict the alien species plant possibly escape from CBG collection. Some researchers have been addressed non-native species colonization at the interface between protected areas and human-dominated

systems (Pysek et al. 2003; Alston and Richardson 2006). The establishment of buffer zones around protected areas is often included on management strategy of plant invasions (Llewellyn et al. 2010).

The remnant forest of CBG has a potential to be developed as a field laboratory and environmental education. The composition and the dynamic of the forest are interesting to be studied. The 2.84 hectare plot was build in 2007 to 2009. It was set to monitor plant diversity and to collect long-term data on the growth, mortality, regeneration, and dynamics of forest. Ten years observation is needed to state it as a long term permanent plot (Bakker et al. 1996).

This paper aims to assess the eligibility of permanent plot in CBG which presented by the preliminary forest inventory data and it comparison with the natural forest vegetation. Hopefully our permanent plot will be a model for lower montane tropical forest vegetation dynamics.

MATERIALS AND METHODS

Cibodas Botanic Garden is located on the foothill of Mount Gede, Cipanas, Cianjur, West Java. CBG is situated at lower montane zone (1,300-1,425 m asl.). The annual rainfall is 2,950 mm/year, average temperature is 20°C and relative humidity is 80%. Permanent plots were established on four of remnant forests sites inside CBG, i.e. Wornojiwo (PW), Kompos (PK), Jalan Akar (PJA), and Lumut Forest (PL). Wornojiwo and Kompos are fragmented forests

inside the CBG and two others are forest border of Mount Gede Pangrango National Park (Figure 1).

The plots are divided into 10x10 m² sub-plots. Total area and number of sub-plots on each site are presented on Table 1. Sub-plot numbers on each site were limited by large area and topographical aspect.

A rapid vegetation assessment was conducted in April-June 2010. Vegetation data was collected using purposive random sampling. Stands were classified into trees, saplings, shrubs, and herbs. Each tree were identified, marked, tagged, and measured (diameter at breast height (dbh), height, and canopy size). Saplings, shrubs, and herbs were identified and their abundance were measured.

Table 1. Total area and number of sub-plots

Site	Area (ha)	Number of sub-plots
Wornojiwo Forest (PW)	3.934	180
Kompos Forest (PK)	2.555	60
Jalan Akar Forest (PJA)	1.086	32
Lumut Forest (PL)	0.855	12
Total	8.43	284

The result of plot inventory data was compared to two plots (1 ha in each) of natural forest vegetation. One plot was located at the edge of the Mount Gede-Pangrango National Park (200 m from the garden) and another one

was located at the interior of the national park forest (1 km from the garden). Parameter such as species richness, Shannon-Wiener diversity index (Odum 1971), species evenness (Heip 1974) and similarity index (Krebs 1999) was used to compare it.

RESULTS AND DISCUSSION

Vegetation of CBG's remnant forest

There are 137 plant species at the remnant forest, which consists of 74 tree species, 30 shrub species, 23 herb species, 6 fern species, and 4 climber species (Table 2). Only 36 tree species reach more than 10 cm in diameter, while 61 species were found as sapling (dbh<10 cm). Tree density was reached 306 tree/ha and tree biomass was achieved 699.24 ton/ha.

