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Forest Ecological Studies of the Montane Forest of Mt. Pangrango, West Java

I. Stratification and Floristic Composition of the Montane Rain Forest near Cibodas

by

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Introduction

This series deals with the results of research conducted in the montane forest of the twin volcanoes, Mt. Gede-Pangrango complex in West Java, Indonesia.

Among the studies of tropical rain forest subsequent to the compilation of Richards (1952), the tenor of the present research is most closely related to the serial contributions by Prof. Kira *et al.* of Osaka City University and by Prof. Shidei *et al.* of Kyoto University, which began in 1957 in Thailand and Cambodia. The main purpose of these studies was to cover the ecosystem metabolism of the tropical forests in Southeast Asia. These projects were extended to the IBP project in Malaysia, where a joint study by Malaysian, English and Japanese members was carried out.

Studies on the vegetation of the tropical rain forest have been undertaken at the Malaysian forest [*e. g.* Ashton (1964), Wyatt-Smith (1964) and Poore (1968)]. Those researches which covered a wide area, analyzed structure, physiognomy and floristic composition.

Although the taxonomical studies are abundant in Indonesia, ecological studies similar to the above-mentioned ones are very limited. Of those, concerning the montane forest in Java, the generalized description of the mountain flora by Steenis *et al.* (1972) and the plant sociological study by Meijer (1959) are good examples.

In this paper, the author reports the stratification and floristic composition of the tropical montane forest near Cibodas Mountain Garden, situated at the foot of Mt. Gede-Pangrango complex. The research was carried out during the author's one-year stay at the National Biological Institute in Bogor (Jan. 1969–Jan. 1970).

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Sample site

Cibodas Mountain Garden is situated at 6°45'S, 107°01'E, about 1400 m above sea level on the foot of the northwestern slope of Mt. Gede-Pangrango complex, approximately 100 km south from Jakarta, capital of Indonesia.

The area of Java and Madura is estimated to be 132, 174 km^2 which covers roughly 6.94 % of the whole of Indonesia. High density of the population is the main cause contributing to the small number of forest area. According to 1963 statistics, the total forest area in Java and Madura is only 23 % of the total land area, while the average forest area in Indonesia is 64 %. Primary forest in Java, therefore, is restricted to out-of-the-way places like peninsulars, small islands and high mountains. The mountain forest of Mt. Gede-Pangrango, which extends from Cibodas Mountain Garden to the summits of the two mountains has been strictly maintained as a nature reserve since 1925. Its montane vegetation has been kept undisturbed and in good condition.

Annual precipitation (3380 mm) shows that this area is the most pluvial in Java. From November until March, precipitation is particularly high due to the influence of the west monsoon. The minimum rainfall occur in August and is as small as ca. 100 mm. Daily fluctuation of rainfall is as follows: rain begins around 10–11 a. m., reaches its peak around 2–3 p. m. and stops in the evening. The relative humidity is always high and never reaches below 70 % even at the driest period in August. Sunshine is seen only in the morning. The west wind blows from November to March, while the east wind predominate the rest of the year. Average annual temperature is 17.9°C without any fluctuation over the year. The daily range is 10°C at minimum and

26.8°C at the most.

Fig. 1 shows Walter's climatic diagram (1955) of Cibodas, Jakarta and Bogor, respectively. Annual temperature in Jakarta, situated near the coast of northern sea, is higher (26.6°C) and annual rainfall smaller (1799 mm) than that of Cibodas. The diagram indicates that a dry period exists in August. In Bogor, 60 km southward from Jakarta, the annual temperature is a little cooler (25.1°C) than Jakarta, but the annual rainfall is the highest over all (3934 mm). There is no indication of dry period in either Bogor or Cibodas. A common factor in these three spots is the heavy rainfall caused by the west monsoon. Owing to this effect, the tropical rain forest can grow in West Java.

A chronology of research studies around Cibodas has been compiled by Steenis and van Steenis Kruseman (1953). Of these, Meijer's investigation may be sufficient to introduce the present study.

Meijer made plant sociological analysis of a 1 ha. plot near Cibodas. The most dominant species in the plot was *Altingia excelsa*, and *Castanopsis javanica*, the next dominant. *Quercus induta*, *Schima wallichii*, and *Machilus rimosa* were found in the succeeding layer. *Macropanax dispermus*, *Saurauia pendula*, *Turpinia pomifera*, *Villebrunea rubescens* and *Antidesma tetrandrum* were included in the lower layer. Seifriz who conducted his research in 1923, noted that *Rasamala* (*Altingia excelsa*) dominated zone found between 1400 m and 1660 m in altitude, thereafter followed by *Podocarpus* zone. The author's plot has no *Rasamala* and only one *Podocarpus*. This indicates that the present plot is situated between *Rasamala* and *Podocarpus* zones. The altitude is estimated at about 1550 m from sea level.

In selecting the study area, the author climbed to the summit of Mt. Pangrango to view the vertical distribution of the vegetation type at the first step, and later on, paid a visit to Meijer's plot. As a result, a 1 ha. plot, located at a 20 minute walk

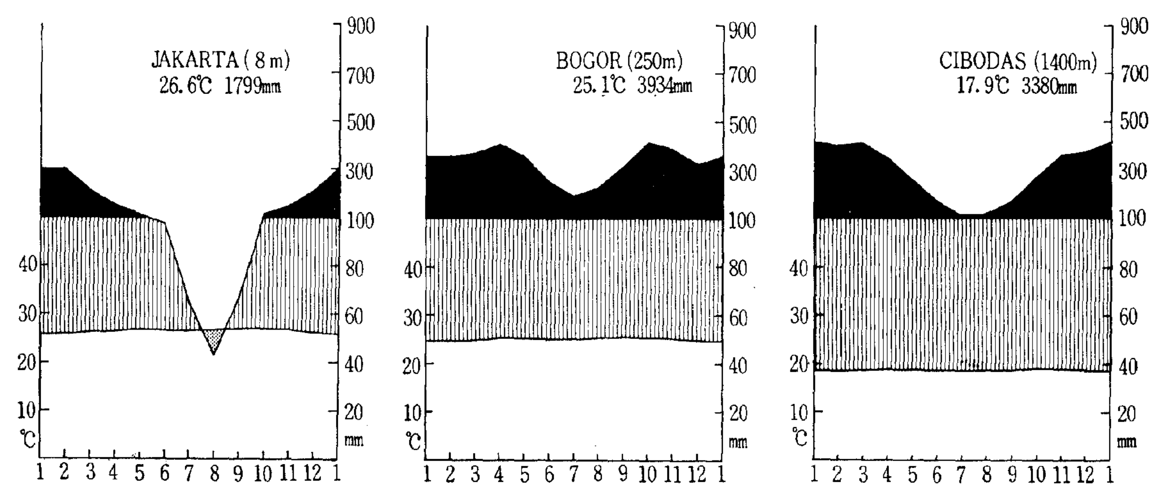

Fig. 1 Comparison of Walter's Climatic Diagram at Jakarta, Bogor and Cibodas

from Cibodas Mountain Garden and a 15 minute walk upward from Meijer's plot, was chosen with the guidance of Bapak. Nurta, a man well acquainted with this area.

The plot exhibited physiognomy typical of the surrounding area. Most of the trunks were covered by moss, and the trunks of the larger-sized trees exhibited numerous epiphytes on which various kinds of woody or non-woody lianas were grown. *Asplenium*'s nest-formed large mass of leaves were characteristic of the scenery. The ground vegetation was thickly covered by *Strobilanthes* and tree ferns and palms appeared above the *Strobilanthes* layer. Trees of *Schima* and *Fagaceae* were abundant and *Saurauia pendula* dominated the lower stratum. The distribution of trees was rather homogeneous except for one spot where a gap in a forest canopy was made by a fallen tree. The slope was almost flat and gently inclined to N–40°W. The humus was rich and the soil included weathered alluvial deposits from volcanic mudstreams. The mother rock was found 75–80 cm under the surface.

Methods of investigation

A 100×100 m^2 plot was accurately chosen, using a compass and measuring tapes, and was subdivided into one hundred 10×10 m^2 subplots. All the trees over 10 cm in diameter at breast height (DBH) were identified. The DBH, total height (H), and the height of the lowest living branch (H_B) were measured and the exact position of all sample trees were mapped. Ten 10×10 m^2 subplots were chosen diagonally for the investigation of trees under 10 cm DBH and taller than 1.3 m in height. Species of each tree, individual number, DBH, diameter at 30 cm above ground (D_{30}), H and H_B were also measured. Plants smaller than 1.3 m in height were studied by placing ten 1×1 m^2 quadrats at regular intervals along the diagonal line of the plot. The species name and number, H, the fresh weight including roots and the life form were recorded.

