LIPI

REINWARDTIA

A JOURNAL ON TAXONOMIC BOTANY, PLANT SOCIOLOGY AND ECOLOGY

ISSN 0034 – 365 X | E-ISSN 2337 – 8824 | Accredited 792/AU3/P2MI-LIPI/04/2016

2017 16 (1)

REINWARDTIA

A JOURNAL ON TAXONOMIC BOTANY, PLANT SOCIOLOGY AND ECOLOGY

Vol. 16 (1): 1 – 48, June 15, 2017

Correspondence on editorial matters and subscriptions for Reinwardtia should be addressed to:
HERBARIUM BOGORIENSE, BOTANY DIVISION,
RESEARCH CENTER FOR BIOLOGY– INDONESIAN INSTITUTE OF SCIENCES
CIBINONG SCIENCE CENTER, JLN. RAYA JAKARTA – BOGOR KM 46,
CIBINONG 16911, P.O. Box 25 CIBINONG
INDONESIA
PHONE (+62) 21 8765066; Fax (+62) 21 8765062
E-MAIL: reinwardtia@mail.lipi.go.id
http://e-journal.biologi.lipi.go.id/index.php/reinwardtia

1	2	3
4	5	6
7	8	9
10	11	12

Cover images: *Catanthera keris* Veldk. (1. Inflorescences; 2. Close up flower; 3. Flower bud), *Medinilla squillula* Veldk. (4. Habit; 5. Branches; 6. Fascicle of uniflorous Infructescences), *Medinilla uninervis* Veldk. (7. Habit. Note 1-nerved leaves; 8. infructescence; 9. Immature and mature fruits), *Medinilla zoster* Veldk. (10. Habit; 11. Inflorescences; 12. Flower). Photo credits: Bangun 223, Lowry & Phillipson 7287, Mahroji, Fabanyo & Soleman 69, Callmander, *et al*. 1067.

The Editors would like to thank all reviewers of volume 16(1):

Agus Susatya - University of Bengkulu, Bengkulu, Indonesia
Agus Sutanto - Indonesian Tropical Fruit Research Institute (ITFRI), West Sumatra, Indonesia
Axel D. Poulsen - Royal Botanic Garden Edinburgh, Edinburgh, Scotland, UK
Andrew Powling - School of Biological Sciences, University of Portsmouth, Portsmouth, UK
Elham Sumarga - School of Life Sciences & Technology, Institut Teknologi Bandung, Bandung, Indonesia
Meekiong Kallu - University Malaysia Sarawak, Samarahan, Sarawak, Malaysia
Harry Wiriadinata - Herbarium Bogoriense, Indonesian Institute of Sciences, Bogor, Indonesia
Ulrich Meve - Lehrstuhl für Pflanzensystematik, Universität Bayreuth, Bayreuth, Germany
Mien A. Rifai - Akademi Ilmu Pengetahuan Indonesia (AIPI), Jakarta, Indonesia

PHYTOSOCIOLOGICAL STUDY OF THE MONTANE FOREST ON THE SOUTH SLOPE OF MT. WILIS, EAST JAVA, INDONESIA

Received January 10, 2017; accepted March 16, 2017

PURWANINGSIH, RUDDY POLOSAKAN

Botany Division, Research Center for Biology –LIPI, Cibinong Science Center, Jln. Raya Jakarta-Bogor Km. 46, 16911, Indonesia. Email: purazali@yahoo.co.id ; Email: ruddypolos@yahoo.co.id

RAZALI YUSUF

Perumahan Tanah Baru D1-11, Bogor, Indonesia.

KUSWATA KARTAWINATA

Integrative Research Center, The Field Museum, 1400 Lake Shore Drive, Chicago, IL 60605, USA. Email: kkjak@indo.net.id

ABSTRACT

PURWANINGSIH, POLOSOKAN, R., YUSUF, R. & KARTAWINATA, K. 2017. Phytosociological study of the montane forest on the south slope of Mt. Wilis, East Java. Indonesia. Reinwardtia 16(1): 31 − 45. —A phytosociological study of a montane forest was carried out on the south slope of Mount Wilis, Kediri, East Java. The objective of the study was to do quantitative measurements of floristic composition and structure of the montane forest located within the seasonally dry climatic region as to date no such study has been undertaken there. It was conducted using the quadrat method by establishing plots of 2500 m^2 each at five locations at the altitudes of 1100 m asl (above sea level), 1200 m asl, 1300 m asl, 1400 m asl and 1500 m asl, thus the total area sampled was 1.25 ha. They were Plot1100 at Bekayang, Plot1200 at Bukit Bendera, Plot1300 at Batutulis, Plot1400 at Mergosepi and Plot1500 at Brak. A total of 1045 trees comprising 74 species of 50 genera and 33 families were recorded. Based on a species constancy index of 100 %, the *Saurauia nudiflora-Weinmannia blumei* association was established. The association consisted of (1) the *Cyathea-Polycias subassociation*, representing the heavily disturbed forest, currently dominated by *Cyathea contaminans* and (2) the *Villebrunea-Syzygium* subassociation, representing the least disturbed forests, dominated by *Syzygium lineatum* and *Villebrunea rubescens*. The lowest number of species (13) was recorded in Plot1100 and the highest number (39) in Plot1300. Important species recorded included *Cyathea contaminans* (Importance Value, IV= 47.97); *Lithocarpus* sp. (IV= 22.07); *Lithocarpus sundaicus* (IV= 14.05); *Saurauia pendula* (IV= 12.85); *Villebrunea rubescens* (IV= 12.12) and *Syzygium lineatum* (IV= 11.22). Diameter measurements showed that 76.60 % of trees in Plot1100 and 86.60 % in Plot1200 consist of small individuals with diameters between 10 and 30 cm. Trees with large diameters of >30 cm occurred in Plot1300, Plot1400 and Plot1500. The presence of large numbers of small trees and lesser numbers of trees with large diameters in a forest stand indicated that the stand was regenerating after heavy disturbance. The presence of the majority of trees with height of < 20 m (99 %) further confirmed the forest's dynamic status.

Key words: association, disturbance, Mount Wilis, phytosociology, regeneration, subassociation.

ABSTRAK

PURWANINGSIH, POLOSOKAN, R., YUSUF, R. & KARTAWINATA, K. 2017. Penelitian fitososiologi hutan pegunungan di lereng selatan Gunung Wilis, Kediri, Jawa Timur. Indonesia. Reinwardtia 16(1): 31 − 45. — Tujuan penelitian ini adalah untuk melakukan pengukuran kuantitatif komposisi flora dan struktur hutan pegunungan, yang terletak di wilayah iklim kering musiman. Penelitian ini dilakukan dengan menggunakan metode kuadrat dengan membuat petak masing-masing 2500 m^2 di lima lokasi dengan elevasi 1100 m dpl., 1200 m, 1300 m, 1400 m dan 1500 m, sehingga total luas petak adalah 1,25 ha. Petak-petak tersebut adalah Petak1100 di Bekayang, Petak1200 di Bukit Bendera, Petak1300 di Batutulis, Petak1400 di Mergosepi dan Petak1500 di Brak. Pencuplikan merekam sebanyak 1.045 pohon, yang terdiri atas 74 jenis, 50 marga dan 33 suku. Berdasarkan indeks konstansi jenis 100% dibentuk asosiasi *Saurauia nudiflora-Weinmannia blumei*. Asosiasi tersebut terdiri atas (1) subasosiasi *Cyathea-Polycias*, yang mewakili hutan terganggu berat, yang saat ini didominasi oleh *Cyathea contaminans* dan (2) subasosiasi *Villebrunea-Syzygium*, yang mewakili hutan sedikit terganggu, yang didominasi oleh *Syzygium lineatum* dan *Villebrunea rubescens*. Jumlah jenis terendah (13) tercatat dalam Petak1100 dan jumlah jenis tertinggi (39) dalam Petak1300. Jenis penting yang tercatat meliputi *Cyathea contaminans* (Nilai Kepentingan, NK= 47,97); *Lithocarpus* sp. (NK = 22,07); *Lithocarpus sundaicus* (NK = 14,05); *Saurauia pendula* (NK= 12,85); *Villebrunea rubescens* (NK= 12,12) dan *Syzygium lineatum* (NK= 11,22). Berdasarkan kelas diameter pohon tercatat bahwa 76,60% pohon dalam Petak1100 dan 86,60% dalam Petak1200 didominasi oleh individu pohon kecil dengan diameter 10 dan 30 cm, sedangkan pohon dengan diameter besar >30 cm dijumpai dalam Peta1300, Petak1400 dan Petak1500. Kehadiran sebagian besar pohon kecil dan beberapa pohon berdiameter besar menunjukkan adanya proses regenerasi hutan setelah terjadinya gangguan berat. Kehadiran mayoritas pohon dengan tinggi batang < 20 m (99%) menegaskan lebih lanjut status dinamika hutan.

Kata kunci: asosiasi, fitososiologi, gangguan, Gunung Wilis, regenerasi, subasosiasi

INTRODUCTION

The Island of Java with a total area of ± 13.5 million ha has the lowest forest cover, amounting to only 0.74 % of the total forest cover of Indonesia or less than 10% of the total area of the island (Fadli, 2004; Simbolon, 2002). Meanwhile the Forestry Law (*UU 41/1999 tentang Kehutanan*) and Spatial Arrangement Law (*UU 26/2007 tentang Tata Ruang*) require 30 % of the total area to be preserved in order to maintain various functions of the forest ecosystems. The lowland natural forests have been converted into agricultural lands and settlements and the remaining natural forests can be found only in the mountains at the altitude of >1000 m, in the form of protected forests and national parks. They are still suffering from human disturbance, especially in the areas near settlements.