Table 2. Total species in the life form classes of CBG's remnant forest

Life form	Number of species
Tree	74
Shrub	30
Herb	23
Fern	6
Climber	4
Total	137

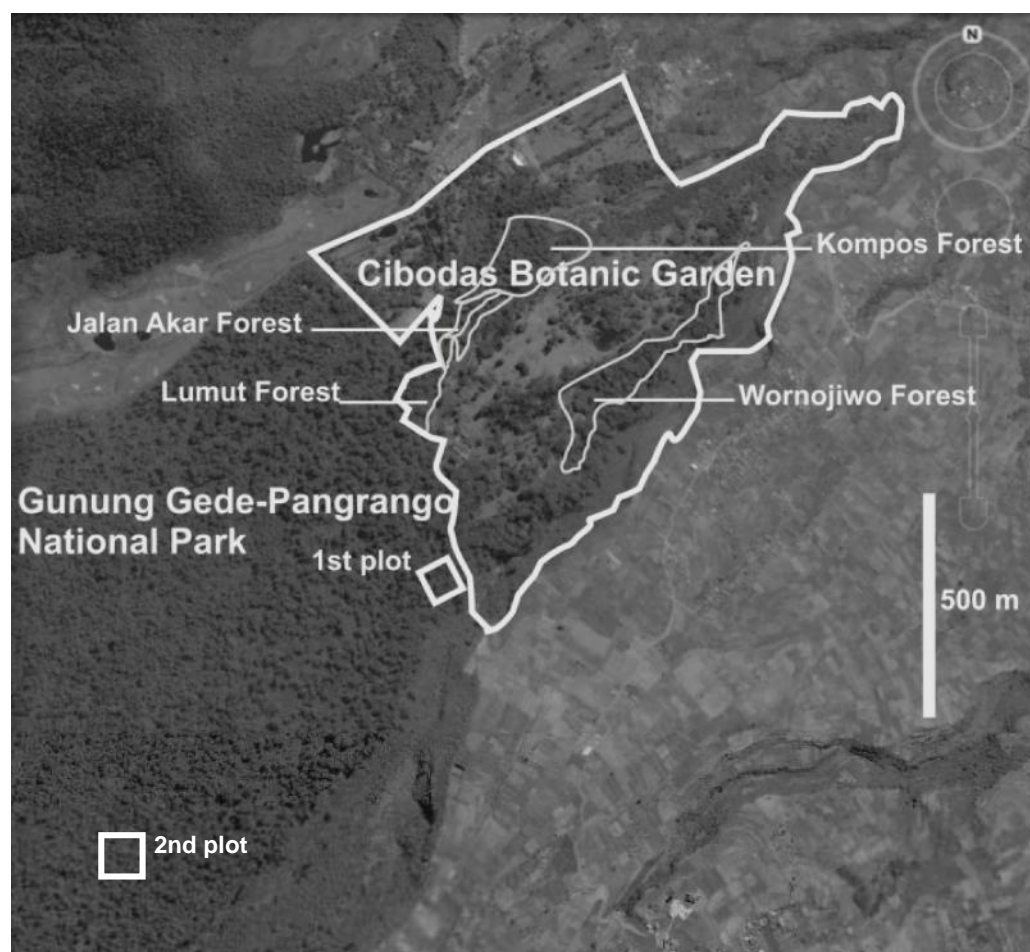
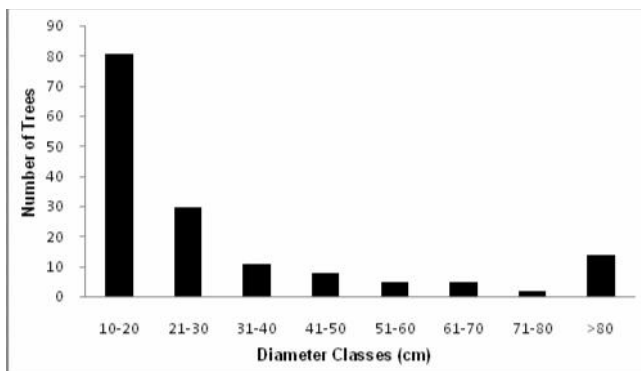