Trees over 10 cm in DBH were marked with white paint at the exact point where the diameter was measured, and numbered for future study. The diameter of a buttressed tree was measured at the point immediately above the buttress. The diameter measurement was made with both caliper and diameter tape. The height of trees lower than 10 m was measured with a scaled, straight bamboo pole, while the Weise's hypsometer was engaged for taller trees. To spot check the error of height measurement, direct measurement by a climber using measuring tape was also done from time to time.

Epiphytes, woody climbers and lianas were recorded by visual observation without instrument on half of 1 ha. plot.

Results and discussion

Some of the important statistics of the 1 ha. plot are summarized in Table 1. The density of trees over 10 cm DBH was not so high. The basal area, however, was rather greater than the value met with in any other tropical forests. Fisher's index of diversity α was smaller compared with the range of tropical forest, but much larger than that of temperate forest.

The diameter distribution histogram of trees over 10 cm DBH is L-shaped, and relatively larger-sized trees (over 50 to 120 cm) constantly occur (Fig. 2).

Table 1 Summary of basic statistics of 1 ha. plot (DBH above 10 cm)

Tree density no/ha	427
No. of species	57
Basal area %	0.522
Fisher's index of diversity	17.7

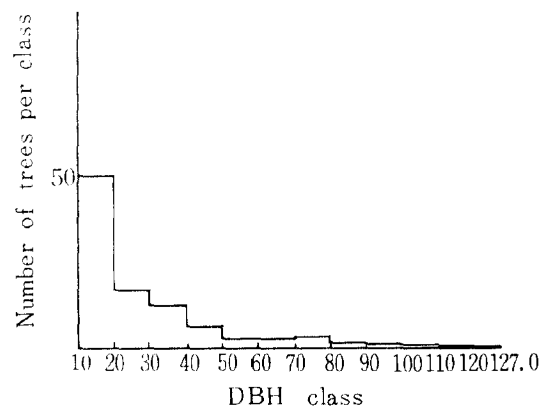

Fig. 2 Frequency histogram of diameter distribution in 1 ha. plot. Only trees larger than 10 cm DBH are shown.

Stratification

Forest structure is decided by the vertical as well as the horizontal distribution of individual trees in the stand, as was pointed out by Ogino (1974). Total height and height under the lowest living branch may constitute the vertical element, while horizontal factors may be characterized as the number and basal area of the trees in the stand. By the combination of these elements, stratification may be precisely recorded. The ecological importance of stratification is related to photosynthetic structure as well as to the regeneration capacity.

A common method of distinguishing stratification is to observe the relation of each tree in the stand. Ogino (1974) divided the structure of forest in Thailand into the following layers: Ap; Trees dominant above the closed canopy and receiving direct full sun light, As; trees in the canopy but partly or completely shaded by Ap, F; trees under the canopy and completely covered by the above layered trees, H; ground vegetation, and C; climber. The types of vegetation were discussed with statistics relating to each layer.

Analysis of stratification using the crown depth diagram as well as by relation between tree height and the height of the lowest living branch was proposed by

Ogawa *et al.* (1965).

In the present study, stratification has been analyzed using Ogawa's method. Fig. 3 shows the height curve, crown curve and H-H_B relation of 1 ha. plot.

The height curve is very smooth from the top to the lower layer, but a slightly depressed point appears at the 15 m level. The crown curve has no such noticeable minima, and indicates a more or less discontinuous change at 26 m and 15 m level, respectively. A comparing these diagrams with H-H_B relation, a step-like distribution of three groups on the H-H_B relation reflects a differentiation of layers occurring at the 26 m and 15 m levels. Solid circles indicate trees smaller than 10 cm DBH. If this group is included, the H-H_B relation reveals a distinguish step-like distribution at the 6 m level.

To summarize, the stand comprises five layers including ground vegetation as follows: lst layer; over 26 m, 2nd layer; 26-15 m, 3rd layer; 15-6 m, 4th layer; 6 m-ground vegetation, and 5th layer; ground vegetation.

Basic statistics in each layer are given in Table 2. Trees under 10 cm DBH are converted into measurement per ha. Considering only trees over 10 cm DBH, we notice

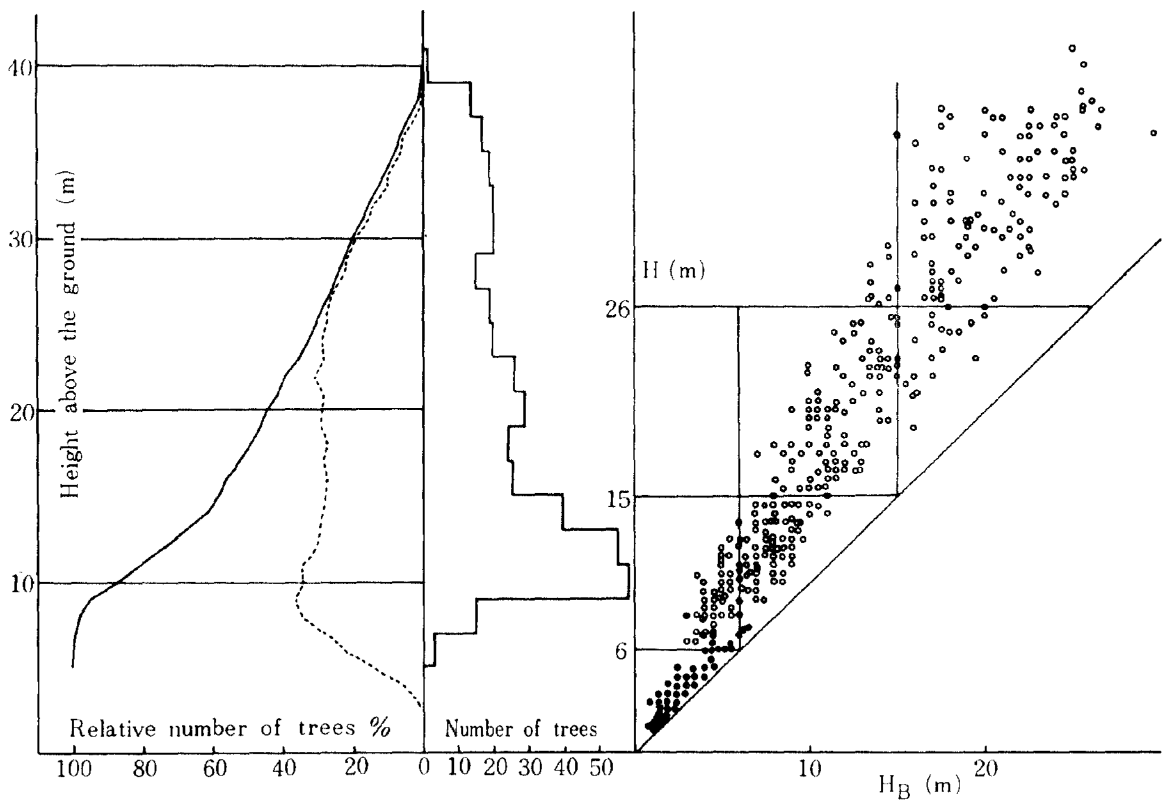

Fig. 3 Crown depth diagram and H-H_B relation in 1 ha. plot
Open circles : trees over 10 cm DBH
Solid circles : trees under 10 cm DBH and taller than 1.3m
Crown depth diagram does not include trees smaller than 10cm DBH

Table 2 Basic statistics of the lst to the 4th layers of 1 ha. plot

		1st layer	2nd layer	3rd layer	4th layer	Broken trees	Total
DBH above 10 cm	No. of trees	116	123	171		17	427
	Basal area %	0.410	0.062	0.032		0.018	0.522
	No. of species	22	28	39			57
	Fisher's index of diversity	8.024	11.294	15.746			17.672
Under 10 cm DBH, taller than 1.3 m	No. of trees			180	2500		2680
	Basal area %			0.005	0.008		0.013
Tree ferns	No. of ferns			13	370		383
	Basal area %			0.002	0.007		0.009
Palms	No. of palms			20	290		310
	Basal area %			0.0002	0.002		0.002

that both the number of trees and the species number increase from the lst to the 3rd layer, while total basal area decrease. Tree ferns and palms in the 3rd and 4th layer is unique to this stand. They covered a considerable amount of the total basal area of the 4th layer.