Montane forests on Java occur at 800-2500 m asl (above sea level), comprising lower montane forest, upper montane forest and subalpine forest, stretching from the everwet to seasonally dry climatic zones. They have been qualitatively described by various authors and summarized by Steenis *et al.* (1972). Recently more quantitative studies have been undertaken by various investigators in the wet montane to subalpine forests of West Java, mainly in Mt. Gede-Pangrango (Yamada, 1975; 1976; 1977; Abdulhadi *et al.* 1998) and Mt. Halimun and Mt. Salak (Simbolon & Mirmanto, 1997; Mirmanto & Simbolon, 1998; Yusuf, 2004; Purwaningsih & Yusuf, 2008). A substantial number of narrative vegetation accounts of most mountains in East Java have been published by various authors as listed by Steenis *et al.* (1972). The only quantitative studies in the seasonal forest in East Java were those of Purwaningsih (2013) Mt Merbabu and Larasati (2004) at Mt. Kelud. The vegetation of Mt. Wilis was described by Koorders, Lörzing and Swart (Steenis *et al.,*1972). The forests on Mt. Wilis have been heavily disturbed by tree poaching and conversion into tree plantations. There are, however, remnants of natural forests, which are developing after heavy disturbances, and those which are least disturbed and still in relatively good condition, including those on the south slope which were selected for the present study. Studies on floristic composition and structure along altitudinal gradients, complemented with habitat factors, are necessary to understand the relationships between vegetation and environmental factors.

The objective of the present study is to do quantitative measurements of floristic composition and structure of the montane forest, as to date no such study has been undertaken. This paper is limited to the description of the forest in terms of the main structural parameters, species richness, pattern of relative abundance and family composition. Such data are important for measuring the suitability and the priority of conservation (Keel *et al.,* 1993) as well as for ecological restoration of disturbed forests.

STUDY SITE

The Wilis mountain range consists of several mountains, where the highest is Mt. Ngliman with a summit of 2563 m asl (above sea level). Mt. Wilis proper with a summit of 2182 m asl lies adjacent to Mt. Slurup with a summit of 2046 m. Mt. Wilis is a non-active volcano and its total area covers 26,634.4 ha. It is geographically located at 07°37"-08°05" South 111°30"-112°09" East covering six regencies, *i.e.* Kediri, Tulungagung, Nganjuk, Madiun, Ponorogo and Trenggalek. The forest and other vegetation on Mt. Wilis are classified as the protected area managed by the State Forest Corporation Unit II East Java (*Perum Perhutani unit* II *Jawa Timur*) comprising BKPH (*Bagian Kesatuan Pemangkuan Hutan*, Forest Management Section) Pace-Kediri (12,863 ha) and BKPH Lawu (15,771.4 ha). The forests in the Mt. Wilis region appear to have been once disturbed and the remnants of undisturbed or least disturbed natural forests are small in extent and located in the areas that have been designated sacred sites, such as near the Batutulis region. Most of the forests, particularly those located in the eastern sections of the Kediri Regency at the altitudes of 1100-1200 m have been disturbed mainly by illegal logging.

The forest cover of Mt. Wilis consists of lowland forest at < 1000 m asl, lower montane forest at 1000-1500 m asl, upper montane forest at >1500 m asl and tree-less short vegetation at 1800 m asl that extends to almost the top of the mountain. On the east slope the forest reaches only up to 1500 m asl while higher up the summit area is covered by the *Imperata cylindrica* grass community, mixed with *Casuarina* tree seedlings. The local community reported that in this area a big fire took place in 1983, followed by recurrent fires in the subsequent years, and rendered the area up to the summit bare and open. This is apparent from the presence of burned tree stumps and the occurrence of canopy gaps of various sizes.

The study site was selected on the south side of Mt. Wilis, within the Jugo and Besuki village region,Kediri. It is located in the rainfall type C of Schmidt & Ferguson (1951), The climate diagram (Fig. 1) of the nearest rainfall station at Besuki (630 m asl) shows the mean annual rainfall of 3459 mm, the two-month dry period in August (76 mm) and September (58 mm) and the ten-month wet period in October-July, where the mean monthly rainfall is >100 mm with the highest mean in January (425 mm) (LMG, 1969).

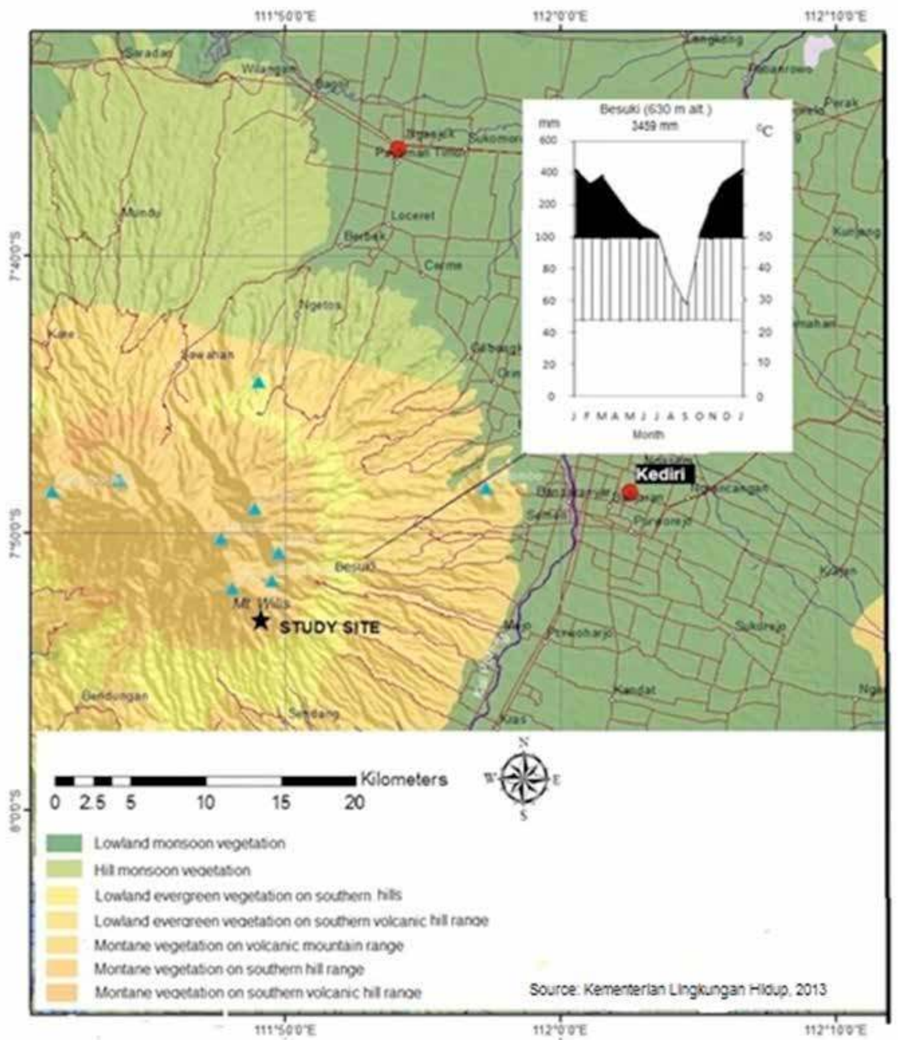

Fig. 1. A map of the study site and climate diagram for Besuki rainfall station at Mt. Wilis. The climate diagram shows the two-month dry period in August (76 mm) and September (58 mm) and the ten-month wet period in October -July with mean monthly rainfalls >100 mm.

The study site was selected at the Sambiroto forest management unit (RPH), where the least disturbed natural forest covers large areas occurring as islands within the matrix of the pine (*Pinus merkusii*) plantations. In general the Sambiroto forest management unit is hilly with hill tops of 1500 m asl at Bukit Batutulis, 1200 m asl at Bukit Bendera, 1600 m asl at Bukit Sekeber and 1700 m asl at Bukit Grangsang. The soils are dark brown latosols with humus layers, stony and not easily erodible.

MATERIALS AND METHODS

Field sampling was carried out in the montane forest on the south slope of Mt. Wilis, using the quadrat method (Cox, 1967; Mueller-Dombois & Ellenberg, 1974). Plots were established in the remnants of disturbed and least disturbed natural forests on relatively flat topography within the pine plantations. Plot size of 0.25 ha (50×50 m) was selected to fit the topography and the size of the existing natural forest remnants. One plot was established in each of the following sites, *i.e.* Plot1100 in Bekayang (1100 m alt), Plot1200 in Bukit Bendera (1200 m alt), Plot1300 in Batutulis (1300 m alt), Plot1400 in Mergosepi (1400 m alt), and Plot 1500 in Brak (1500 m alt). Thus the total area of forest sampled was 1.25 ha. Each plot was divided into 25 sub-plots of 10x10 m each. Within each subplot all trees with DBH (Diameter at Breast Height) ≥10 cm were identified, their positions were recorded, and their diameters measured bole heights and tree heights were estimated. Woody lianas with DBH ≥10 cm were treated as trees. A forest profile diagram for each plot was constructed from a strip of 10×50 m nested within each plot.