Figure 1. Location of permanent plot on Cibodas Botanical Garden

Table 3. Class diameter of trees of CBG's remnant forest

Tree species	Class diameter								Tree number
	10-20 cm	21-30 cm	31-40 cm	41-50 cm	51-60 cm	61-70 cm	71-80 cm	> 80 cm	
<i>Villebrunea rubescens</i> (Bl.) Bl.	33	3	1	1					38
<i>Ostodes paniculata</i> Bl.	7	11	3	3					24
<i>Macropanax dispernum</i> (Bl.) Kuntze	8	5	5						18
<i>Castanopsis argentea</i> (Bl.) A. DC.	1	1			1	2	1	7	13
<i>Ficus ribes</i> Reinw. Ex Bl.	8	1							9
<i>Saurauia pendula</i> Bl.	2	2							4
<i>Decaspermum</i> sp.	4								4
<i>Cestrum aurantiacum</i> Lindl.	3	1							4
<i>Ficus fistulosa</i> Reinw. Ex Bl.	2							1	3
<i>Elaeocarpus oxypirens</i> Koord. & Val.	2			1					3
<i>Dysoxylum nutans</i> Miq	1	1					1		3
<i>Castanopsis javanica</i> (Bl.) A. DC								3	3
<i>Altingia excelsa</i> Noronha				2				1	3
<i>Saurauia reinwardtiana</i> Bl.	1		1						2
<i>Lithocarpus indutus</i> (Bl.) Rehder						2			2
<i>Ficus variegata</i> Bl.		2							2
<i>Ficus heterophylla</i> Blanco	2								2
<i>Viburnum sambucinum</i> Reinw. ex Bl.	1								1
<i>Turpinia sphaerocarpa</i> Hassk.	1								1
<i>Trema orientalis</i> Bl.				1					1
<i>Toona sureni</i> Merr.		1							1
<i>Schima wallichii</i> Choisy						1			1
<i>Saurauia cauliflora</i> DC.		1							1
<i>Rauvolfia javanica</i> Koord. & Val.				1					1
<i>Prunus arborea</i> (Bl.) Kalkman	1								1
<i>Persea rimosa</i> Zoll. Ex Meissner								1	1
<i>Neonauclea obtusa</i> Bl.					1				1
<i>Lithocarpus pallidus</i> (Bl.) Rehder					1				1
<i>Helicia serrata</i> Bl.	1								1
<i>Fagraea</i> sp.	1								1
<i>Ficus lepicarpa</i> Bl.	1								1
<i>Eurya</i> sp.	1								1
<i>Elaeocarpus sphaericus</i> Schum.			1						1
<i>Elaeocarpus angustifolius</i> Bl.		1							1
<i>Bridelia</i> sp.					1				1
<i>Acer laurinum</i> Hassk.								1	1
	81	30	11	8	5	5	2	14	156

**Figure 2.** Distribution of tree class diameter of CBG's remnant forest

Villebrunea rubescens and *Ostodes paniculata* are the two most common trees, but they never reach more than 50 cm in diameter (Table 3). As the small diameter trees, their

high abundance is related to colonization and turnover rate in the disturbed forest (Whitmore 1975). Furthermore, hurricane occurring in 1976 (Yamada 2010. *pers. comm.* 17 July) and 1984 in Cibodas (Whitten and Whitten 1996) might change the dynamics and increase the abundance of typical species of secondary forest (*V. rubescens*) and the pioneer species (i.e. *O. paniculata*). Disturbance in secondary forest would be advantageous for short-lived, light demanding, and fast growing species as well as for most pioneer species at gap sites in mature forests (Brokaw 1985). These growth traits affect largely the stand structure (Yoneda 2006).

Castanopsis argentea (chestnut) is presents almost in all class diameter and relatively easy to be found. This plant is relatively big and has heavy fruit which makes it poorly adapted for long-distance dispersal. It is typical of laurophyll forest dominated by evergreen Fagaceae. Heriyanto et al. (2007) stated that the highest distribution of *C. argentea* is around 1,400 m asl.

Altingia excelsa is one of the emergent trees in the lower montane forest. The biggest *A. excelsa* founded in this study reaching 170 cm diameter and laid in *C. argentea* canopy. *A. excelsa* is major trees species in the altitude 1,500-1,800 m asl and give the highest contribution to its community (Seifrizz 1923; Arrijani 2008). Therefore, Seifrizz (1923) was divided the vegetation of Mount Gede into 5 zone, one of which was rasamala (*A. excelsa*) sub-zone.

Distribution of tree diameter is a tool to describe the forest regeneration through age structure of tree. In our

study, the distribution of tree in the CBG's remnant forest based on class diameter follows J-inverse curve (Figure 2). This shape showed the common patterns of tropical forest dynamics (Ogawa et al. 1965), similar to Meijer plot on lower mountain forest of Mount Gede (Meijer 1959), natural forest of Mount Papandayan (Setiawan and Sulistyawati 2008), lowland forest of Batang Gadis National Park (Kartawinata et al. 2004), lowland forest in Northern Siberut (Hadi et al. 2009) and lowland forest in Batanta Island, Raja Ampat (Mirmanto 2009).