The stratum which was divided into 5 layers is a general view of the vertical distribution pattern of the stand as a whole. Note that within the plot itself, five layers do not always appear at any given spot. For example, the schematic diagram of trees over 10 cm DBH found in the ten 10×10 m^2 subplots on the diagonal line of the plot (Fig. 4) indicate that, among 10 subplots, seven subplots have trees beyond 26 m. Yet, a complete stratum can be found only in SP-1, SP-4 and SP-7, while in SP-3, SP-5 and SP-9, the lst layer is almost entirely absent. Viewing these uneven spot units as a whole, they constitute five layers.

Among the 100 subplots, trees belonging to the lst, 2nd and 3rd layer were not appear at 30, 26 and 15 subplots, respectively. There was one subplot where no trees over 10 cm DBH were grown. The composition of the ground vegetation of this subplot was very similar to that of another subplots, as it was completely covered by the surrounding trees and no direct sunshine was reached to the ground. Supposing that it was a mark of a old gap, this fact may drive the conclusion that if the size of gap is smaller than 10×10 m^2, the recovering of the vegetation may proceed smoothly.

However, a rather new gap made by a fallen tree at the northwestern part of the plot was received the full sun-light and the species belongs to *Zingiberaceae* was abundant on the ground. The size of this gap was nearly 100 m^2. Compared with the above mentioned subplot, this new gap looks take much longer time to recover to the original vegetation. Taking these facts into account, it can be concluded that the maximum size of crown gap in which regeneration can occur without any difficulties would be not larger than 100 m^2 at the most.

The homogeneity of 8 species which appear equally among three layers show an equilibrium in structure. Within the 8 species, *Schima wallichii* and *Castanopsis javanica* were the most dominant species. These trees are also an important source of timber.

The relationship between regeneration capacity and stratification is significant from the view point of forestry practice. If indiscriminate planning is engaged, the very stability of the forest may be endangered. In a case similar to the present plot, forestry working plan should be managed to take only a small number of trees out and only those whose succeeding generation is found to be abundant in the lower stratum. The most important, is that the crown gap made by fallen tree should not be so large as to offer a wide invasion of species dominant in the secondary site. Judging from the data in the present plot, the size of a gap should not be wider than 100 m^2. Kramer's observation which appeared in Richards (1952) recommended a 10 acre standard as the maximum gap size. But this area seems to be still too large to the author. Blanford's (1929) measurement (6 m across), on the other hand, may be the most reasonable in the context of the tropical rain forest.

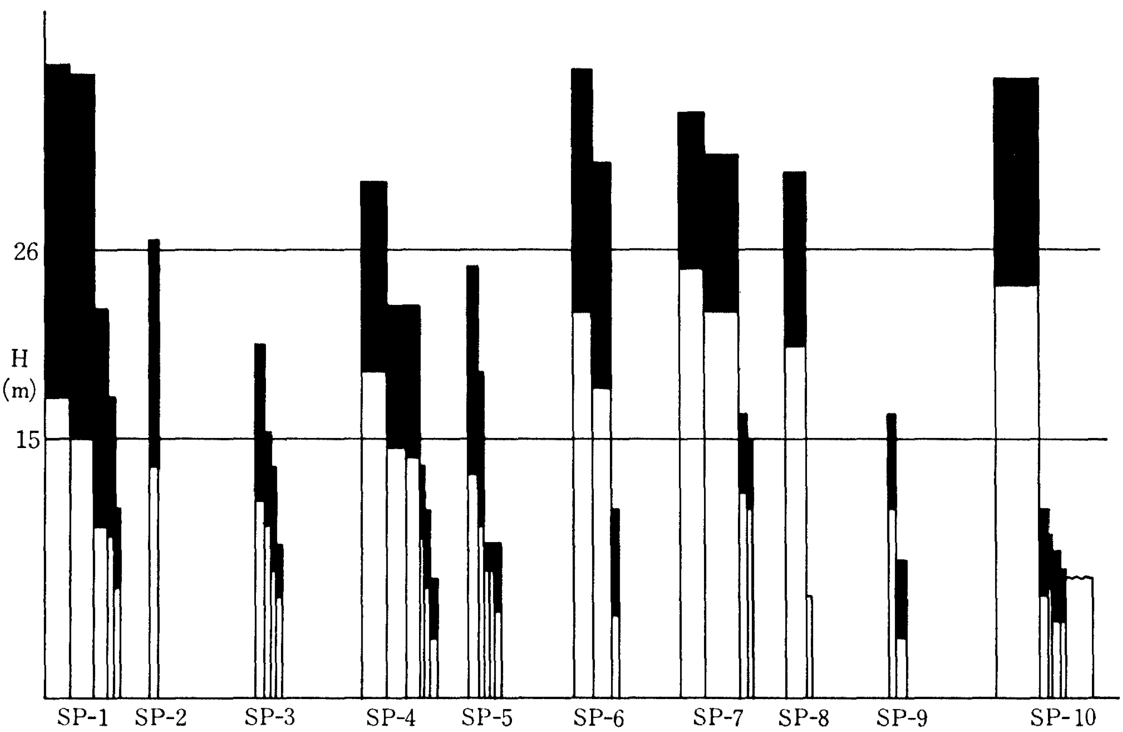

Fig. 4 Schematic diagram of the height and the height under the lowest living branch of the trees over 10 cm DBH on 10 subplots (10 × 10 m^2 each) taken at regular intervals along a diagonal line of 1 ha. plot. Crown depth is indicated in black and broken trees by wavy lines.

The most serious misunderstanding in the management of the tropical forest is related to the belief that careful exploitation is unnecessary since the size of the forest is generally much larger than that of the temperate forest. This conclusion is completely wrong. Commercial interests who follow this *rationale*, benefit while risking whole scale destruction of the forest. Since competition is severe, especially the stage of the opening of a gap, effective management needs sufficient consideration.

Although trees in the lower stratum are not so important as a source of timber, they are extremely important for maintaining the balance of the forest stand. Fisher's index of diversity α reveals greater complexity on the lower layer, which also supports, the stand preserves equilibrium in the stratification.

Floristic composition

All the trees over 10 cm DBH found on the 1 ha. plot are given separately for the three tree strata, together with their individual numbers and relative dominance in terms of percentage basal area, in Table 3.

Schima wallichii and *Castanopsis javanica* predominated the lst layer. The succeeding species were *Persea rimosa*, *Lithocarpus pseudomoluccus* and *Vernonia arborea*. The indigenous species in this layer were 10, such as *Lithocarpus rotundatus*, *Pygeum parviflorum*, *Litsea resinosa*, *Platea latifolia*, *Engelhardia spicata*, etc.

In the 2nd layer, *Persea rimosa*, *Decaspermum fruticosum*, *Castanopsis javanica*, and *Polyosma ilicifolia* were more or less evenly distributed and 4 species (*Acronychia laurifolia*, *Glochidion macrocarpum*, *Acronodia punctata* and *Ilex cymosa*.) appeared only in this layer.

Saurauia pendula occupied 36 % of basal area in the 3rd layer. *Turpinia sphaerocarpa*, *Symplocos fasciculata*, and *Ficus ribes* were also occurred in the same layer. Seventeen species were found only in this layer, such as *Saurauia pendula*, *Ficus ribes*, *Villebrunea rubescens*, *Castanopsis argentea*, *Saurauia blumiana*, *Antidesma tetrandrum*, etc.

Of the three strata, *Schima wallichii* is the most dominant species both in number and relative dominance. Together with the next dominant *Castanopsis javanica*, these two species have far greater value than the succeeding groups. Seventy-five percent of the number and 96 % of basal area of *Schima wallichii* are distributed in the lst layer, while the number of *Castanopsis javanica* is found equally among three layers as 54 %, 30 % and 16 % from the lst to 3rd layer.

The third species is *Persea rimosa* whose number is largest in the 2nd layer and height class is lower than the former two species. *Lithocarpus pseudomoluccus*, belonging to *Fagaceae*, shows a similar distribution pattern to that of *Castanopsis javanica*.