Density, frequency and dominance were defined and calculated according to the standard method (Cox, 1967; Mueller-Dombois & Ellenberg, 1974; Rahmah *et al.,* 2016). Density is defined as the number of individuals per unit area. The number of individuals per species was later calculated for the total area of the plot, which was 0.25 hectare. The density in the plot is the sum of the individuals of all species and is expressed in terms of the number of individuals per hectare. The Relative Density (RD) for each species was calculated using the following formula:

$$RD = \frac{number\ of\ individuals\ of\ a\ species}{total\ number\ of\ individuals}\ x100\ \%$$

Frequency relates to the number of times a species occurs in subplots in the plot and is expressed as percentage of the total number of subplots.

$$RF = \frac{frequency\ of\ a\ species}{sum\ frequency\ of\ all\ species}\ x100\ \%$$

Tree dominance is usually defined as stem cover, which is the same as basal area. The basal area (BA) was obtained with the formula:

$$BA = (½d)^2\pi$$

where *d* stands for diameter. The dominance of a species is measured by summing the BA values for all individuals in the species. The Relative Dominance (RDo) was obtained with the following formula:

$$RDo = \frac{dominance\ of\ a\ species}{dominance\ of\ all\ species}\ x100\ \%$$

The sum of RD, RF and RDo indicates the importance of a species in the plot. The Importance Value (IV) is then calculated with the following formula:

$$IV = RD + RF + Rdo$$

The Family Important Value (FIV) was calculated by summing up Importance Values of all species in a family (Kartawinata *et al.* 2004). Shannon's index of diversity was calculated using the formula (Chao & Shen 2003)

$$H = -\sum_{i=1}^{s} P_i\ lnP_i$$

In each subplot percentage of canopy gaps and the projected tree crown coverage were estimated, and topography and soil type were noted. Herbarium specimens for each species within the plot were collected and identified at the Herbarium Bogoriense, Research Center for Biology–LIPI, Cibinong. The identity and nomenclature of each tree species follow Backer & Bakhuizen van den Brink, Jr. (1963-1968).

RESULTS

Species composition

Table 1 shows that overall within 1.25 ha sample plots we recorded 1045 trees, comprising 74 species, 50 genera and 33 families. It shows also vegetation characteristics of the five plots. Table 2 presents the species composition of each plot. It indicates that each species has its own significance and distribution and groupings in the forest community. A grouping of species may be designated as an association on the basis of degree of constancy (Mueller-Dombois & Ellenberg, 1974). In the present study, based on the 100 % constancy of *Saurauia nudiflora* and *Weinmannia blumei,* the forest community on the slope of Mt. Wilis along the altitudes of 1100-1500 m may be designated as *Saurauia nudiflora-Weinmannia blumei* association or for short *Saurauia-Weinmannia* association.

Using the species distribution and the synthesis table method (Mueller-Dombois & Ellenberg, 1974) two groups forming two subassociations could be identified and they were related to the degree of disturbance. The grouping was entirely based on floristic composition, hence application of PCA (Principle Component Analysis) to confirm it was unnecessary. One subassociation covered Plot1100 and Plot1200, which were heavily disturbed plots. It was characterized by species Group 2 comprising *Alangium javanicum, Polycias nodosa, Cyathea contaminans, Magnolia* sp., *Mussaenda teysmanniana,* and *saurauia pendula* species. (Table 2), which could be assigned as characteristic species. On account of species dominance, it may be designated as the *Cyathea contaminans-Polycias nodosa* subassociation or for short *Cyathea-Polycias* subassociation. It was dominated by *Cyathea contaminans (*IV= 215.8 and 49.14*)* followed by *Polycias nodosa* (IV= 20.20 and 23.67). Other species with high importance values were *Alangium javanicum* (IV= 23.67) and *Mussaenda teysmanniana* (IV= 18.54). Other species are listed in Group 3 and Group 4, which were restricted to Plot1100 and Plot1200, respectively.

Another subassociation was found in Plot1300, Plot 1400 and Plot1500, which were least disturbed plots. It was characterized by species Group 9 (Table 2) consisting of *Antidesma tetandrum, Ficus ribes, Litsea elliptica, L. noronhae, S. lineatum, Toona sureni, Turpinia sphaerocarpa,*

Table 1. Vegetation characteristics of the five plots at Mt. Wilis

Vegetation characteristics	All plots (1100-1500 m alt)	Plot1100 (Bekayang 1100 m alt)	Plot 1200 (Bukit Bendera 1200 m alt)	Plot1300 (Batutulis 1300 m alt)	Plot1400 (Mergosepi 1400 m alt)	Plot1500 (Brak 1500 m alt)
Plot size (ha)	1.25	0.25	0.25	0.25	0.25	0.25
Number of species	74	13	30	39	31	28
Number of genera	50	13	25	29	24	22
Number of families	33	12	19	22	20	19
Number of trees	1045	235	301	221	140	148
Density (trees/ha)	836	940	1204	884	560	592
Basal area (m^2/ha)	29.65	22.08	22.92	45.12	32.76	25.52
Shannon's diversity index	3.40	0.78	2.78	3.05	3.00	2.76

Vernonia arborea, and *Villebrunea rubescens*. They could be designated as the characteristic species. Based on the species dominance it may be designated as the *Villebrunea rubescens-Syzygium lineatum* subassociation or for short *Villebrunea-Syzygium* subassociation. Other species are listed in Table 2 as Group 7, whose distribution was restricted to Plot1300 and Plot1400, Group 8 in Plot1300, Group 9 in Plot1400, Group 10 to Plot1500 and Group 11 to Plot1300 and Plot1500. Species in Group 5 essentially belonged to the *Villebrunea-Syzygium* subassociation but occurred also in the *Cyathea-Polycias* subassociation in Plot1200. Group 12 consists of species with fortuitous distribution, including *Macaranga tanarius* and *Trema orientalis* which are secondary forest species that filled canopy gaps.

Table 3 shows the number of species and family importance values of selected common families, *i.e*., those occurring in 3 to 5 plots. Of 33 families, four families with high mean Family Importance Values (FIV) were Cyatheaceae (FIV= 58.25), Fagaceae (37.26), Lauraceae (26.22) and Actinidiaceae (20.62). Highest FIV of Cyatheaceae was recorded in the Plot1100 at Bekayang, where *Cyathea contaminans* had IV= 215.8, that made the plot a mono-dominant community. In Plot1200 at Bukit Bendera, it occurred with relatively high IV (49.4), but it was absent in the Plot1300 at Batutulis, Plot 1400 at Mergosepi and Plot1500 at Brak (Table 2).

The families with the highest number of species were Lauraceae (10), Rubiaceae (8), Euphorbiaceae (5) and Moraceae (5). Although Lauraceae had the highest number of species, it had a low number of individuals (52) much less than Cyatheaceae (277), which was the highest. The number of families having one tree species was high (78%) while families containing one species and one tree were Arecaceae and Elaeocarpaceae (Table 2). Only two tree species were recorded in all five plots at Mt Wilis and they constitute the characteristic species of the *Saurauia-Weinmannia* association

Structure

Forest structure is defined by size and density as well as horizontal and vertical distribution of trees (Kershaw, 1964; Mueller-Dombois & Ellenberg, 1974). The structure of forests in the study sites is depicted by graphs (Figs. 2 & 3) and profile diagrams (Figs. 4a-e). Diameter classes show that 76.60% of trees at Plot1100 and 86.60% of trees at Plot1200 were dominated by small individuals with diameters of 5.1-30.0 m and only few trees had diameters >30 cm (Figure 2). Trees with large diameters >30 cm occurred in Plot1300, Plot1400 and Plot1500. Few of the trees had diameter >50 cm (7-10%), examples were *Engelhardtia spicata* (100 cm) in Plot1500 and *Lithocarpus* sp. (130 cm) in plot 1300. Other large trees included *Syzygium lineatum* and *Toona sureni*.

Table 4 shows nine tree species with relatively high density of individuals with diameters < 40 cm to indicate their regeneration status in all plots. *Alangium javanicum, Cyathea contaminans*, *Mussaenda teysmanniana* and *Polycias nodosa,* which were confined to and prevalent in heavily disturbed Plot1100 and Plot1200 (Table 2), had good regeneration. *Antidesma tetandrum, Clerodendrum phyllomega* and *Villebrunea rubescens* were regenerating relatively well in the least disturbed Plot1300, Plot1400 and Plot1500, while the regeneration of *Saurauia pendula* and *Laportea* sp. was good in almost all plots (Table 2).

The behavior of other species in terms of the diameter classes was as follows:

1) Species that were represented in almost all diameter classes up to 100 cm but with low

Table 2. Total Basal Area (BA in m[2]), Total Density (D in trees/ha) and Importance Value (IV) of tree species recorded in five plots in the montane forest of Mt. Wilis, Kediri, East Java.