Strobilanthes hamiltoniana (Steud), *Dichroa febrifuga* Lour., *Polyalthia subcordata* (Bl.) Bl., and *Dendrocnide stimulan* (L.f.) Chew are the most common species in shrub layer (Table 4). In the herb layer, *Cyrtandra picta* Bl., *Calathea lietzei* E. Morren, *Elatostema nigrescens* Miq, and *E. cuneatum* Wight are abundant. *Diplazium pallidum* (Bl.) T. Moore and *Calamus reinwardtii* Mart. are also abundant at the fern and climber life form, respectively.

Table 4. Species of shrub, herb, fern, and climber, as well as saplings of CBG's remnant forest

Shrub	Sapling
<i>Allophylus cobbe</i> (L.) Raeusch	<i>Acer laurinum</i> Hassk.
<i>Ardisia crenata</i> Sims	<i>Alangium rotundifolium</i> (Hassk.) Bloemb.
<i>A. villosa</i> Roxb.	<i>Alangium</i> sp.
<i>A. fuliginosa</i> Bl.	<i>Antidesma tetrandrum</i> Bl.
<i>Ardisia</i> sp.	<i>Bonnetia</i> sp.
<i>Bocconia frutescens</i> L.	<i>Casearia coriacea</i> Vent.
<i>Breynia microphylla</i> (Kuzweil ex Teijsm. & Binn.) Müll. Arg.	<i>Castanopsis argentea</i> (Bl.) A. DC.
<i>Bridelia multiflora</i> Zipp. ex Scheff.	<i>C. javanica</i> (Bl.) A. DC.
<i>Clerodendrum eriosiphon</i> Schau	<i>C. tungurrut</i> (Bl.) A. DC.
<i>Coffea</i> sp.	<i>Cestrum aurantiacum</i> Lindl. **
<i>Dichroa febrifuga</i> Lour.	<i>Cryptocarya ferrea</i> Bl.
<i>Ficus ampelas</i> K.D. Koenig ex Roxb.	<i>Decaspermum</i> sp.
<i>F. cuspidata</i> Reinw. ex Bl.	<i>Dysoxylum excelsum</i> Bl.
<i>Dendrocnide stimulans</i> (L. f.) Chew	<i>D. nutans</i> Miq.
<i>Lasianthus laevigatus</i> Bl.	<i>Elaeocarpus obtusus</i> Bl.
<i>L. stercorarius</i> Bl.	<i>E. oxypren</i> Koord. & Val.
<i>L. rigidus</i> Miq.	<i>E. pierreii</i> Koord. & Val.
<i>Lasianthus</i> sp.	<i>E. sphaericus</i> Schum.
<i>Magnolia candollei</i> Link	<i>Euonymus javanicus</i> Bl.
<i>Maoutia diversifolia</i> Bl.	<i>Ficus alba</i> Reinw. Ex Bl.
<i>Maoutia</i> sp.	<i>F. fistulosa</i> Reinw. Ex Bl.
<i>Mycetia cauliflora</i> Reinw	<i>F. ribes</i> Reinw. Ex Bl.
<i>Pavetta montana</i> Reinw. ex Bl.	<i>Ficus</i> sp.
<i>Polyalthia subcordata</i> (Bl.) Bl.	<i>Flacourtia rukam</i> Zoll. & Moritzi
<i>Psychotria angulata</i> Korth	<i>Glochidion cyrtostylum</i> Miq.
<i>Saprosma dichotomum</i> (Korth.) Boerl.	<i>Glochidion</i> sp.
<i>Solanum ferox</i> L.	<i>Helicia serrata</i> Bl.