The species mentioned above and ones which found in the lst layer mainly belong to *Fagaceae*, *Lauraceae*, and *Theaceae*. The montane forest near Cibodas is dominated by *Rasamala* from 1400–1660 m according to Seifriz (1923). The shape of this species is not as distinctive as the emergent species belongs to *Dipterocarpaceae* or *Leguminosae*, which are prevalent in lowland Southeast Asian forests, but, is relatively conspicuous beyond the continuous crown layer. Meijer (1959) also noted *Rasamala* is the dominant species in his plot, which is located about 100 m below that of the present study.

In this study, however, no *Rasamala* was observed and only one *Podocarpus* was found. This means this stand is situated at the transition zone between *Rasamala* and *Podocarpus* zone. The dominant species are the species belonging to *Fagaceae*, *Lauraceae* and *Theaceae*. *Vernonia arborea* is the exception, not belonging to three families but rather dominant in the lst layer.

Polyosma integrifolia and *Macropanax dispermus* are the transition groups from the lst to the 2nd layer. *Turpinia sphaerocarpa* and *Symplocos fasciculata* are frequently found in the 2nd layer and dominant in the 3rd layer.

Saurauia pendula is overwhelmingly dominant in the 3rd layer, the second in total number to *Schima wallichii*. The life form is typical in the lower stratum which has comparatively low height for its diameter.

Fig. 5 is the summarized distribution pattern of each group on an H–H_B diagram.

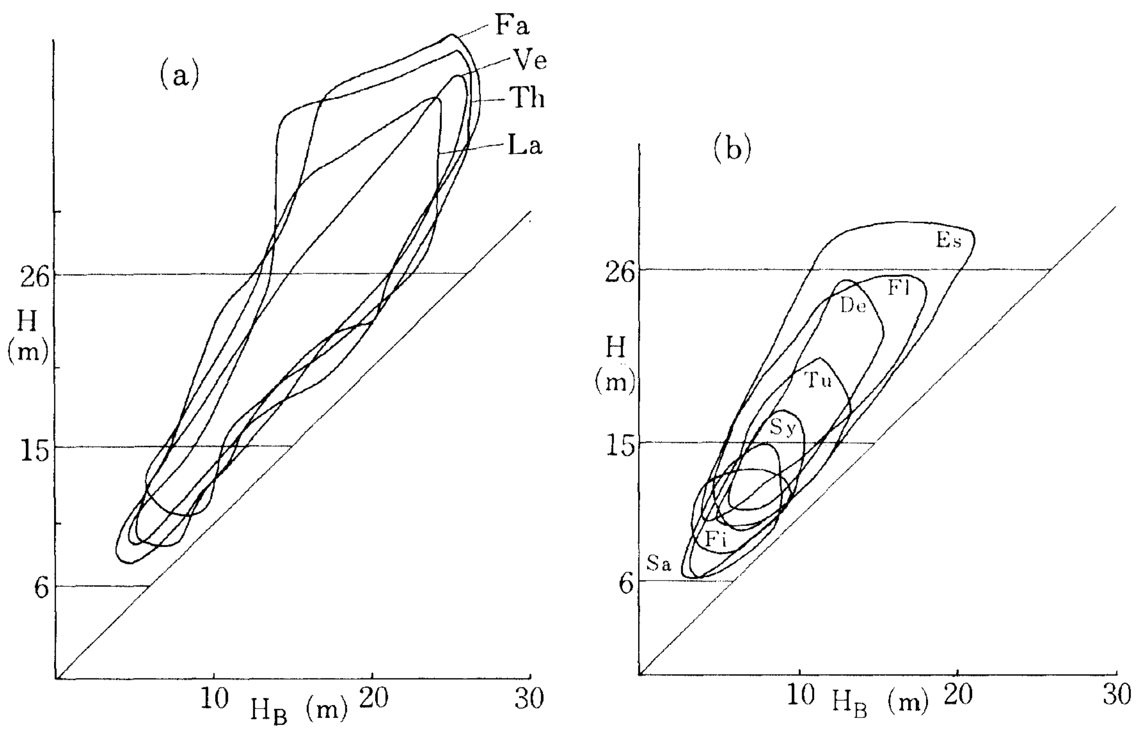

Fig. 5 Summarized H–H_B relations of dominant groups in three layers (a), and those in lower layers (b) in 1 ha. plot. Each line indicates the range of distribution. Key to symbols. Fa, Fagaceae ; Th, Theaceae ; La, Lauraceae ; Ve, Vernonia arborea ; Sa, Saurauia pendula ; Fi, Ficus ribes ; Sy, Symplocos fasciculata ; Tu, Turpinia sphaerocarpa ; De, Decaspermum fruticosum ; Fl, Flacourtia rukam ; Es, Escalloniaceae (Polyosma ilicifolia and P. integrifolia).

Table 3 Floristic composition of 1 ha. plot (trees over 10 cm DBH)

Species Name	1st layer		2nd layer		3rd layer		Broken trees		Total	
	No.	Relative dominance	No.	Relative dominance	No.	Relative dominance	No.	Relative dominance	No.	Relative dominance
Schima wallichii ssp. noronhae (Reinw. ex Bl.) Bloemb.	35	30. 57	9	8. 76	3	1. 34			47	25. 12
Saurauia pendula Bl.					44	35. 67	2	1. 73	46	2. 24
Castanopsis javanica (Bl.) DC.	20	25. 02	11	10. 15	6	2. 54			37	21. 01
Persea rimosa (Bl.) Kosterm.	11	6. 81	13	9. 59	4	1. 45	2	29. 72	30	7. 61
Turpinia sphaerocarpa Hassk.			5	3. 27	14	10. 37	5	5. 88	24	1. 23
Lithocarpus pseudomoluccus (Bl.) Rehd.	9	5. 29	6	4. 13	7	3. 08			22	4. 83
Decaspermum fruticosum var. polymorphum (Bl.) Bakh. f.			13	4. 86	7	2. 97			20	0. 76
Vernonia arborea Buch.-Ham.	6	4. 68	9	7. 34	4	1. 63			19	4. 64
Symplocos fasciculata Zoll.			2	0. 78	13	5. 83	1	1. 18	16	0. 49
Polyosma integrifolia Bl.	3	0. 61	9	6. 83	4	1. 36			16	1. 37
Polyosma ilicifolia Bl.			11	9. 39	4	1. 47			15	1. 20
Ficus ribes Reinw. ex Bl.					10	4. 76			10	0. 29
Macropanax dispermus (Bl.) O. K.	1	0. 48	2	4. 90	4	4. 44			7	1. 23
Flacourtia rukam Zoll. et Mor.			5	2. 92	1	0. 41			6	0. 37
Syzygium antisepticum (Bl.) Merry & Perry	4	2. 73	2	1. 83					6	2. 36
Astronia spectabilis Bl.			3	1. 42	2	0. 75			5	0. 21
Castanopsis argentea (Bl.) DC.					3	1. 10	2	1. 27	5	0. 11
Lithocarpus rotundatus (Bl.) A. Camus	4	5. 14					1	49. 22	5	5. 75
Mischocarpus fuscescens Bl.			3	2. 50	2	0. 99			5	0. 36
Saurauia blumiana Benn.					5	4. 12			5	0. 25
Villebrunea rubescens (Bl.) Bl.					5	2. 27			5	0. 14
Antidesma tetrandrum Bl.					4	1. 79			4	0. 11
Lithocarpus indutus (Bl.) Rehd.	3	1. 78	1	0. 50					4	1. 45
Pygeum parviflorum Teysm. et Benn.	4	1. 50							4	1. 17
Syzygium rostratum (Bl.) DC.			3	2. 35	1	0. 35			4	0. 30
Viburnum sambucinum Bl.					3	3. 36	1	1. 14	4	0. 25
Acronychia laurifolia Bl.			3	4. 94					3	0. 58
Casearia tuberculata Bl.	1	0. 33	1	1. 65	1	0. 74			3	0. 50