No	Species	Plot1100			Plot1200			Plot1300			Plot1400			Plot1500		
		BA	D	IV	BA	D	IV	BA	D	IV	BA	D	IV	BA	D	IV
	Grup 1															
1	*Saurauia nudiflora*	0.41	14	10.57	0.38	72	18.15	0.60	84	22.50	0.05	16	6.17	58	0.94	39.52
2	*Weinmannia blumei*	0.01	8	4.64	0.07	32	7.66	0.09	24	6.67	0.11	4	3.00	4	0.08	3.03
	Grup 2															
3	*Alangium javanicum*	0.01	8	4.67	0.34	108	23.67									
4	*Cyathea contaminans*	4.98	788	215.8	1.00	240	49.14									
5	*Magnolia sp.*	0.01	4	2.33	0.12	16	5.89									
6	*Mussaenda teysmanniana*	0.01	4	2.48	0.18	96	18.54									
7	*Polycias nodosa*	0.15	44	20.20	0.38	116	23.67									
8	*Saurauia pendula*	0.69	14	5.35	0.38	72	18.15									
	Grup 3															
9	*Archidendron clypearia*	0.03	12	5.47												
10	*Erythrina subumbrans*	0.07	16	10.17												
11	*Melastoma malabatrichum*	0.01	8	4.64												
12	*Melochia sp.*	0.03	8	4.97												
	Grup 4															
13	*Aglaia edulis*				0.04	16	3.92									
14	*Alseodaphne umbellifolia*				0.08	40	8.44									
15	*Artocarpus elastica*				0.02	4	1.22									
16	*Dolichandrone spathacea*				1.14	112	38.54									
17	*Elaeocarpus* sp.				0.01	4	1.15									
18	*Ficus* sp.				0.01	4	1.12									
19	*Glochidion rubrum*				0.04	12	3.62									
20	*Lindera polyantha*				0.08	8	3.26									
21	*Lithocarpus pseudomolucca*				0.61	76	21.33									
22	*Macaranga semiglobosa*				0.16	36	9.55									
23	*Pinanga kuhlii*				0.00	4	1.02									
24	*Symplocos sp.*				0.07	32	7.66									
	Grup 5															
25	*Lasianthus laevigatus*				0.08	36	8.78	0.02	8	2.32						
26	*Nauclea purpurascens*				0.00	4	1.02	0.02	8	1.74						
27	*Phoebe grandis*				0.01	4	1.09	0.12	20	5.28						
	Grup 6															
28	*Engelhardtia spicata*				0.06	12	3.89	0.38	4	4.51	1.11	16	20.05	12	1.71	20.69
29	*Ficus grossularioides*				0.05	16	3.98	0.01	4	1.15	0.10	4	2.86	12	0.51	13.25
30	*Helicia attenuata*				0.04	8	2.67	0.03	20	5.71	0.02	8	3.45	0	0	0
31	*Laportea* sp.				0.02	4	1.30	0.00	4	1.12	0.20	76	26.77	0	0	0
32	*Lithocarpus sundaicus*				0.36	44	13.03	1.08	44	18.43	0.32	28	13.39	18	1.25	23.24
	Grup 7															
33	*Debregeasia dichotoma*							0.01	4	1.14						
34	*Lithocarpus sp.*							5.48	160	79.52						
35	*Nauclea obtusa*							0.04	4	1.43						
36	*Nauclea subdita*							0.02	8	2.39						
37	*Schefflera divaricata*							0.05	8	2.59						
38	*Talauma candollii*							0.03	12	3.54						

No	Species	Plot1100			Plot1200			Plot1300			Plot1400			Plot1500		
		BA	D	IV	BA	D	IV	BA	D	IV	BA	D	IV	BA	D	IV
	Grup 8															
39	*Acer laurinum*							0.10	4	2.00	0.01	4	1.71			
40	*Clerodendron phyllomega*							0.44	84	21.10	0.38	20	12.74			
41	*Cyathea orientalis*							0.12	44	10.49	0.05	8	2.99			
42	*Litsea accedentoides*							0.08	24	5.96	0.11	12	6.17			
43	*Neolitsea javanica*							0.13	16	5.48	0.40	8	8.14			
44	*Platea latifolia*							0.08	4	1.76	0.91	40	27.27			
45	*Syzygium laxiflorum*							0.04	16	4.09	0.07	4	2.42			
	Grup 9															
46	*Antidesma tetrandum*							0.08	44	10.17	0.08	28	11.44	2	0.02	1.87
47	*Ficus ribes*							0.01	8	2.25	0.01	4	1.71	6	0.04	4.39
48	*Litsea elliptica*							0.02	8	2.34	0.05	4	2.21	8	0.35	8.62
49	*Litsea noronhae*							0.11	32	9.69	0.32	28	15.22	18	0.32	14.87
50	*Syzygium lineatum*							0.63	80	24.90	0.30	24	12.48	8	1.99	21.53
51	*Toona sureni*							0.15	16	5.69	0.84	12	15.13	12	1.52	22.28
52	*Turpinia*							0.14	28	8.87	0.45	28	15.86	4	0.04	3.71
53	*Vernonia arborea*							0.67	16	9.71	0.74	16	14.63	4	0,11	4.33
54	*Villebrunea rubescens*							0.03	16	3.96	0.30	96	30.69	60	0.51	39.88
69	*Astronia spectabilis*	0	0	0	0	0	0	0.01	8	1.67	0	0	0	4	0.02	3.57
70	*Ficus fistulosa*	0	0	0	0.03	8	2.52	0.01	4	1.21	0	0	0	12	0.39	11.31
71	*Lithocarpus spicatus*	0.09	4	3.79	0.07	20	5.35	0	0	0	0.66	4	9.73	0	0	0
72	*Litsea sp.1*	0.02	8	4.88	0	0	0	0	0	0	0	0	0	12	0.3	10.60
73	*Macaranga tanarius*	0	0	0	0.34	48	15.43	0	0	0	0.25	12	7.90	0	0	0
74	*Trema orientalis*	0	0	0	0	0	0	0.38	4	4.51	0	0	0	4	1.73	17.09

Table 3. Number of species (NSp) and Family Importance Values (FIV) of common families (occurring in 3 to 5 plots).

	Plot 1100		Plot 1200		Plot 1300		Plot1400		Plot 1500		Mean FIV
Family	**NSp**	**FIV**	**NSp**	**FIV**	**NSp**	**FIV**	**NSp**	**FIV**	**NSp**	**FIV**	
Actinidaceae	1	15.9	1	18.2	1	23.4	1	6.19	1	39.4	20.62
Lauraceae	1	4.88	4	13.8	7	27.4	6	45.9	5	38.9	26.22
Fagaceae	1	3.79	3	39.7	2	96.4	2	23.2	1	23.2	37.26
Cyatheaceae	1	216	1	49.1	1	11.0	2	8.36	1	6.76	58.25
Rubiaceae	1	2.48	3	28.3	4	7.63	1	3.57	1	2.36	8.87
Moraceae			4	8.84	3	4.92	2	4.59	3	28.8	9.43
Meliaceae			1	3.92	2	7.61	1	15.2	2	24.1	10.17
Juglandaceae			1	3.89	1	4.58	1	20.1	1	20.7	9.85
Euphorbiaceae			3	28.6	1	10.7	2	19.4	2	3.64	12.47
Urticaceae			1	1.30	3	5.89	2	57.7	1	39.8	20.938
Verbenaceae					1	22.0	1	12.78	1	3.02	7.56
Myrtaceae					2	29.0	2	15	2	23.3	13.46
Asteraceae					1	9.94	1	14.7	1	4.31	5.79
Staphyleaceae					1	9.42	1	15.9	1	3.69	5.82

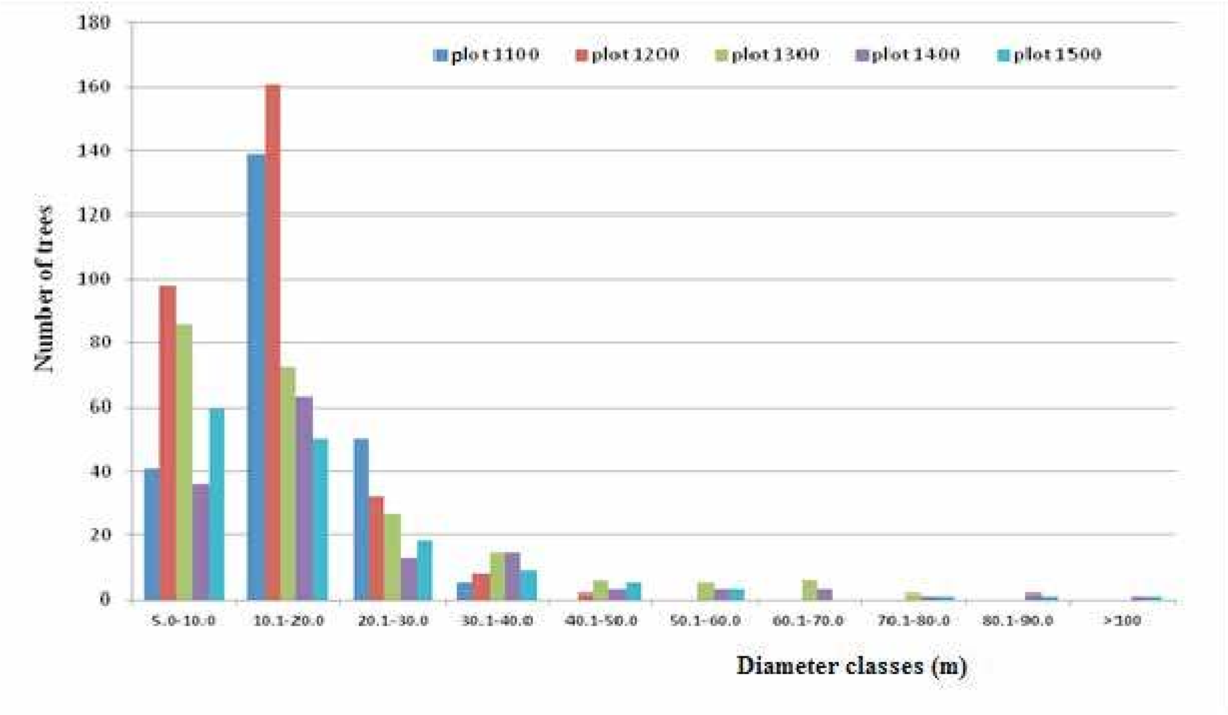

Fig. 2. Number of trees according to the diameter classes in the study plots on the south slope of Mt. Wilis.