<i>S. verbascifolium</i> L.	<i>Lithocarpus indutus</i> (Bl.) Rehder
<i>Strobilanthes hamiltoniana</i> (Steud.)*	<i>L. pseudomoluccus</i> (Bl.) Rehder
<i>Strobilanthes</i> sp.	<i>Litsea noronhae</i> Bl.
	<i>Macropanax dispernum</i> (Bl.) Kuntze
	<i>Mastixia trichotoma</i> Bl.
Herb	<i>Meliosma ferruginea</i> Bl.
<i>Achyranthes bidentata</i> Bl.	<i>Michelia montana</i> Bl.
<i>Alpinia</i> sp.	<i>Mischocarpus fuscescens</i> Bl.
<i>Amomum coccineum</i> (Bl.) K. Schum.	<i>Neonauclea lanceolata</i> (Bl.) Merr.
<i>Boehmeria rugosissima</i> Miq.	<i>Ostodes paniculata</i> Bl.
<i>Calathea lietzei</i> E. Morren	<i>Persea rimosa</i> Zoll. Ex Meissner
<i>Commelina</i> sp.	<i>Phoebe grandis</i> (Nees) Merr.
<i>Curculigo capitulata</i> (Lour.) Kuntze	<i>Platea latifolia</i> Bl.
<i>Curculigo recurvata</i> W.T. Aiton	<i>Polyalthia subcordata</i> (Bl.) Bl.
<i>Elatostema cuneatum</i> Wight	<i>Polyosma</i> sp.
<i>E. nigrescens</i> Miq.	<i>Pygeum</i> sp.
<i>Cyclosorus</i> sp.	<i>Pyrenaria serrata</i> Bl.
<i>Cyrtandra picta</i> Bl.*	<i>Rauvolfia javanica</i> Koord. & Val.
<i>Forrestia mollissima</i> (Bl.) Koord.	<i>Saurauia cauliflora</i> DC.
<i>Impatiens chonoceras</i> Hassk.	<i>S. pendula</i> Bl.
<i>I. platypetala</i> Hassk.	<i>S. reinwardtiana</i> Reinw. Ex Bl.
<i>Musa acuminata</i> Colla	<i>Schima wallichii</i> Choisy
<i>Nervilia punctata</i> Makino	<i>Sloanea sigun</i> (Bl.) K. Schum.
<i>Pilea angulata</i> (Bl.) Bl.	<i>Symplocos cochinchinensis</i> (Lour.) S. Moore
<i>P. melastomoides</i> (Poir.) Wedd.	<i>Symplocos</i> sp.
<i>Schismatoglottis acuminatissima</i> Schott	<i>Syzygium pycnanthum</i> (Bl.) Merr. & L.M. Perry
<i>Zingiber inflexum</i> Bl.	<i>S. racemosum</i> (Bl.) DC.
<i>Z. odoriferum</i> Bl.	<i>Toona sureni</i> Merr.
	<i>Trevesia sundaica</i> Miq.
Fern	<i>Turpinia montana</i> (Bl.) Kurz
<i>Cyathea contaminans</i> (Wall. ex Hook.) Copel.	<i>T. sphaerocarpa</i> Hassk.
<i>Diplazium bantamense</i> Bl.	<i>Viburnum lutescens</i> Bl.
<i>D. javanicum</i> Makino	<i>Villebrunea rubescens</i> (Bl.) Bl.
<i>D. pallidum</i> * (Bl.) T. Moore	
<i>D. repandum</i> Bl.	
<i>Nephrolepis biserrata</i> (Sw.) Schott	
Climber	
<i>Calamus reinwardtii</i> Mart. *	
<i>Plectocomia elongata</i> Mart. ex Bl.	
<i>Tetrastigma papillosum</i> Planch.	
<i>Smilax zeylanica</i> L.	