Eurya acuminata DC.			1	0. 29	2	1. 04			3	0. 10
Lithocarpus elegans (Bl.) Hatus. ex Soepadmo	1	0. 96			2	0. 83			3	0. 81
Litsea resinosa Bl.	3	0. 86							3	0. 68
Manglietia glauca Bl.			2	1. 11	1	0. 47			3	0. 16
Michelia montana Bl.	1	0. 32	2	3. 78					3	0. 70
Platea latifolia Bl.	3	4. 61							3	3. 62
Acronodia punctata Bl.			2	1. 86					2	0. 22
Dysoxylum alliaceum Bl.			1	0. 95	1	0. 46			2	0. 14
Elaeocarpus stipularis Bl.			1	0. 25	1	0. 27			2	0. 05
Engelhardia spicata Lech. ex Bl.	2	2. 49							2	1. 96
Hypobathrum frutescens Bl.					2	0. 70			2	0. 04
Litsea mappacea (Bl.) Boerl.			1	0. 91	1	0. 29			2	0. 13
Pithecellobium clypearia (Jack) Bth.							2	9. 33	2	0. 33
Pyrenaria serrata Bl.					2	0. 54			2	0. 03
Saurauia reinwardtiana Bl.					1	0. 25	1	0. 52	2	0. 03
Cinnamomum parthenoxylon (Jack) Meissn.	1	2. 05							1	1. 61
Cinnamomum sintoc Bl.	1	0. 40							1	0. 31
Glochidion macrocarpum Bl.			1	2. 17					1	0. 26
Gordonia excelsa (Bl.) Bl.	1	2. 28							1	1. 79
Ilex cymosa Bl.			1	0. 59					1	0. 07
Lithocarpus tijsmannii (Bl.) Rehd.	1	0. 62							1	0. 48
Macropanax undulatus (Wall. ex G. Don) Seem.					1	0. 26			1	0. 02
Meliosma ferruginea Bl.					1	0. 25			1	0. 02
Podocarpus imbricatus Bl.	1	0. 48							1	0. 38
Pygeum arboreum (Bl.) Endl. ex F. v. M.					1	0. 27			1	0. 02
Saurauia nudiflora DC.					1	0. 53			1	0. 03
Tarenna laxiflora (Bl.) K. & V.					1	0. 41			1	0. 03
Viburnum coriaceum Bl.					1	0. 27			1	0. 02
Viburnum lutescens Bl.					1	0. 38			1	0. 02
Total	116	100. 00	123	100. 00	171	100. 00	17	100. 00	427	100. 00

Dominant species groups indicate the similar pattern of distribution among three layers equally and groups dominant in the 2nd and the 3rd layer show the overlapping yet gradual changes among each stratum.

Families which have more than 3 species are *Fagaceae*, *Lauraceae*, *Theaceae*, *Saurauiaceae*, *Caprifoliaceae* and *Myrtaceae*. The most dominant family is *Fagaceae* (18 % in number and 34 % in basal area) and with *Lauraceae* and *Theaceae*, dominate the lst layer, as mentioned above. *Myrtaceae* is found mainly in the 2nd layer and *Saurauiaceae* and *Caprifoliaceae* belongs to the 3rd layer. Special to each family is a single species predominant in both number and basal area. *Castanopsis javanica* in *Fagaceae*, *Persea rimosa* in *Lauraceae*, *Schima wallichii* in *Theaceae* and *Saurauia pendula* in *Saurauiaceae*.

Generally speaking, in the tropical rain forest of lowland Southeast Asia, the number of trees per species is small and a dominant species does not exist. The most abundant species in southern Thailand, for example, *Padbruggea pubescens* covers only 7.8 % of density and 11.9 % of basal area (Ogawa et al. 1965). Moreover, Richards' study (1952) showed that the average number of trees per species is six to ten in 1.5 ha. plots in lowland forests.

With due regard to the above examples, the number of trees per species is shown to be relatively large in this stand. Twelve species count more than 10 individuals each and the species number of only one individual is 14. These features may indicate the different status of the montane forest from the lowland one. The decrease in air temperature is probably the key factor in deciding the species distribution and the adaptability to lower temperature can be analogized to examine the dominant group.

Ground vegetation

The investigation of plants smaller than 10 cm DBH was carried out separately above and below 1.3 m from the forest floor. Conclusions were arrived at through consideration of data at both levels.

Table 4 is a summary of the plants which appeared in ten 10×10 m^2 subplots. Species number in each life forms are 21 in trees, 8 in shrubs, 2 in herbs and ferns and 1 in palms. The most abundant species in each life form are *Strobilanthes cernua* in shrubs, *Nicolaia solaris* in herbs, *Cyathea raciborskii* in ferns and *Pinanga coronata* in palms.

In the case where the individual plant is not so big, the dominant species decided by the sole measurement is not always suitable. Many kinds of indices using a combination of several measurement, have been advocated. The SDR (summed dominance ratio) proposed by Numata *et al.* (1958) is used for the present analysis. SDR is calculated according to the following formula:

Table 4 Floristic composition of plants under 10 cm DBH and taller than 1.3 m. Based on 10 subplots of 10 × 10 m^2 size systematically placed along the diagonal line of 1ha. plot. Life forms are classified according to Backer (1963—1968).

Species Name	No. of individuals	Frequency	Basal Area (cm^2)	Mean Height (m)	SDR % (N'F' BA')	SDR % (N'F' BA'H')
Trees						
Castanopsis argentea (Bl.) DC.	5	3	35.86	3.9	13.9	22.7
Hypobathrum frutescens Bl.	4	4	44.64	4.0	17.8	25.9
Symplocos fasciculata Zoll.	4	2	29.73	4.0	9.7	19.8
Decaspermum fruticosum J. R. & Forst. var. polymorphum (Bl.) Bakh. f.	3	2	98.66	3.8	12.8	21.5
Saurauia pendula Bl.	3	3	39.97	3.6	13.7	21.5
Turpinia sphaerocarpa Hassk.	3	2	82.16	5.2	13.7	25.3
Apodytes cambodiana Pierre	2	2	28.31	5.8	9.2	25.0
Astronia spectabilis Bl.	2	2	9.06	4.0	8.3	18.7
Casearia tuberculata Bl.	2	2	23.83	3.5	9.0	17.7
Persea rimosa (Bl.) Kosterm.	2	2	65.83	7.3	11.0	31.1
Vernonia arborea Buch.-Ham.	2	1	47.38	3.5	6.4	15.8
Antidesma tetrandrum Bl.	1	1	69.40	8.0	7.2	30.4
Eurya acuminata DC.	1	1	51.53	7.0	6.4	26.7
Ficus ribes Reinw. ex Bl.	1	1	49.02	6.0	6.3	23.5
Glochidion cyrtostylum Miq.	1	1	10.75	4.5	4.4	17.4
Glochidion macrocarpum Bl.	1	1	2.84	4.0	4.1	15.6
Macropanax dispermus (Bl.) O. K.	1	1	14.52	6.0	4.6	22.2
Polyosma integrifolia Bl.	1	1	3.14	3.5	4.1	14.0
Lithocarpus pseudomoluccus (Bl.) Rehd.	1	1	43.01	8.0	6.0	29.5
Lithocarpus tijsmannii (Bl.) Rehd.	1	1	1.13	2.0	4.0	9.3
Schima wallichii (DC.) Korth. ssp. noronhae (Reinw. ex Bl.) Bloembergen	1	1	18.86	8.0	4.8	28.6
Shrubs						
Strobilanthes cernua Bl.	145	9	180.90	2.3	75.2	63.6
Ardisia fuliginosa Bl.	63	9	205.85	3.0	57.5	52.5
Talauma candollii Bl.	8	4	38.34	4.0	18.4	26.3
Saurauia reinwardtiana Bl.	4	2	86.10	5.4	12.4	26.2
Viburnum lutescens Bl.	3	2	82.00	6.0	12.0	27.7
Claoxylon glabrifolium Miq.	1	1	0.95	2.0	4.0	9.2
Lasianthus sp.	1	1	3.46	3.0	4.1	12.5
Saurauia blumiana Benn.	1	1	5.73	3.5	4.2	14.1
Palms						
Pinanga coronata (Bl. ex Mart.) Bl.	31	5	244.67	3.9	37.2	40.1
Tree Ferns						
Cyathea raciborskii Copel.	37	9	705.17	3.1	75.2	66.1
Cyathea contaminans (Wall. ex Hook.) Copel.	1	1	86.59	7.5	8.0	29.5
Herbs						
Nicolaia solaris (Bl.) Horan.	24	1	117.84	3.0	14.8	20.5
Cyrtandra sp.	5	1	3.95	1.5	5.0	8.5

$$SDR=\frac{\text{Density ratio(D')}+\text{Frequency ratio(F')}+\text{Cover ratio(C')}}{3}\%$$

Density ratio (Frequency and Cover ratio) is the ratio in terms of percentage of numbers (frequency and cover) of each species to the numbers of the most abundant species. If the height ratio is added, the denominator changes to 4.