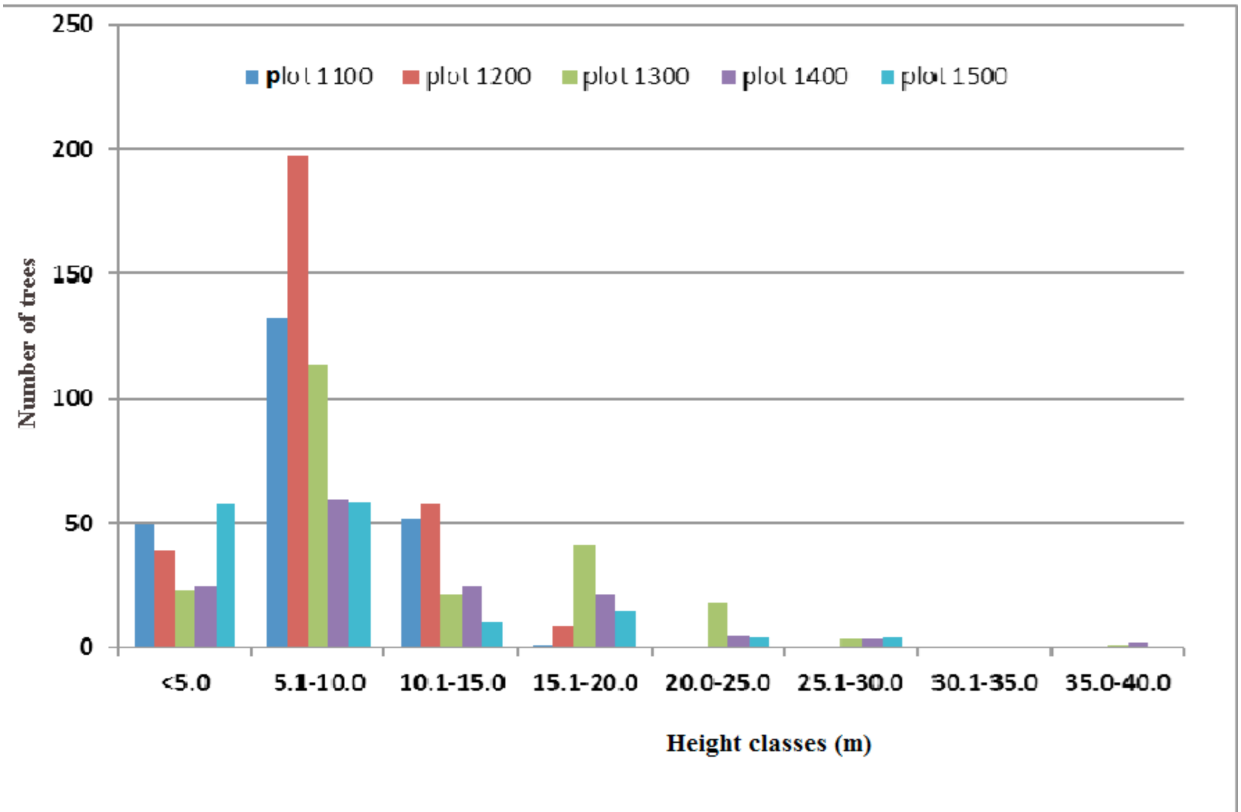

Fig. 3. Number of trees according to height classes in the study plots on the southern slope of Mt. Wilis.

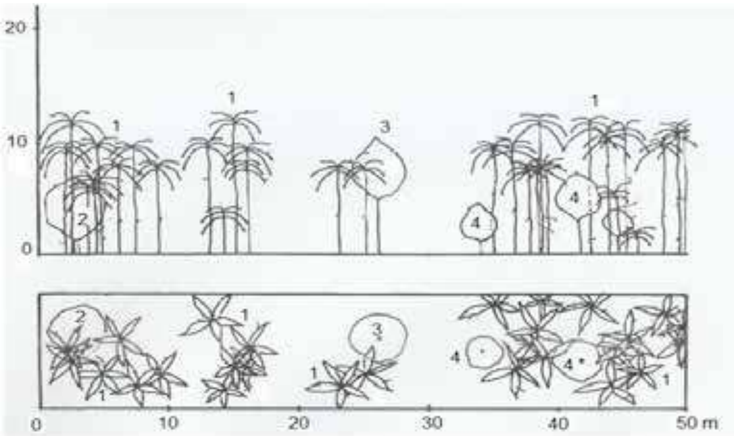

Fig. 4a. Canopy profile diagram of Plot1100 (Bekayang): 1. *Cyathea contaminans*; 2. *Saurauia pendula*; 3. *Polyscias nodosa*; 4. *Astronia spectabilis*

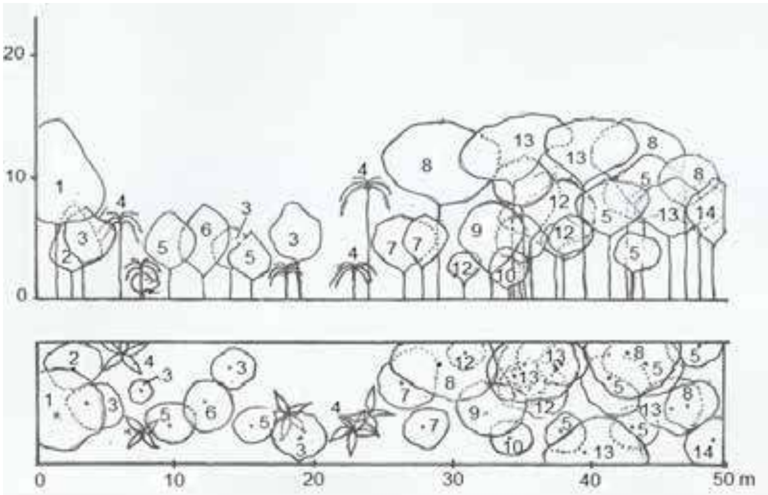

Fig. 4b. Canopy profile diagram of Plot1200 (Bukit Bendera); *1. Lindera polyantha; 2. Ficus fistulosa; 3. Macaranga semiglobosa;* 4. *Cyathea contaminans*; 5. *Polyscias nodosa*; 6. *Mussaenda teysmanniana*; 7. *Saurauia nudiflora*; 8. *Dolichandrone spathacea*; 9. *Helicia attenuata*; 10. *Artocarpus elastica*; 11. *Engelhardtia spicata*; 12. *Symplocos* sp.; 13. *Lithocarpus pseudomoluccana*; 14. *Macaranga tanarius*

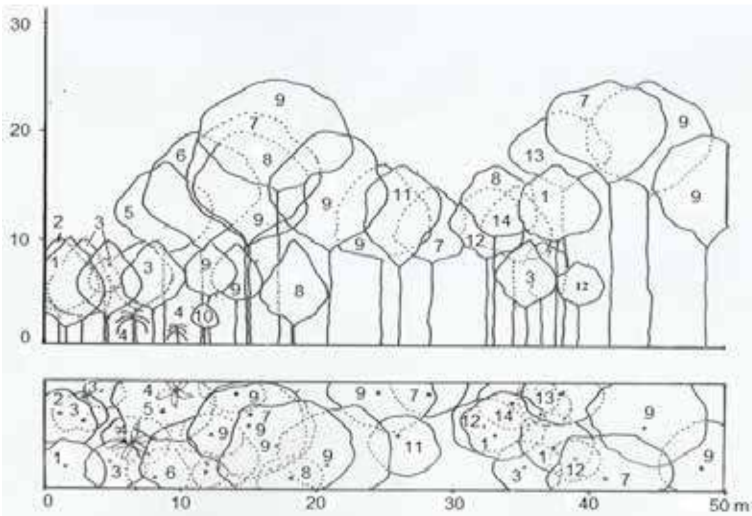

Fig. 4c. Canopy profile diagram of Plot1300 (Batutulis); 1. *Clerodendron phyllomega*; 2. *Astronia spectabilis*; 3. *Saurauia pendula*, 4. *Cyathea orientalis*; 5. *Lithocarpus sundaicus*; 6. *Toona sureni*; 7. *Syzygium lineatum*; 8. *Schefflera divaricata*; 9. *Lithocarpus* sp.; 10. *Helicia attenuata*; 11. *Litsea noronhae*; 12. *Syzygium laxiflorum*; 13. *Engelhardtia spicata*; 14. *Turpinia sphaerocarpa*

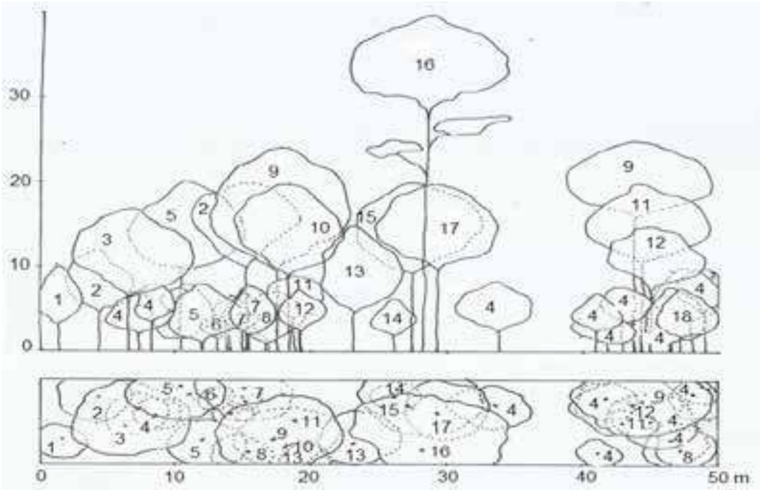

Fig. 4d. Canopy profile diagram of Plot1400 (Mergosepi): 1. *Litsea noronhae*; 2. *Platea latifolia*; 3. *Litsea accendentoides*; 4. *Villebrunea rubescens*; 5. *Engelhardtia spicata*; 6. *Mussaenda frodosa*; 7. *Antidesma tetrandum*; 8. *Turpinia sphaerocarpa*; 9. *Toona sureni*; 10. *Lithocarpus sundaicus*; 11. *Actinodaphne glomerata*; 12. *Syzygium lineatum*; 13. *Neolitsea javanica*; 14. *Laportea* sp.; 15. *Clerodendron phyllomega*; 16. *Lithocarpus spicatus*; 17. *Weinmannia blumei*; 18. *Helicia attenuata*

