AN ACRE OF DISTRIBUTED FOREST

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AN ACRE OF DISTURBED FOREST

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INTRODUCTION:

Portion of Sungei Buloh Forest Reserve compartment No. 30 was cleared as an extension of the Rubber Research Institute Experiment Station in 1954. In order to follow the changes in soil and vegetation following cultivation an acre plot was sampled. However, the results are probably of more general interest as an example of lowland forest some years after selective exploitation.

HISTORY:

Only a rough outline of the history of the whole compartment is known, there is no precise history of the particular acre. In 1934 and 1935 trees were taken for plywood manufacture, in 1936 pole felling and the extraction of White Meranti (*Anthoshorea* group) were undertaken, in 1939 to 1941 a so-called 'final' felling was carried out. This latter was in fact an extraction of desired timbers only. The large trees of *Dialum*, *Koompassia*, *Melanorrhoea* and *Ochanostachys*, found scattered throughout the area were evidently not touched during these fellings. The ages of certain large trees were computed after Edwards (1930).

Ochanostachys amentacea	—	17, 52, 55, 62, 73, 93, 113, 172 and 206 years.
Shorea leprosula	—	14, 16, 19, 19, 21, 22, 23, 25 and 31 years.
Shorea parvifolia	—	10, 11, 18, 22, 25 and 29 years.

These are very rough estimates, but indicate that we were dealing with a mixed population, *i.e.* trees left by the previous exploiters of the forest and trees which had advanced in growth from seedling or sapling since disturbance.

SOIL:

A pit was dug near the centre of each square chain quadrat. These pits fell along a transect through the sample plot and the profile obtained is shown in fig. 1. Despite small variations in the depth of the humic layer, the general profile was similar throughout. The profile was of the podsolic type, although we did not excavate far enough to reach the B horizon. The soil structure was fairly good, the fertility as judged by the % Nitrogen was fair but owing to the large proportion of coarse sand, the soil was very permeable. The clay particles had been washed downward.

THE SURVEY:

The sample plot was one acre, 10 chains × 1 chain (660 feet × 66 feet), or in metric measure 4,047 sq. metres (201.2 × 20.1 m). The long axis ran in a south-westerly direction. The plot was divided into ten quadrats of 1 square chain in which all trees 12½ inches (31.75 cms.) a girth or more were recorded and measured, these were the "tree samples". Plants more than 5 feet (150 cms.) high, but 12 inches or less in girth, were recorded and measured in a strip, one quarter of the plot width running along the central axis of the plot. This was divided into 40 quadrats each, 16.5 feet square (approx. 1.5 metres square), these were the "pole samples". Smaller plants were recorded in a strip one tenth of the plot width,

divided into 100 quadrats, each 6.6 feet square (approx. ⅕ metres square), *i.e.* 1 milliacre, these were the "ground flora samples".

Certain trees were located on the boundaries of the quadrats. In these cases every tree any portion of the base of which was within the north and west boundaries was included, whereas along the east and south boundaries the whole of the base of the tree had to be within the quadrat boundary for inclusion.

TREE SAMPLES:

The list of trees (12½ inches girth or more) in the sample plot is given in Table I. Species, which did not appear in the sample plot but which were on the east and south boundaries, are given in an addendum to Table I, certain of these were larger trees than those found in the sample plot. In Table II the percentage representation is given.

The Frequency index indicates the proportion of the one square chain quadrats in which the species was present.

The occurrence of prop roots, buttresses and fluting of the trunk is given in Table III.

The distribution of the trees in this class has been investigated, irrespective of species or subdivisions of this class into girthor height categories, by two methods.

Firstly each one square chain quadrat was divided into 16 equal sub-quadrats and the number of trees in each determined. The Chi- square test was applied.