Fig. 6 a is a composition curve of SDR calculated by density, frequency and coverage ratio. In Fig. 6 b height ratio is added to Fig. 6 a. The species name is arranged according to life forms on the cross axis. Fig. 6 a indicates that the shrubs, palms and tree-ferns are much more dominant than trees. Once the height element is included, however, trees come to dominate as shown in Fig. 6 b. The average SDR number per each life form calculated from the sum of each category appears in Fig. 6 c where the dominance pattern in each category is more easily seen.

Plants smaller than 1.3 m in height are shown in Table 5, based on the ten 1×1 m^2 quadrats. Herbs is the most abundant in species number, and combined with ferns, more than 50 % of species number belongs to these life forms. The number of individuals is also very high in herbs (68.2%) and next highest in shrubs. Fig. 7 a, b

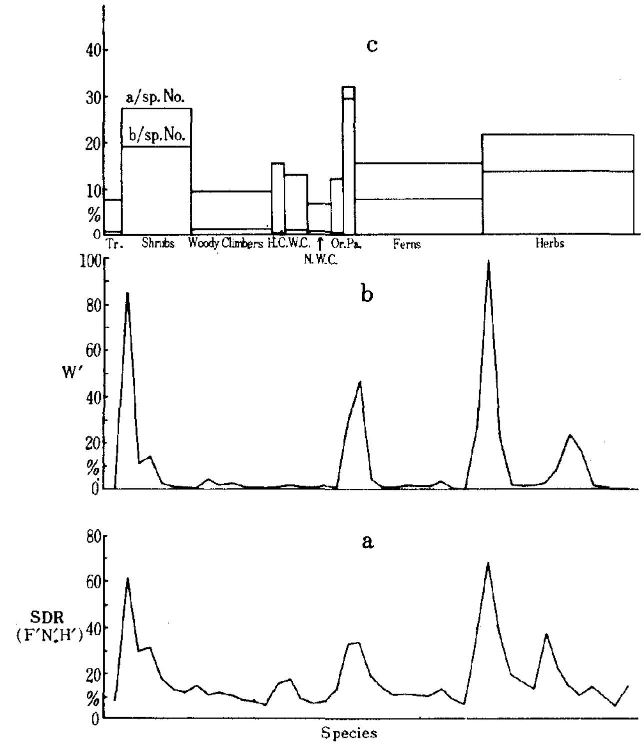

Fig. 6 Composition curve of the plants smaller than 10 cm DBH and taller than 1.3 m. a–SDR by N′, F′ and BA′ ; b–SDR by N′, F′, BA′ and H′ ; c–a. /species No., b. / species No. in each life form. Species order is the same as Table 4.

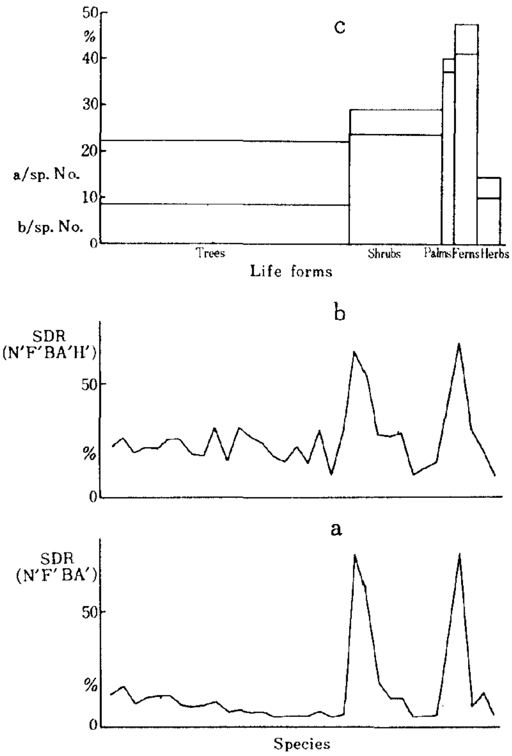

Fig. 7 Composition curve of the ground vegetation (plants smaller than 1.3 m in height). a–SDR by F′, N′ and H′. b–W′. c–a. /species No., b. /species No. in each life form. Species order is the same as Table 5.

Table 5 Floristic composition of ground vegetation (plants smaller than 1.3 in height). Based on 10 quadrats of 1 × 1 m² size systematically placed along the diagonal line of 1 ha. plot. Life forms are classified according to Backer (1963—1968) and the author's own observation.

Species Name	Frequency	Number of Individuals	Fresh Weight including root (g)	Mean Height (cm)	SDR (F'N'H')
Trees					
Saurauia pendula Bl.	1	2	16	11.0	7.7
Shrubs					
Strobilanthes cernua Bl.	8	35	1957	72.5	62.0
Psychotria divergens Bl.	4	5	251	42.8	29.8
Ardisia fuliginosa Bl.	3	5	334	63.3	31.3
Rubus moluccanus L.	2	3	45	30.0	17.4
Saurauia reinwardtiana Bl.	1	1	19	30.0	12.7
Talauma candollii Bl.	1	1	9	25.0	11.3
Woody Climbers					
Tetrastigma sp.	3	3	14	4.3	14.4
Cissus adnata Roxb.	2	2	94	5.0	10.2
Ficus lanata Bl.	2	2	37	8.5	11.2
Ficus trichocarpa Bl.	1	1	47	20.0	10.0
Piper baccatum Bl.	1	1	12	13.0	8.0
Piper cilibracteum DC.	1	1	4	10.0	7.2
Tetrastigma papillosum (Bl.) Planch.	1	1	4	5.0	5.8
Herbaceous Climbers					
Smilax sp.	1	1	10	40.0	15.5
Woody Creepers					
Piper sulcatum Bl.	2	2	30	30.0	17.2
Piper sp.	1	1	14	15.0	8.6
Non-woody Creepers					
Malaxis sp.	1	1	2	6.0	6.1
Scindapsus hederaceus (Z. & M.) Miq.	1	1	28	10.0	7.2
Orchids					
A species of Orchidaceae	2	2	11	12.5	12.3
Palms					
Pinanga coronata (Bl. ex Mart.) Bl.	2	2	676	85.0	32.4
Ferns					
Cyathea raciborskii Copel.	3	4	1089	71.7	33.4
Thelypteris heterocarpa (Bl.) Ching	2	2	92	35.0	18.6
Nephrolepis acumimata (Houtt.) Kuhn	2	3	15	15.0	13.2
Asplenium sp.	1	1	12	20.0	10.0
Diplazium sp.	1	3	30	20.0	10.5
Diplazium pallidum (Bl.) Moore	1	1	27	20.0	10.0

Species Name	Frequency	Number of Individuals	Fresh Weight including root (g)	Mean Height (cm)	SDR (F'N'H')
Dryopteris hirtipes (Bl.) O. K.	1	1	22	20.0	10.0
Dryopteris sp.	1	2	70	30.0	13.0
Egenolfia appendiculata (Willd.) J. Sm.	1	1	4	15.0	8.6
Trichomanes sp.	1	1	2	7.0	6.3
Diplazium dilatatum Bl.	1	1	620	110.0	35.0
Herbs					
Elatostema paludosum (Bl.) Hassk.	7	137	2285	20.7	68.2
Cyrtandra picta Bl.	6	18	507	30.0	37.7
Zingiber inflexum Bl.	3	7	35	17.7	19.1
Arisaema filiforme Bl.	2	3	26	25.0	16.0
Amomum hochreutineri Val.	1	1	32	30.0	12.7
Coleus galeatus (Poir.) Bth.	1	1	200	120.0	37.7
Cyrtandra sp.	1	6	540	60.0	22.3
Elatostema sp.	1	18	355	20.0	14.1
Forrestia marginata (Bl.) Back.	1	3	24	20.0	10.5
Forrestia sp.	1	1	20	35.0	14.1
Lycianthes laevis (Dunal) Bitt.	1	1	2	20.0	10.0
Musa acuminata Colla	1	2	2	4.0	5.8
Amomum pseudo-foetens Val.	1	1	65	35.0	14.1

indicates the composition curve by SDR and weight ratio (W'). The species names are ordered by frequency. The diagram using SDR is more balanced than those using W'. Each life form has its maximum SDR in particular one species. Fig. 7 c shows the average SDR and W' of each life form unit, in which shrubs, herbs, and ferns are dominant and woody climbers and palms are next dominant.