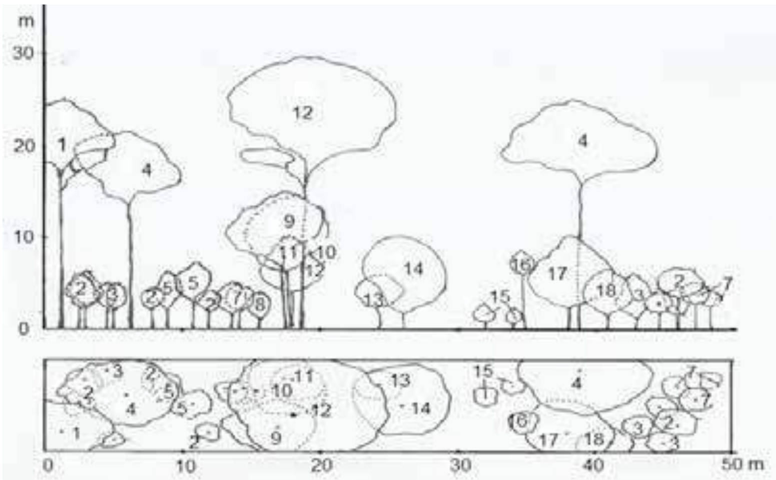

Fig. 4e. Canopy profile diagram of Plot1500 (Brak). 1. *Lithocarpus sundaicus;* 2. *Saurauia pendula*; 3. *Villebrunea rubescens*; 4. *Toona sureni*; 5. *Ficus ribes*; 6. *Turpinia sphaerocarpa*; 7. *Engelhardtia spicata*; 8. *Astronia spectabilis*; 9. *Litsea elliptica*; 10. *Symplocos fasciculata*; 11. *Syzygium* sp.; 12. *Syzygium lineatum*; 13. *Ficus fistulosa*; 14. *Litsea noronhae*; 15. *Cyathea crenulata*; 16. *Ficus grossularioides*; 17. *Melochia* cf. *umbellata*; 18. *Trema orientalis*

Table 4. Overall regeneration in all plots represented by species with small diameters (<40 cm) and with relatively high density (individuals/plot).

Species	**Diameter class (cm)**			
	5-10	**10-20**	**20-30**	**30-40**
Cyathea contaminans	32	169	52	4
Saurauia pendula	22	29	8	2
Clerodendrum phyllomega	10	8	2	4
Villebrunea rubescens	38	12	1	
Polycias nodosa	16	22	2	
Mussaenda teysmanniana	20	5		
Alangium javanicum	13	16		
Antidesma tetandrum	10	9		
Laportea sp.	10	11		

density were *Engelhardtia spicata, Lithocapus sundaicus, Lithocarpus* sp., *Syzygium lineatum, Turpinia sphaerocarpa and Vernonia arborea.* 2) Species with diameters of 10-40 cm but with irregular pattern of distribution and low density (1 -14 trees/ha) were *Artocarpus elasticus, Acer laurinum, Actinodaphne glomerata, Actinodaphne procera, Aglaia edulis, Alseodaphne umbellifolia, Archidendron clypearia, Astronia spectabilis, Breynia racemosa, Cyathea crenulata, Cyathea orientalis, Debregeasia dichotoma, Dolichandrone spathacea Elaeocarpus* sp., *Erythrina subumbrans, Ficus fistulosa, Ficus grossularioides, Ficus* sp., *Flacourtia rukam, Glochidion rubrum, Helicia attenuata, Lasianthus laevigatus, Lasianthus* sp., *Lindera polyantha, Lithocarpus pseudomoluccus, Litsea accendens, Litsea elliptica, Litsea noronhae, Litsea* sp.1, *Litsea* sp.2, *Macaranga tanarius, Macaranga semiglobosa, Magnolia sp., Melastoma malabatricum, Melochia umbellata, Mussaenda frondosa, Nauclea obtusa, Nauclea purpurescens, Nauclea subdita, Neolitsea javanica, Phoebe grandis, Pinanga kuhlii, Premna obtusifolia, Pyrenaria serrata, Saurauia nudiflora, Schefflera divaricata, Symplocos fasciculata, Symplocos* sp., *Syzygium laxiflorum, Syzygium sp., Talauma candollei* and *Weinmannia blumei.*

3) Species represented in high diameter classes (60-100cm) but sparingly present in the lower diameters were *Toona sureni* (50-70 cm), *Trema orientalis* (50-70 cm), *Lithocarpus spicatus* (90-100 cm), *Platea latifolia* (70-80 cm) and *Ficus ribes* (80-90 cm).

DISCUSSION

The forest on the south slope of Mt. Wilis, as sampled by the five plots in the present study, belongs to the humid montane forest. It is indicated by the Schmidt & Ferguson (1951) rainfall type C and the climate diagram (Fig. 1) of the nearest rainfall station at Besuki (630 m alt) which shows the mean annual rainfall of 3459 mm. It fits the phenomenon described by Steenis *et al*. (1972) and Steenis & Schippers-Lammertse (1965).

It is stated that the north slopes of the mountains in that region (Wilis, Lawu, Arjuno, Semeru, Iyang and Ijen), being on the leeward sides, were exposed to extremely dry air masses during the dry season, leading to the formation of a seasonally dry climate and seasonally dry monsoon forests. The south slopes, however, being on the windward sides, were constantly receiving rainfall resulting from the exposure to wetter air masses coming from the southeast, hence no dry period developed here, resulted in the development of moist climate and moist forests. The species composition of the forests on the south slopes was typical of that of moist montane forest of Java (Steenis *et al*., 1972). Because there is no dry season on the south slope of Mt. Wilis, in the present plots no typical seasonal monsoon forest trees were recorded, such as *Butea monosperma* and *Casuarina junghuhniana,* the latter of which is generally dominant in the seasonal monsoon montane forests in East Java.

Plot1300 located at 1300 m alt had the highest number of species, basal area, density, species diversity index. Plot1400 also had high values for vegetation characteristics, not much different from those of the Plot1300. They indicated that the forest conditions in these plots were better than those in the three others. The latter had lower values of the vegetation characteristics, which were assumed to be related to the degree of forest disturbance. The local inhabitants from the nearby villages often passed through these plots and tree cutting took place from time to time leading to the formation of open forest canopy.

Table 5 shows that the number of tree species in the present plots was lower than those in the wet montane forests at Mt. Halimun in West Java, but higher than those in seasonal montane forest at Mt. Merbabu and Mt. Kelud and at moist montane forest at Mt. Ciremai. The difference in species richness and species composition in West and East Java was in general due to differences in climate (Steenis & Schippers-Lammertse,1965; Steenis *et al*., 1972), but the difference with Mt. Ciremai was likely due to heavy human disturbance instead of climate, as they are located in similar rainfall type C of Schmidt and Ferguson (1951).

The species richness in Mt. Wilis is comparable to that in other montane forests at Mt. Gede and Mt. Halimun-Mt. Salak corridor, which were heavily to slightly disturbed. It is much lower that that in Mt. Halimun, which was likely due to severe disturbance by human activities compared to that in Mt. Halimun, which was relatively little disturbed. In addition it was due to difference in the climate, where the south slope of Mt Wilis belongs to the Schmidt & Ferguson rainfall type C (slightly seasonal humid climate), while Mt. Halimun belongs to the rainfall type A (perhumid climate).

Forest destruction in Mt. Willis was due mainly to activities of people living in settlements in the vicinity of the montane forests. Tree poaching by cutting was the most common practice in the area and has led to the formation of canopy gaps of different sizes, which were so widespread in the forests of the area (Figs. 4a-e). Our qualitative observations showed that tree regeneration took place under such gaps and the kind and density of seedlings and saplings present varied with gap size, as observed also in various tropical forests

Table 5.Comparison of the number of tree species in selected plots on several mountains in Java

Site	Alt. (m)	Plot size (Ha)	Number of tree species	Source
East Java				
Mt. Wilis	1100-1500	1,25	72	Present study
Mt . Kelud	600-1000	0.75	29	Larasati (2004)
Central Java:				
Mt. Merbabu,	1700-2400	1,75	19	Purwaningsih 2013
West Java:				
Mt. Halimun	900-1200	1.0	116	Simbolon, 2001
Mt. Halimun-Mt. Salak Corridor	900	1.0	69	Yusuf, 2004
Mt. Gede	800	1.0	70	Nelva *et al.* 2009
Mt. Ciremai	1600-2000	1.2	57	Purwaningsih & Yusuf 2008

elsewhere (Brokaw, 1985; Hartshorn, 1980; Poore, 1968; Runkle, 1981, Whitmore, 1984). This explains the presence of *Saurauia nudiflora* and *Weinmannia blumei* in all plots, thus with 100% constancy. They are secondary forest species (Steenis *et al*., 1972; Whitmore, 1984) that can grow on open sites in heavily damaged mountain forest as well as in small canopy gaps of primary and least disturbed mountain forests.

Cyatheaceae was recorded to have the highest FIV compared to the other families (Table 3). It was due to the fact that the entire Plot1100 was practically covered by *Cyathea* spp., especially the tree fern, *Cyathea contaminans* (Table 2, Fig. 4a). This species occurs in the wet tropics at the altitudes of 200-1500 m, especially in the mountain regions, and is very tolerant to direct solar radiation (Holttum, 1963; Steenis *et al*., 1972). Any open sites within and outside forests will be generally and aggressively invaded by this species if mature tree fern individuals are present in the vicinity (Steenis *et al*., 1972; Whitmore, 1984). It is, therefore, implied that the total dominance of *C. contaminans* on Plot1100 indicated that the plot was once covered by natural forest, which was later totally cleared, resulting in the formation of large gaps, enabling the spores of *C. contaminans* to invade the open forest floors. The invasion of *C. contaminans* by spores was faster than that by any disseminules of other species. Rapid entry and later the fast growth of foliage prevented other seeds and disseminules from seed banks to grow and develop under the shade of *C. contaminans* foliage.