No. of trees in sub-quadrat	0	1	2	3	4	5	6	Total
No. of sub-quadrats Actual	30	64	47	17	2	0	0	160
Estimated (Poisson)	41	56	38	17	6	2	0	160
No. of trees Actual	0	64	94	51	8	0	0	217

Actual Mean: 1.356 Chi-Squared 10.84

Variance: 0.892 Probability 9.6 %

The trees were not perfectly distributed at random, but showed a slight tendency to regular distribution; however, the deviation from random distribution was not significant and could not be established with confidence. An objection to this analysis is that the sub-quadrats were regularly arranged and not chosen at random.

Secondly Hopkins' method (1954) was applied. In this a plant is chosen at random and the distance to the nearest plant of the same category is measured, this procedure is repeated, Also points are chosen at random and the distance from each point to the nearest plant of the category concerned is measured. Equal

numbers of randomly selected plants and points are treated in this manner. The sum of the squares of the distances from the random points to the nearest plants to them is divided by the sum of the squares of the distances from the randomly chosen individual plants to their nearest plants, this quotient is the coefficient of aggregation.

In this instance the distances were measured in arbitrary units on an accurate ground plan for 50 points and 50 trees (12½ inches or more in girth) chosen at random. The coefficient of aggregation obtained was:—0.95 which indicates aprobability that the distribution was random of 42%.

A coefficient of 1.00 indicates random distribution, higher values indicate aggregation and lower values indicate a regular distribution. No significant departure from random distribution of the trees could be detected in this case.

These two tests agree in that the trees were distributed at random with a not significant tendency to regular distribution. From the silviculturalist's viewpoint a more regular distribution would have been preferable.

The trees are separated into height and girth classes in Table IV, the curve in fig. 2 is an approximate expression of the relationship of height to girth. The larger trees are given by species in Table V. The groups were selected on the basis of discontinuities in the histograms. *Ochanostachys amentacea* occurs in the upper range for both features, but it could hardly be considered dominant, although shortly after disturbance much of the remaining shade was probably provided by this species.

The most frequent tree was *Endospermum malaccense*, which was less evident in the "pole" samples and absent from the ground flora. This and other evidence suggests that *Endospermum* was one of the first trees to invade or regenerate in the most disturbed portions. It occurred in five of the ten one-square chain quadrats; the species found apparently in association with *Endospermum* in these quadrats, but not elsewhere, are given in Table VI, which gives also those which showed the reverse relationship. We have remarked that *Ochanostachys* will have provided shade where left and the act of leaving the *Ochanostachys* will have been the converse of disturbance in any case. The quadrats where *Endospermum* and *Ochanostachys* occur overlap. However, certain species appeared to be associated with *Ochanostachys*, two of which did not seem to be associated wih *Endospermum* (Table VI). The species associated with *Ochanostachys* are not believed to be quick growing. None has been much desired as timber in the past. None was well represented in the "pole", or ground flora samples. Probably these species were left untouched with the *Ochanostachys* during disturbances.

"Pole "and ground flora samples:

The results of these samplings are given in Tables VII and VIII, Tables IX and X respectively. The lianes, climbers, creepers and epiphytes have been omitted from this report.

The erect plants in all samplings have been divided into height classes, 0-5, 6-10. . . . . .91-95, 96-100 feet. The numbers from the ground flora quadrats have been multiplied by 10, those from the "pole" samples by 4, the latter overlap with the tree sample, Thus estimated numbers of the plants in each height class for the whole acre have been obtained. These are expressed in a histogram, fig. 3; note that logarithms of numbers are employed for the vertical scale.

No particular association between different elements in the pole or ground flora samples could be found, nor could any relationship be detected between any element in these lower strata and the character of the upper story, e.g. with the

presence or absence of *Endospermum* or *Ochanostachys*. The different species were scattered throughout the length of the sample plot. This may indicate that this undergrowth had all developed under shade either of the trees left at disturbance or of fast growing trees such as *Endospermum malaccense* and *Shorea leprosula* after disturbance.

The abundance of Rubiaceae in the lower levels was owing to the presence of many small trees and shrubs typical of this layer. With the exceptions of *Ixonanthes isocandra* and *Xerospermum intermedium*, the populous species in the tree sample were poorly represented at lower levels. Desired timber species were particularly poorly represented.