Some of the characteristic points of the 4th and 5th layers are as follows:

Tree species found in the 5th layer is only *Saurauia pendula*, which belongs to the 3rd layer properly and does not reach the 1st layer. The lack of saplings of *Fagaceae*, *Lauraceae* and *Theaceae* in the 5th layer is interesting. This, however, may be due to small sample size. Actually, the author found such saplings by careful investigation in the stand. Meijer also noted the existence of these saplings. Thus the balance of regeneration capacity is still being maintained in this layer, though the fact is not clear in the data.

Strobilanthes cernua is a vast, abundant species in the shrubs. This species widely covered the ground layer from 50 to 200 cm in height. Steenis *et al.* (1972) mentioned that this group often occurs gregariously in the Javanese mountain forest undergrowth in complete dominance. According to his report, this group grows steadily for seven or more years to attain a height of 2-3 m (sometimes higher), suddenly flowers and then dies off. Gregarious germination follows shortly afterward, and the same cycle begins again. This fact is one of the typical examples which affords proof of the dynamic stability in each layer. *Ardisia fuliginosa* is the next abundant species in shrubs.

As briefly mentioned in the preceding section of the stratification, palms and tree ferns are the characteristic group over the *Strobilanthes*' thick layer. Palms, *Pinanga coronata*, grow up forming clumps sporadically in the stand. Their height is 2-8 m and their total number count 310., and 2446.7 cm^2 in basal area per ha. Two species of tree ferns were found in this plot, one is *Cyathea contaminance* which is relatively taller than the other, *Cyathea raciborskii*. The average height range is 50 cm – 10 m, and thier growth is isolated. Total number per 1 ha. is 383. and total basal area is 8895.0 cm^2/ha., which is bigger than palms.

Of the herb group, *Nicolaia solaris* appeared to be the largest in number. Unlike other species, however, it occurs only once on the sunny spot of a rather large gap made by a fallen tree. *Elatostema paludosum* is more commom in general and is a dominant species of herbs. The second most abundant is *Cyrtandra* sp. Species belonging to *Zingiberaceae*, such as *Zingiber inflexum*, *Amomum hochreutineri*, and *Amomum pseudo-foetens* occur with *Musa acuminata* at rather light habitat.

Woody climbers and creepers are not rich on the ground layer mainly due to the small sample area. As mentioned in the following section, they play an important part in characterizing the stand.

Compared with the lowland forest, the 4th and 5th layer of the montane forest of this region are distinguished by the existence of *Pinanga* and *Cyatheaceae* above the gregarious *Strobilanthes* mass. Richness of the total soil herbs is also noticeable. Soil herbs, including herbs, ferns and orchids, number 24 in this plot, and 73 in Meijer's plot.

Epiphytes and woody climbers

The microclimate within the complicated canopy may have a noteworthy influence on the distribution of epiphytes and woody climbers. The tropical montane forest, in which the relative humidity is supposed to be very high throughout the year, is known to have an abundance of epiphytes and woody climbers. Went (1940) carried out a detailed study of epiphytes and woody climbers and reported its richness in the surroundings of Cibodas. The author recorded the species number of these groups, which can be observed from the ground without instrument. Investigation covered the trees over 10 cm DBH found in half of the 1 ha. plot. Total number of the trees investigated was 237.

Of the four groups, orchids is the richest in species number (40), but, as many of the species in this group were not identified, some of those thought to be different may be prove to be identical. The species number of ferns is 29 and woody climbers and epiphytic treelets group has same number (26). The rate of the trees with epiphytes to ones without epiphytes is shown in Fig. 8. The percentage of non-epiphytic trees is larger in the small size class (38. 3 % in 10 cm DBH class), but, as tree size increases, almost all have epiphytes except for two trees of 80 cm DBH class. The average number of epiphytic species on one tree is given in Table 6.

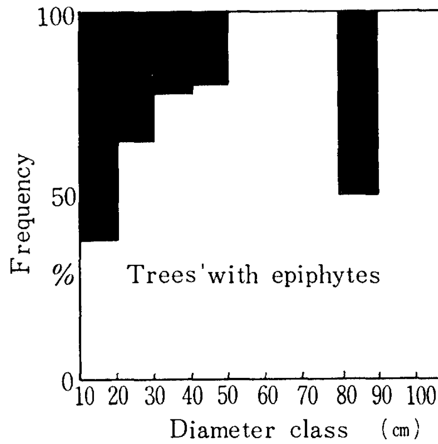

Fig. 8 Relationship between trees with epiphytes and those without epiphytes

Ficus ribes and *Symplocos fasciculata* have no epiphytes save one tree in each. These species are a main component of the 3rd layer. On the whole, epiphytes is found more on the larger trees than on the smaller ones.

Table 7 is lists the whole species of epiphytes devided into four groups and enumerates the frequency of occurrence of species on the trees in each diameter class.

Among ferns, *Asplenium nidus* is the most abundant (47), and distributed evenly from smaller to larger trees. As noted by observation, this species is the most distinctive in the stand, but is rare on *Castanopsis javanica*, *Polyosma ilicifolia* and *P. integrifolia*. Next abundant is *Oleandra musifolia*, which is found on *Schima wallichii* and *Persea rimosa*. Yet other species indicate rather arbitrary distribution and no such tendencies are exhibited.

Appendicula ramosa and *Liparis pallida* among orchids are relatively abundant on small size trees.

Within the third group, *Fagraea ceilanica* and *Schefflera scandens* are evenly distributed in each class. The former was not found on *Decaspermum fruticosum*, *Polyosma integrifolia* and *Saurauia pendula*, but was found to be abundant on the larger-sized *Schima wallichii*. The latter did not appear on *Decaspermum* and *Turpinia*. *Medinilla verrucosa* and *M. laurifolia* mainly grow on small-sized trees, while *Vaccinium lucidum* is found more on large-sized trees. *Agalmyla parasitica* is evenly found in each class. Both the frequently appearing epiphytes as well as the rarely appearing species occurred solely on the larger-sized trees, such as *Castanopsis javanica*, *Persea rimosa*, *Lithocarpus pseudomoluccus* and *Schima wallichii*. Relatively scarce epiphytes such as *Medinilla speciosa*, *Ficus sinuata* and *Procris frutescens* occur on *Saurauia pendula* which never enjoy the full sun-light at the 3rd layer.

In the woody climbers group, *Ficus lanata*, *Piper baccatum* and *Ficus sagittata* grow evenly in each class. Abundant species are found in each class, but rare species

Table 6 Average number of epiphytic species per tree and the number of tree without epiphytes in each diameter class (trees larger than 10 cm DBH found on half of 1 ha. plot.)

Species Name	Average number of epiphytic species per tree (only trees with epiphytes)										Number of trees without epiphytes									
	10	20	30	40	50	60	70	80	90	100	10	20	30	40	50	60	70	80	90	100
Schima wallichii (DC.) Korth. ssp. noronhae (Reinw. ex Bl.) Bloembergen	1	1	3.5	3.2	6	4.8	4.3	7	4.5		2	1								
Saurauia pendula Bl.	2.5	1.7									7	2								
Castanopsis javanica (Bl.) DC.	2	1.3	3.5	2		3.5	5		6	5	3	3	1	1						
Persea rimosa (Bl.) Kosterm.	3		3	2			4			8	2		1							
Turpinia sphaerocarpa Hassk.	3.5	5									4	1								
Lithocarpus pseudomoluccus (Bl.) Rehd.		5	2.5	3.5	4	7	3	5												
Decaspermum fruticosum var. polymorphum (Bl.) Bakh. f.	2.0	1									4									
Vernonia arborea Buch.-Ham.			3						3.5		1		1							
Symplocas fasciculata Zoll.		3									11									
Polyosma integrifolia Bl.	1	1	3								2		1							
Polyosma ilicifolia Bl.	2	3	3.7								5		1							
Ficus ribes Reinw. ex Bl.	1										7									
Macropanax dispermus (Bl.) O. K.	1.5		2		5						1									
Flacourtia rukam Zoll. et Mor.	1										1	2								
Syzygium antisepticum (Bl.) Merry & Perry												1								
Astronia spectabilis Bl.		1									1									
Castanopsis argentea (Bl.) DC.											3									
Lithocarpus rotundatus (Bl.) A. Camus							4													
Mischocarpus fuscescens Bl.		3	6								2									
Villebrunea rubescens (Bl.) Bl.	1										2									
Antidesma tetrandrum Bl.	1										2									
Lithocarpus indutus (Bl.) Rehd.							6				1	1								
Pygeum parviflorum Teysm. et Benn.			2.5											1						
Syzygium rostratum (Bl.) DC.											1									