The secondary species occurring in the plots belonged to Euphorbiaceae, Actinidiaceae and Moraceae, whose distribution in Indonesia ranges from lowland to montane forests. It appears that species of Euphorbiaceae, dispersed by wind, birds and mammals (Pijl, 1982), were more adaptable to low altitudes, hence they were more abundant in the lowland forests than in the montane forests. In the present study we recorded five species occurring mainly at the altitude of 1200 m. One of the species, *Macaranga tanarius,* was abundant and dominant in disturbed forest with large canopy gaps, while other species including *Antidesma tetandrum, Glochidion rubrum* and *Macaranga semiglobosa* were less abundant and they occurred in least disturbed forest with small canopy gaps. Many other secondary forest species seedlings began to invade gaps in disturbed primary forest areas, including *Ficus ribes, F. fistulosa* and *F. grossularioides* (Moraceae), *Saurauia nudiflora* and *S. pendula* (Actinidiaceae), *Vernonia arborea* (Asteraceae) and *Villebrunea rubescens* (Verbenaceae) (Table 2). It should be noted that two secondary forest species (*V. arborea* and *Trema orientalis*) could reach large diameters. *Vernonia arborea* could reach diameters of 60-70 cm in Plot1300 and 80-90 cm in Plot1400, while *T.orientalis* could reach diameters of 50-60 cm in P1200 and 70-60 cm in Plot1300. The two species are known to be long-lived secondary forest species (Whitmore, 1984). It could be implied that the plots, where the two species currently occurred, were disturbed in the past.

The number of species in the plots varied with altitude. At the altitudes of 1300-1500 m in slightly disturbed primary forests the number of species was high, especially at Batutulis, while at the altitudes of 1100-1200 m it was low, as confirmed also by the species diversity index (Table 1). The low number of species in the low altitude plot (Plot1100) was due to the high coverage and dominance of *C.contaminans* that practically excluded other species altogether (Table 2, Fig. 4a). The high number of secondary forest species was related to the presence of large gaps. The plots at higher altitudes, where the primary forests were least disturbed with small gaps (Figs. 4c-e), and the primary species were dominant. Dominant species in primary forest that could grow in gaps of various sizes included *Lithocarpus sundaicus* and *Syzygium lineatum.*

The number of individuals in the diameter classes of 5-10 cm and 10-20 cm may be used to indicate the regeneration status of a forest stand (Mueller-Dombois & Ellenberg, 1974; Richards, 1996). Table 4 shows the overall regeneration in all plots as indicated by relatively large number of individuals with diameters of ≤ 20 cm, comprising only of nine species which were distributed in different plots. The presence of large numbers of small trees and a smaller number of trees with large diameters in a forest stand indicated that the stand was regenerating after heavy disturbance. The presence of a majority of trees with height of < 20 m (99%) further confirmed the forest's dynamic status. There were few trees with heights >20 m (Fig. 3). At higher elevations in Plot 1300, Plot1400 and Plot1500 the percentage of trees with heights of < 20 m was 70-85%, those with heights of 20-25 m was 12-27% and those with heights >30 m was 1- 4 %. The latter consisted mainly of *Engelhardtia spicata, Lithocarpus spicatus, Lithocarpus sp., Litsea noronhae, Syzygium lineatum, Toona sureni, Villebrunea rubescens* and *Weinmannia blumei,* which occurred at altitude ≥1300 m in Plots 1300, Plot1400 and Plot1500 (Figs. 4c-e). The tree species with highest basal areas were *Lithocarpus* sp. (5.48 m^2), which occurred in Plot1300 and *Cyathea contaminans* (4.98 m^2) in Plot1100. The local community considered Plot1300 at Batutulis as a sacred site, hence local people would not dare to trample the plot, thus making it least disturbed.

Table 2 shows that each species had its own significance, distribution and groupings leading to the formation of *Saurauia nudiflora-Weinmannia blumei* association, extending along the altitudinal gradient from 1100 m to 1500 m asl. in the forest community on the south slope of Mt. Wilis. Further grouping of species led to the establishment of the *Cyathea contaminans-Polycias nodosa* subassociation characterized by species Group 2 in heavily disturbed plots and the *Villebrunea rubescens-Syzygium lineatum* subassociation characterized by species Group 9 in least disturbed plots (Table 2).

At the altitudes of 1100-1200 m tree species that were commonly encountered were mostly secondary forest species, including *Cyathea contaminans, Saurauia nudiflora, Macaranga tanarius, Ficus* spp. At the altitudes of 1300-1500 m, however, they were mostly primary forest species belonging to Fagaceae, Lauraceae, Myrtaceae, etc. Secondary forest species were present but sparingly. It may be implied that the forests in this area were secondary forests in the lower altitudes and slightly disturbed primary forests higher up, composed mainly of primary forest species mixed with scattered secondary forest species.

CONCLUSION

The forest communities along the altitudinal gradient of 1100-1500 m have a low species richness and are designated as the *Saurauia-Weinmannia* association, which has two subassociations. The existence of two subassociations is related to the degree of disturbance. It is predicted that the subassociations will remain unchanged in many years to come as the regeneration is poor, hence the successions leading to communities similar to the original ones prior to disturbances would take a very long time. The succession can be enhanced by applying ecological restoration through planting tree species native to the sites, complemented with actions to prevent fire and tree poaching. The ecological restoration, especially on bare, unforested and burnt sections of the mountain, will help in increasing species diversity, improving forest conditions and expanding the coverage of forest to satisfy the requirements stipulated in Spatial Arrangement Law (*UU 26/2007 tentang Tata Ruang*) that necessitate the preservation of 30% of the total area of a region in order to maintain various functions of the forest ecosystems. Species that will survive and maintain themselves in the forest in the future are currently represented in almost all diameter classes, although with low density. These are *Engelhardtia spicata, Lithocarpus sundaicus, Lithocarpus* sp., *Syzygium lineatum, Turpinia sphaerocarpa* and *Vernonia arborea.*

REFERENCES

ABDULHADI, R., SRIJANTO, A. & KARTAWINATA, K. 1998. Composition, structure and changes in a montane rain forest at the Cibodas Biosphere Reserve, West Java, Indonesia. Pp. 601-612 In: DALLMEIER, F. & COMISKEY, J.A. (Eds.), *Forest Biodiversity Research, Monitoring and Modeling. Conceptual Background and Old World Case Studies.* Man and the Biosphere Series, vol. 20. The Parthenon Publishing Group, New York.

BACKER, C. A. & BAKHUIZEN VAN DEN BRINK, Jr. R. C. 1963 1965 & 1968. *Flora of Java*, Vol. 1, 2 & 3, N.V. P. Noordhoff, Groningen.

BROKAW, N. V. L 1985. Gap-phase regeneration in Tropical Forest. *Ecology* 60(33) : 682-687 p.

CHAO, A. & SHEN, T. 2003. Nonparametric estimation of Shannon's Index of diversity when there are unseen species in sample. *Environmental and Ecological Statistics* 10: 429- 443.

COCKBURN, P. F. 1972. Fagaceae. In: WHITMORE, T. C. *Tree Flora of Malaya a Manual for Foresters* 1. Pp. 196-231.

COX, W. G. 1967. *Laboratory manual of general ecology.* Wm. C. Brown Company Publisher, Dubuque.

FADLI, A. 2004. Pulau Jawa di ambang kehancuran. http://timpakul.web.id/jawa.html (Access on 9 January 2013)

HARTSHORN, G. S. 1980. Neotropical forests dynamics. In: EWEL, J. (Ed.). *Tropical Succession*. *Biotropica* (Supplement) 12(2): 23–30.

HOLTTUM, R. E. 1963. Cyatheaceae. *Flora Malesiana* II 1 (2): 65–176.

KARTAWINATA, K., SAMSOEDIN, I., HERIYANTO, M. & AFRIASTINI, J. J. 2004. A tree species inventory in a one-hectare plot at the Batang Gadis National Park, North Sumatra, Indonesia. *Reinwardtia* 12: 145–157.

KEEL, S., GENTRY, A. H. & SPINZI, L. 1993. Using vegetation analysis to facilitate the selection of conservation sites in Eastern Paraguay. *Conservation Biology* 7(1): 66–75.

KERSHAW, K. A. 1964. *Quantitative and dynamic ecology*. Edward Arnold Publishing Co. Ltd. London.

LARASATI, I. 2004. Keanekaragaman tumbuhan dan populasinya di Gunung Kelud, Jawa Timur. *Biodiversitas* 5(2): 71–76.

LMG (Lembaga Meteorologi dan Geofisika). 1969. Tjurah hujan rata2 di Djawa dan Madura periode1931-1960 (Mean rainfall in Java and Madura, 1931-1960 period). *Meteorological Note* No. 8, Part 1: 1–132.

MIRMANTO, E. 1991. Struktur dan komposisi hutan DAS Cisadane Hulu. In: WITJAKSONO, MARWOTO, R. M. & SUPARDIYONO, E. K. (Eds.). *Prosiding Seminar Hasil Penelitian dan Pengembangan* SDH 1990/1991. Pp 33–41.

MIRMANTO, E & SIMBOLON. H. 1998. Vegetation analysis of Citorek area, Gunung Halimun National Park. In: SIMBOLON, H., YONEDA, M. & SUGARDJITO, J. (Eds). *Gunung Halimun: The last Submontane Tropical Forest in West Java. Biodiversity Conservation Project in Indonesia* 4: 41–59.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. *Aims and Methods of Vegetation Ecology.* John Wiley & Sons, New York.