The percentage representation tables have been extended to include the Dipterocarpaceae, whose, representation was poor in these lower strata.

Comparative figures are scanty, but Barnard (1956) reports that in a virgin Jungle Plot of Sungei Menyala Forest Reserve, the average density of the economic timber species seedling population never fell bellow 2,333 per acre. Only 5 out of 27 milliacre quadrats were ever bare of economic seedlings at any time during six and half years. Probably little more than 10% of the identified plants in our Sungei Buloh ground flora quadrats could be considered as tolerable economic species. Assuming a similar proportion among the unidentified seedlings (which is doubtful for we had the kind assistance of the foresters in identification), there may have been 1;400 small plants of tolerable species per acre, none of preferrred species (Barnard 1950). This estimate is probably generous and indicates poor stocking compared with Barnard's figures.

The explanation lies in the history of the area. The forest was disturbed by the protracted exploitation of desired timbers, leaving large trees of unwanted species. The conclusion of this period coincided with the outbreak of the War in the Pacific Region, as a result silvicultural measures to promote selective regeneration of desired species were not applied at this stage when they were probably most needed.

It must be appreciated that this is a very small sample from which to draw any conclusions. Tentatively we suggest the following scheme for the past and continued development of the upper storey trees.

	Most disturbed portion	Least disturbed portion
Remnants		*Ochanostachys amentacea* *Elaeocarpus aff nitidus* *Nephelium lappaceum* *Shorea parvifolia*
Pioneers of advanced growth	*Endospermum malaccense* *Shorea leprosula* *S, singkawang* *Litsea megacarpa* *Macaranga populifolia*	
Probable successors	*Eugenia* spp. *Ixonanthes icocandra* *Xerospermum intermedium*	

CONCLUSION:

Disturbance of forest without silvicultural measures has produced a stand of trees distributed more or less at random. Although some acceptable economic species are present in the top storey, the majority of the plants likely to dominate further regeneration are not preferred timber species.

ACKNOWLEDGEMENTS:

We are most grateful to Mr. G.M.F. Grundy for examination of the soil and to Mr. J. Wyatt-Smith and Mr. K.M. Kochummen (Forest Research Institute) for plant identification. The survey formed part of the research programme on vegetation of the Rubber Research Institute of Malaya and the Director's permission to contribute this account to the Symposium is gratefully acknowledged.

POSTSCRIPT:

The paper presented to this Symposium by J. Wyatt-Smith entitled "Development of a Silvicultural System for the Conversion of Natural Inland Lowland Evergreen Rainforest of Malaya" should be consulted for an interpretation of the changing assessment of the economic status of various species and to obtain an appreciation of the area discussed in a historical perspective. This will indicate that the advanced growth of *Shorea* species in the upper strata may be considered satisfactory and the starting point for inadequate regeneration, although silvicultural measures might have encouraged a better distribution and improved stocking. The conclusions of the paper as presented should be modified in this way.

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BIOGRAPHICAL NOTES OF AUTHORS

PAUL R. WYCHERLEY, Ph.D , B.Sc. (Hons) Lond.

Born in England in 1928. After graduation from University College, London in 1949, various ecological physiological and taxonomic aspects of the "viviparous" grasses were investigated.

oined the staff of the Botanical Division of the Rubber Research Institute of Malaya in January, 1953. Current investigations include the association of naturally occurring vegetation and of sown cover crops with the main crop *Hevea*, improved methods of establishment of desired cover crops, plantation practice and economy, "secondary" characteristics of *Hevea*.

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Born in India in 1923. Lecturer in Botany at S. D. College, Alleppy 1951 to 1952, Assistant Botanist in charge of the herbarium of the Botanical Division of the Rubber Research Institute of Malaya 1952 to 1957. At present in India.