Species Name	Average number of epiphytic species per tree (only trees with epiphytes)										Number of trees without epiphytes									
	10	20	30	40	50	60	70	80	90	100	10	20	30	40	50	60	70	80	90	100
Viburnum sambucinum Bl.		2									2									
Acronychia laurifolia Bl.		2	1	3																
Casearia tuberculata Bl.	1		3																	
Eurya acuminata DC.	3										1									
Lithocarpus elegans(Bl.)Hatus. ex Soepadmo							6													
Litsea resinosa Bl.			3									1	1							
Manglietia glauca Bl.	1										1	1								
Michelia montana Bl.				3									1	1						
Platea latifolia Bl.				2														2		
Acronodia punctata Bl.		2. 5																		
Elaeocarpus stipularis Bl.	2										1									
Hypobathrum frutescens Bl.											1									
Litsea mappacea (Bl.) Boerl.		2									1									
Pithecellobium clypearia (Jack) Bth.		1																		
Pyrenaria serrata Bl.	2																			
Saurauia reinwardtiana Bl.	2																			
Cinnamomum parthenoxylon (Jack) Meissn.										5										
Cinnamomum sintoc Bl.				4																
Glochidion macrocarpum Bl.				1																
Gordonia excelsa (Bl.) Bl.										6										
Macropanax undulatus (Wall. ex G. Don) Seem.											1									
Meliosma ferruginea Bl.											1									
Podocarpus imbricatus Bl.						3														
Pygeum arboreum (Bl.) Endl. ex F. v. M.											1									
Tarenna laxiflora (Bl.) K. & V.	1																			
Viburnum coriaceum Bl.	1																			
Viburnum lutescens Bl.											1									

Table 7 Floristic composition of epiphytes and climbers found on the trees larger than 10 cm DBH in half of 1 ha. plot.

Species	Diameter class 100	90	80	70	60	50	40	30	20	10	Total
Ferns											
Asplenium nidus L.	1	1		4	1	4	5	11	7	13	47
Oleandra musifolia (Bl.) Presl.	4	1		2	3			2	1		13
Nephrolepis acuminata (Houtt.) Kuhn								1	2	1	4
Elaphoglossum califolium (Bl.) Moore			1							3	4
Lycopodium phlegmaria L.			1					2			3
Hymenophyllum junghuhnii v. d. B.										3	3
Elaphoglossum petiolatum (Sw.) Urban							1			1	2
Crypsinus macrochasmus (Bak.) Copel.							1			1	2
Asplenium caudatum Forst.										1	1
Asplenium thunbergii Kunze						1					1
Davallia trichomanoides Bl.										1	1
Lomariopsis spectabilis (Kunze) Mett.										1	1
Asplenium spp. A.–B.						1		1			2
Davallia spp. A.–E.	1				1			2		1	5
Elaphoglossum spp. A.–D.	1			1			1			1	4
Hymenophyllum spp. A.–B.									1	1	2
Polypodium sp.							1				1
A species of Polypodiaceae								1			1
Trichomanes sp.										1	1
Orchids											
Appendicula ramosa Bl.				1				4	2	4	11
Liparis pallida (Bl.) Lindl.					1		1	3	1	2	8
Malaxis blumei (Boerl. & J. J. S.) Bakh. f.										3	3
Bulbophyllum uniflorum (Bl.) Hassk.							1	1			2
Cyperorchis rosea (J. J. S.) Schltr		2									2
Agrostophyllum sp.										1	1
Bulbophyllum sp.								1			1
Liparis sp.					1						1
Thirty-two species of Orchidaceae		2		3	1	2	6	9	4	5	32
Treelets and lichens											
Fagraea ceilanica Thunb.	1	2	2	7	2			5	4	4	27
Schefflera scandens (Bl.) Vig.	2	1		4	3	2	4	4	4	2	26
Medinilla verrucosa (Bl.) Bl.	1		1	1	1		2	4	2	4	16
Medinilla laurifolia (Bl.) Bl.	1					1		4	4	5	15
Vaccinium lucidum (Bl.) Miq.	2	3	1	2	4		2			1	15
Agalmyla parasitica (Lamk) O. K.	1					1		2	1	7	12
Schefflera lucescens (Bl.) Vig. var. rigida (Bl.) Bakh. f.		1	1	1			3	1		2	9
Ficus deltoidea Jack.		1	1	3	1	1		1			8
Aeschynanthus horsfieldii R. Br.					2			1	1	1	5
Vaccinium laurifolium (Bl.) Miq. var. ellipticum (Bl.) Sleum.		1	1	1	1	1					5

Species	Diameter class 100	90	80	70	60	50	40	30	20	10	Total
Procris frutescens Bl.								1		3	4
Medinilla speciosa (Reinw. ex Bl.) Bl.									1	3	4
Ficus sinuata Thunb. ssp. cuspidata (Reinw. ex Bl.) Corner					1					2	3
Vaccinium laurifolium (Bl.) Miq. var. laurifolium			1		1		1				3
Rhododendron javanicum (Bl.) Benn.				1	1						2
Hedychium roxburghii Bl. var. roxburghii									1		1
Ilex spicata Bl.			1								1
Diplycosia heterophylla Bl.					1						1
Usnea sp.		1									1
Fagraea sp.					1						1
Schefflera spp. A–F.		1					2	1	1	1	6
Woody climbers and others											
Ficus lanata Bl.	2	2		1	3		5	4		1	18
Piper baccatum Bl.	1	1		4	1			1	1	3	12
Rhaphidophora pinnata (L. f.) Schott				1		1	1	2	3	4	12
Ficus sagittata Vahl	1		1	2	1	1	1	2		1	10
Tetrastigma dichotomum (Bl.) Planch.				2	1	1	2	2		1	9
Embelia ribes Burm. f.							2	1	3	2	8
Ficus trichocarpa Bl.				1		1	2		1	2	7
Elaeagnus conferta Roxb.		1		1					3		5
Dendrotrophe umbellata (Bl.) Miq.	1	1		1						1	4
Piper cilibracteum DC.	1			1				1			3
Psychotria sarmentosa Bl.								2	1		3
Freycinetia insignis Bl.								1	1	1	3
Cissus adnata Roxb.	1									1	2
Kadsura scandens (Bl.) Bl.							1			1	2
Dissochaeta leprosa (Bl.) Bl.										1	1
Rubia cordifolia L.										1	1
Mussaenda frondosa L.									1		1
Actinidia callosa Lindl. var. callosa									1		1
Embelia pergamacea DC.	1										1
Alyxia reinwardti Bl.										1	1
Smilax macrocarpa Bl.										1	1
Smilax spp. A.–D.	1	1								2	4

are found on smaller-sized trees. This tendency is the reverse of that in the former group. Many kinds of species in this group grow on *Schima wallichii* and *Lithocarpus pseudomoluccus* regardless of size class. On the contrary, on *Castanopsis javanica* and *Saurauia pendula*, this group occurs only in larger size trees.

The total frequency of species appearance is 61 in orchids, 98 in ferns, 165 in epiphytic treelets, and 109 in woody climbers, totaling 433. The total number of species is 121, assuming all the unidentified species are different. These numbers will increase with further detailed study, focussing on the upper part of the branch layer of each tree.

According to Went (1940), a species rarely grows one individual but averages 3-4 individuals, and sometimes 7 individuals on the same tree. At the montane forest in Equador, 2555 individuals from 91 species of epiphytes and 778 individuals from 49 species of woody climbers were reported in 465 m^2 plot [Grubb *et al.* (1963)]. Meijer referring to Went's study, estimated 100 species in epiphytes, 20 of woody climbers, 10 of non-woody climbers and creepers, 1 of stranglars and 1 of the semi parasite. Compared with these figures, the total number of species found in the stand is not surprising, but, the total individual number remains unknown. More intensive survey is quite necessary for future study.

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