NELVA, H., KARTAWINATA, K. & SAMSOEDIN, I. 2009. An undescribed lowland forest at Bodogol, the Gunung Gede-Pangrango National Park, Cibodas Biosphere Reserve, West Java, Indonesia. *Reinwardtia* 13 (1): 33–44.

PIJL, L VAN DER, 1982. *Principles of Dispersal in Higher Plants*. Spinger-Verlag, Berlin.

POORE, M. E. D. 1968. Studies in Malaysian rain forest. The forest on trissic sediments in Jengka Forest Reserve. *J. Ecology* 56: 143–196.

PURWANINGSIH, 2013. Analisis hutan sekunder di Taman Nasional Gunung Merbabu, Jawa Tengah. In: IRSADI, A., SAIFUL, R. & HABIBAH, N..A. (Eds.). *Prosiding Seminar Nasional Biologi "Peran Biologi dan Pendidikan Biologi dalam Pengembangan Karakter Konservasi" Universitas Negeri Semarang.* 323–329.

PURWANINGSIH & YUSUF, R. 2008. Analisa vegetasi hutan pegunungan di Taman Nasional Gunung Ciremai, Majalengka, Jawa Barat. *Jurnal Biologi Indonesia.* (5): 385-398. (Edisi Khusus Kawasan Gunung Ciremai Bagian 1).

RAHMAH, KARTAWINATA, K., NISYAWATI, WARDHANA, W. & NURDIN, E. 2016. Tree species diversity in the lowland forest of the core zone of the Bukit Duabelas National Park, Jambi, Indonesia. *Reinwardtia* 15(1): 11–26.

RICHARDS, P. W. 1996. *The Tropical Rain Forest, an Ecological Study*. Second edition. Cambridge University Press, Cambridge.

RUNKLE, J. R. 1981. Gap regeneration in some old growth forest of the Eastern United States. *Ecology* 62(4) : 1041–1051.

SCHMIDT, F. H. & FERGUSON, J. H. 1951. Rainfall Types Based on Wet and Dry Period Ratios for Indonesia with Western New Guinea. Verdalingen 42. Djawatan Meteorologi dan Geofisika, Jakarta.

SIMBOLON, H. 2001. The growth dynamics on tree species of Fagaceae family in a tropical montane rain forest of West Java, Indonesia. *Berita Biologi.* 5(6): 659–666. (Edisi Khusus "Biodiversitas Taman Nasional Gunung Halimun").

SIMBOLON, H. & MIRMANTO, E. 1997. Vegetation analysis of Citorek area, Gunung Halimun National Park. In: SIMBOLON, H., YONEDA, M. & SUGARDJITO, J. (Eds). *Gunung Halimun*: *The last submontane tropical forest in West Java.* LIPI, JICA, PHPA, Bogor

SIMBOLON, H., WIRIADINATA, H. & YONEDA, M. 1998. Plant diversity in Gunung Halimun National Park, West Java Indonesia: Inventorying activities. In: SIMBOLON, H. YONEDA, M. & SUGARDJITO, J. (Eds). *Gunung Halimun: The Last Submontane Tropical Forest in West Java. Biodiversity Conservation Project in Indonesia.* 4: 1–9.

SOEPADMO, E 1972. Fagaceae. *Flora Malesiana* 7(3): 265–403.

VAN STEENIS, C. G. G. J. & SCHIPPERS-LAMMERTSE, A. F. 1965. General part: Concise plant geography of Java. In: BACKER, C. A. & BAKHUIZEN VAN DEN BRINK Jr. R. C *Flora of Java* 2, N.V.P. Noordhoff, Groningen. Pp. 3–72.

VAN STEENIS, C. G. G. J., HAMZAH, A. & TOHA, M. 1972. *The Mountain Flora of Java.* Leiden. 90 pp.

WHITMORE, T. C. 1984. *Tropical rain forest of the Far East.* 2nd edition. Clarendron Press. Oxford.

YAMADA, I. 1975. Forest ecological studies of the montane forest of Mt. Pangrango, West Java. I. Stratification and floristic composition of the montane rain forest near Cibodas. *The Southeast Asian Studies* 13: 402–426.

YAMADA, I. 1976. Forest ecological studies of the montane forest of Mt. Pangrango, West Java. II. Stratification and floristic composition of the forest vegetation of the higher part of Mt. Pangrango. *The Southeast Asian Studies* 13: 513–534.

YAMADA, I. 1977. Forest ecological studies of the montane forest of Mt. Pangrango, West Java. IV. Floristic along the altitude. *The Southeast Asian Studies* 15: 226–254.

YUSUF, R. 2004. Keanekaragaman jenis pohon pada hutan terganggu di daerah koridor Taman Nasional Gunung Halimun. *Berita Biologi* 7(1 &2): 41–50.

INSTRUCTION TO AUTHORS

Scope. *Reinwardtia* is a scientific irregular journal on plant taxonomy, plant ecology and ethnobotany published in June and December. Manuscript intended for a publication should be written in English.

Titles. Titles should be brief, informative and followed by author's name and mailing address in one-paragraphed.

Abstract. English abstract followed by Indonesian abstract of not more than 250 words. Keywords should be given below each abstract.

Manuscript. Manuscript is original paper and represent an article which has not been published in any other journal or proceedings. The manuscript of no more than 36 pages by using Times New Roman 11, MS Word for Windows of A4 with double spacing, submitted to the editor through <reinwardtia@mail.lipi.go.id>. New paragraph should be indented in by 5 characters. For the style of presentation, authors should follow the latest issue of Reinwardtia very closely. Author(s) should send the preferred running title of the article submitted. Every manuscript will be sent to two blind reviewers.

Identification key. Taxonomic identification key should be prepared using the aligned couplet type.

Nomenclature. Strict adherence to the International Code of Nomenclature is observed, so that taxonomic and nomenclatural novelties should be clearly shown. English description for new taxon proposed should be provided and the herbaria where the type specimens area deposited should be presented. Name of taxon in taxonomic treatment should be presented in the long form that is name of taxon, author's name, year of publication, abbreviated journal or book title, volume, number and page.

Map/line drawing illustration/photograph. Map, line drawing illustration, or photograph preferably should be prepared in landscape presentation to occupy two columns. Illustration must be submitted as original art accompanying, but separated from the manuscript. The illustration should be saved in JPG or GIF format at least 350 pixels. Legends or illustration must be submitted separately at the end of the manuscript.

References. Bibliography, list of literature cited or references follow the Harvard system as the following examples.

Journal : KRAENZLIN, F. 1913. *Cyrtandraceae* novae Philippinenses I. *Philipp. J. Sci.* 8: 163–179.
MAYER, V., MOLLER, M., PERRET, M. & WEBER, A. 2003. Phylogenetic position and generic differentiation of *Epithemateae* (*Gesneriaceae*) inferred from plastid DNA sequence data. *American J. Bot.* 90: 321–329.

Proceedings :TEMU, S. T. 1995. Peranan tumbuhan dan ternak dalam upacara adat "Djoka Dju" pada suku Lio, Ende, Flores, Nusa Tenggara Timur. In: NASUTION, E. (Ed.). Prosiding Seminar dan Lokakarya Nasional Etnobotani II. LIPI & Perpustakaan Nasional: 263–268. (In Indonesian).
SIMBOLON, H. & MIRMANTO, E. 2000. Checklist of plant species in the peat swamp forests of Central Kalimantan, Indonesia. In: IWAKUMA, T. *et al.* (Eds.) Proceedings of the International Symposium on: Tropical Peatlands. Pp.179-190.

Book : RIDLEY, H. N. 1923. *Flora of the Malay Peninsula 2*. L. Reeve & Co. Ltd, London.

Part of Book : BENTHAM, G. 1876. *Gesneriaceae*. In: BENTHAM, G. & HOOKER, J. D. *Genera plantarum 2*. Lovell Reeve & Co., London. Pp. 990–1025.

Thesis : BAIRD, L. 2002. *A Grammar of Kéo: An Austronesian language of East Nusantara*. Australian National University, Canberra. [PhD. Thesis].

Website : http://www.nationaalherbarium.nl/fmcollectors/k/KostermansAJGH.htm). Accessed 15 February 2012.

Reinwardtia
Published by Herbarium Bogoriense, Botany Division, Research Center for Biology, Indonesian Institute of Sciences
Address: Jln. Raya Jakarta-Bogor Km. 46 Cibinong 16911, P.O. Box 25 Cibinong
Telp. (+ 62) 21 8765066; Fax (+62) 21 8765062
E-mail: reinwardtia@mail.lipi.go.id

REINWARDTIA Author Agreement Form

Title of article :

Name of Author(s) :

I/We hereby declare that:

- My/Our manuscript was based on my/our original work.
- It was not published or submitted to other journal for publication.
- I/we agree to publish my/our manuscript and the copyright of this article is owned by Reinwardtia.
- We have obtained written permission from copyright owners for any excerpts from copyrighted works that are included and have credited the sources in our article.

Author signature (s) Date

Name

REINWARDTIA
Vol. 16. No. 1. 2017

CONTENTS

Page

Reinwardtia is a LIPI accredited Journal (792/AU3/P2MI-LIPI/04/2016)
http://e-journal.biologi.lipi.go.id/index.php/reinwardtia

Herbarium Bogoriense
Botany Division
Research Center for Biology – Indonesian Institute of Sciences
Cibinong Science Center
Jln. Raya Jakarta − Bogor, Km 46
Cibinong 16911, P.O. Box 25 Cibinong
Indonesia