DISCUSSION

DR. KOSTERMANS

Apparently the same type of forest as described by Mr. Wycherley occurs in Central Sumatra on poor soils. *Shorea leprosula, Sh. ovalis* and *Sh. parvifolia* are the most common emergent trees, together with some 5 other kinds of *Shorea* which are far more rare and have harder and better timber. It looks as if the latter have been eliminated by selective felling in Mr. Wycherley's plot. In Sumatra likewise only the former three remain and regenerate after the better *Shoreas* have been cut out.

Nephelium lappaceum does not occur in wild state in Sumatra; I discovered it in East Borneo. In Sumatra there are several other kinds of *Nephelium.* The wild *Nephelium lappaceum* was an enormous tree of 120 feet with buttresses up to 12 feet high.

DR. WYCHERLEY

About half the larger specimens of *Nephelium lappaceum* were buttressed and extended into the largest size class (see tables I, III and V). It was not the cultivated variety, but probably the wild species from which the fruit tree was derived.

DR. KOSTERMANS

Ochanostachys is likewise very common in this type of forest in Sumatra. It is not used there, although it has good timber and its occurrence in such quantities in Mr. Wycherley's tables suggest likewise, that they were not used during the selective felling.

PROF. GILLILAND

In our discussion of the poor representation of *Dipterocarpaceae* in the lower levels you mentioned Mr. Nicholson's shading experiments, suggesting that light might be a limiting factor. I would like to defend the position adopted by Mr. Nicholson. He states that seedlings do best in about 50-75% full light which is an indication of optimum light conditions. Secondly I would like to ask whether the rooting of *Flemingia* is not sufficiently deep and if so whether it has nodules down to any depth.

DR. WYCHERLEY

Flemingia congesta has deeper rooting, appears to thrive on degraded soils and circulate nutrients better than the conventional creeping leguminous covers. Moreover the shade tolerance is better, but the degree of nodulation less. However, reliance on plants of one family and one or two growth forms may be unsound. Such a limited spectrum of not very persistent species in association with the main tree crop probably cannot maintain soil fertility, control erosion and circulation of nutrients as achieved by natural forest. We may need to find in natural vegetation further 'elements' which contribute to these processes and introduce them into cultivation of tree crops.

MR. WYATT-SMITH

All foresters in Malaya will be most interested in this paper which we have been eagerly awaiting. Dr. Wycherley draws attention to the representation of the *Dipterocarpaceae* and remarks that it is poor in the lower strata. I am not at all surprised at this for the following reasons. It is recognised in Malaya that natural Dipterocarp forest generally has a pool of regeneration, which is released when the forest canopy is opened up. Some of this goes right through, much succumbs in the struggle for existence. The existence of 19 trees of Shorea species per acre greater than 12.5 ins. in girth would be considered by Malayan foresters to be extremely good and illustrates clearly the number that have gone through and in this case without apparently any silvicultural assistance. The comparative absence of dipterocarps in the lower strata can, I consider, be explained both by the large number of casualties in the struggle for existence after final felling, when seed bearers were removed, and the absence of recruitment since that date through the new crop trees being too young to flower, fruit and produce quantities of viable seed.

DR. WYCHERLEY

The forester's perspective, for which we are grateful, balances the picture; a note to this effect will be added to our paper.

DR. FOSBERG

Could the phosphate deficiency in soil after clearing of forest be evidence of the presence of the greater portion of it in the actual biomass, which is being removed by the clearing, rather than in the soil itself?

DR. WYCHERLEY

In most Malayan soils non-availability or fixation of phosphate is more important than deficiency owing to lack of loss. Some phosphate will be removed in timber extraction; but most of the previous vegetation is often burnt on the site in agricultural clearings. Phosphate returned to the soil under such conditions rapidly ceases to be available. We want cover crops which maintain phosphate circulation in available forms, perhaps in their litter. Legumes respond well to applied phosphate.