Note: * dominant/abundant species; ** alien species

Forest stratification was described by tree height. Figure 3 shows five strata on Wornojiwo forest. The emergent species is *Castanopsis argentea*. Its stratification is correlated with stand basal area which is almost a half of percentage basal area occupied by Fagaceae (Table 5). This value, 32.67 m² ha⁻¹, was higher than the basal area occupied by Fagaceae in a tropical montane forest of Doi Inthanon National Park, Northern Thailand; 8.17 m² ha⁻¹ (Noguchi 2007). The percentage of Fagaceae in CBG remnant forest (49.95%) is much higher than in Padang at the elevation above 700 m; >10% (Nishimura et al. 2006; Fujii et al. 2006). The dominance of Fagaceae is resulting from its vigorous growth rate and low logging impact because of its low timber quality (Yoneda et al. 2006).

The complexity of Wornojiwo forest described by 5 strata of plant i.e. 0-10 m, 10-20 m, 20-30 m, 30-40 m and above 40 m. Richards (1952) consider the tropical rain forest to be the most complex and highly organized terrestrial community in the world, has five or six distinct strata. It is similar with the montane humid forests in Meghalaya, northeast India, which have five-layered distribution of plant species in the community (Jamir et al. 2006). In the second layer *Macropanax dispernum* relatively abundant in the maximum height achieves 40 m. It is similar to the vegetation layer of Mount Manglayang, West Java (Mutaqien et al. 2008).

The canopy with relatively continuous gap occurring in several places was important for regeneration. Forest regeneration showed a good result, indicated by almost all

tree species had the sapling stage. Our detailed survey found 61 sapling species as pointed out in Table 4. Sapling can be found easily especially in Jalan Akar and Lumut forest which adjacent to natural forest of Mount Gede Pangrango National Park as seed source.

Table 5. Basal area in tree family of CBG's remnant forest

Rank	Family	Basal area (m ² ha ⁻¹)	% Basal area
1	Fagaceae	32.67	49.95
2	Euphorbiaceae	12.3	18.81
3	Urticaceae	10.25	15.69
4	Araliaceae	5.09	7.79
5	Hamamelidaceae	1.87	2.86
6	Moraceae	1.24	1.90
7	Meliaceae	0.34	0.52
8	Lauraceae	0.29	0.45
9	Aceraceae	0.28	0.44
10	Actinidiaceae	0.28	0.43

Is the CBG's permanent plot representing the natural vegetation?

Forest inventory on CBG permanent plot were compared to natural forest vegetation at the edge and the interior of Mount Gede Pangrango National Park to get evidence of its representation of lower montane vegetation (Table 6). Although the vegetation of both CBG's permanent plot and the natural forest vegetation plot on Mount Gede Pangrango National Park are located at the same vegetation zone i.e. lower montane zone (Whitmore 1984), the natural forest vegetation has lower number of

species than CBG's permanent plot but have higher value of H' and species evenness. It may be caused by; (i) natural factor, such as in the tropical regions tree species richness (trees > 10 cm dbh in 1 ha plot), decreases with increasing altitude (summarized in Aiba et al. 2002), (ii) logging which occurs in national park, although it is a protective area but some people living around this area are collecting forest natural resource easily. As found for forest islands in Wisconsin, disturbance contributes significantly to variability in the number of species (Dunn and Loehle 1988); (iii) effect of the existence of CBG which conserves many non-native plant species which could escape into forest; and (iv) edge effect which may increase biodiversity in adjacent area (CBG permanent plot). Natural forest closer to CBG has the highest value of tree density and H', but the % basal area is lower than the farther of natural forest plot. This points out that the first plot of natural forest has younger succession stage than the second one.

Species composition of the CBG permanent plot represented the lower montane forest vegetation of Java. In Java, the lower montane are dominated in terms of abundance by the Oaks (*Lithocarpus* and *Quercus*), Chestnuts (*Castanopsis*), and numerous species of Laurels (Fagaceae and Lauraceae, respectively) but the Magnoliaceae, Hamamelidaceae and Podocarpaceae are also well represented (Sukardjo 1978; Mukhtar and Pratiwi 1991; van Steenis 1972). Only *Castanopsis javanica* present in the all plot (Table 7). *Cestrum aurantiacum* as invasive alien species is dominant spread in the CBG permanent plot only. Their canopy would inhibit native sapling growth (Galbraith-Keith and Handel 2008).



Figure 3. Profile diagram of Wornojiwo forest of CBG's remnant forest

Table 6. Comparison of tree stand of CBG permanent plot and plots in the natural forest vegetation of Mount Gede Pangrango National Park

	CBG permanent plot	First plot of natural forest	Second plot natural forest
Distance from CBG	Inside CBG	200 m (edge forest)	1 km (interior of the forest)
Altitude (m asl)	1,300-1,425	1,450-1,500	1,594-1,611
Number of tree species	74	63	51
Tree density (tree/ ha)	306	408	314
Basal area (%)	0.447	0.428	0.347
Shannon's Diversity Index (H')	2.84	3.29	3.20
Species Evenness	1.52	1.82	1.87

Table 7. Comparison the tree stand important value index (IVI) of the CBG permanent plot and natural forest vegetation in Mount Gede Pangrango National Park

CBG permanent plot		First plot of natural forest		Second plot of natural forest	
Species	IVI	Species	IVI	Species	IVI
<i>Villebrunea rubescens</i>	49.70	<i>Castanopsis tungurrut</i>	26.88	<i>Schima wallichii</i>	57.13
<i>Ostodes paniculata</i>	43.02	<i>Villebrunea rubescens</i>	18.94	<i>Turpinia sphaerocarpa</i>	32.55
<i>Macropanax dispernum</i>	29.90	<i>Sloanea sigun</i>	14.92	<i>Vernonia arborea</i>	12.48
<i>Castanopsis argentea</i>	37.31	<i>Altingia excelsa</i>	14.33	<i>Saurauia pendula</i>	11.09
<i>Ficus ribes</i>	16.21	<i>Ostodes paniculata</i>	14.09	<i>Macaranga rhizinooides</i>	9.72
<i>Cestrum aurantiacum**</i>	7.40	<i>Castanopsis argentea</i>	13.29	<i>Manglietia glauca</i>	9.53
<i>Decaspermum</i> sp.	5.84	<i>Laportea stimulans</i>	11.06	<i>Persea rimosa</i>	9.28
<i>Saurauia pendula</i>	7.36	<i>Macropanax dispernum</i>	10.13	<i>Lithocarpus pseudomoluccus</i>	5.93
<i>Altingia excelsa</i>	9.39	<i>Castanopsis javanica</i>	9.60	<i>Saurauia blumiana</i>	5.72
<i>Castanopsis javanica</i>	9.33	<i>Turpinia sphaerocarpa</i>	9.11	<i>Castanopsis javanica</i>	5.35

Note: ** alien species

In general, plant composition of the remnant forest of CBG's plot is more similar to the first plot of natural forest rather than the second one. Table 8 shows that CBG permanent plot has 39% similarity to first plot of natural forest and only 31% similar to the second plot of natural forest. Both plots located in natural forest have the higher similarity, i.e. 52%. Jacob (1981) said that no two hectares have exactly the same species composition in the rain forest. It is indicated the remnant forest of CBG showed good representative of Mount Gede Pangrango forest vegetation. The representation will be best if the alien species (*C. aurantiacum*) removed from the permanent plot.

Table 8. Similarity index among the remnant forest of CBG's plot and the plots at natural forest of Mount Gede Pangrango National Park

	CBG permanent plot	First plot of natural forest	Second plot of natural forest
CBG's remnant forest plot	1	0.39	0.31
First plot of natural forest	0.39	1	0.52
Second plot of natural forest	0.31	0.52	1

Due to the small size and high degree of fragmentation, the CBG's remnant forest is susceptible to abiotic and biotic disturbance. Edge effects increased susceptibility to invasions by exotic plants and animals (Ross et al. 2002; Ecroyd and Brockerhoff 2005). In spite of climatic change, the presence of invasive species is one of the greatest threats to biodiversity (Primack and Miller-Rushing 2009). It refers to their adaptability to disturbance and to a broader range of biogeographic conditions and environmental controls (Burgiel and Muir 2010). The presence of invasive alien species i.e *Cestrum aurantiacum* and *Brugmansia candida* 100 m away from CBG proved the spread of invasive species from CBG was out of control. Monitoring in the successive years is needed to maintain diversity, monitor forest dynamics and also the spread of invasive plant from CBG.

CONCLUSION

There were 137 plants species consisting of 74 tree species, 30 shrub species, 24 herb species, 6 fern species, and 4 climber species present in CBG permanent plot. The dominance of fagaceous (*Castanopsis argentea*), *Villebrunea rubescens* and *Ostodes paniculata* indicated the remnant forest of CBG is secondary lower montane forest. In comparison with natural forest, the remnant forest

of CBG showed good representative of Mount Gede Pangrango forest vegetation. It is indicated by 39% of its species composition are similar with the edge forest and 31% are similar with the forest interior.

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