TABLE I

Trees 12½ inches or more in girth at 54 inches from the ground (or above buttresses)

Index No.	FAMILY Species	No. of trees	Mean height ft.	Mean girth ins.	F. Index
	Dilleniaceae				
1	*Dillenia eximia* Miq.	2	45*	19	0.2
	Annonaceae				
2	*Mitrephora maingayi* Hk. f. et. Th.	1	54	15	0.1
3	*Xylopia ferruginea* Hk.f. et. Th.	3	67	28	0.2
	Polygalaceae				
4	*Xanthophyllum sp.*	3	50	25	0.3
	Guttiferae				
5	*Garcinia eugeniaefolia* Wall	2	76	34	0.2
6	*hombroniana* Pierre	2	45	18	0.1
7	*parvifolia* Miq.	1	57	19	0.1
8	*sp.*	2	62	20	0.2
9	*Kayea sp.*	4	60	33	0.3
	Dipterocarpaceae				
10	*Shorea hypocra* Hance	1	65	21	0.1
11	*leprosula* Miq.	9	73	27	0.5
12	*parvifolia* Dyer.	6	66	29	0.5
13	*singkawang* Burck	3	51	23	0.3
	Malvaceae				
14	*Durio griffithii* (Mast.) Bakh.	2	77	38	0.2
	Sterculiaceae				
15	*Sterculia laevis* Wall.	2	42	17	0.2
	Tiliaceae				
16	*Grewia blattifolia* Corner	3	42	16	0.2
17	*Elaeocarpus floribuudus* Bl.	1	64	29	0.1
18	aff. *nitidus* Jack	5	50	18	0.2
19	aff. *mastersii* King	1	46	20	0.1
20	*stipularis* Bl.	3	75	38	0.3
	Gonystylaceae				
21	*Gonystylus maingayi* Hk. f.	1	61	14	0.1
	Linaceae				
22	*Ixonanthes icosandra* Jack	5	69	36	0.4
	Ochnaceae				
23	*Gomphia sp.*	1	55	18	0.1

*One tree broken

TABLE I (*Continued*)

Index No.	FAMILY Species	No. of trees	Mean height ft.	Mean girth ins.	F. Index
	Burseraceae				
24	*Canarium rufum* Benn.	3	55	15	0.2
25	*Santiria* aff. *griffithii* Engl.	1	72	32	0.1
26	*laevigata* Bl.	1	68	27	0.1
27	*tomentosa* Bl.	1	82	43	0.1
	Meliaceae				
28	*Aglaia sp.*	3	47	15	0.3
29	*Amoora malaccensis* Ridl.	2	54	19	0.2
30	*Chisocheton sp.* 1	2	45	16	0.2
31	*sp.* 2	1	57	20	0.1
	Olacineae				
32	*Ochanostachys amentacea* Mast.	9	77	40	0.7
33	*Strombosia avanica* Bl.	2	65	33	0.1
	Sapindaceae				
34	*Mischocarpus sumatranus* Bl.	1	53	14	0.1
35	*Nephelium* aff. *hamulatum* Radlk.	1	45	17	0.1
36	*lappaceum* L.	7	59	22	0.5
37	*Pometia alnifolia* Radlk.	3	54	24	0.3
38	*Xerospermum intermedium* Radlk.	5	57	21	0.4
	Anacardiaceae				
39	*Buchanania sessilifolia* Bl.	2	52	18	0.2
40	*Melanochyla angustifolia* Hk. f.	2	59	24	0.1
	Leguminosae				
41	*Adenanthera bicolor* Moon	1	53	14	0.1
42	*Dialium maingayi* Bak.	1	91	69	0.1
43	*platysepalum* Bak.	2	59	18	0.2
44	*Pithecellobium splendens* Miq.	2	41	16	0.2
	Rosaceae				
45	*Pygeum polystachyum* Hk. f.	1	67	22	0.1
46	aff. *stipulaceum* King	1	60	17	0.1
	Legnotidae				
47	*Carallia brachiata* Merr.	1	49	19	0.1
48	*Gynotroches axillaris* Bl.	1	52	14	0.1
49	*Pellacalyx saccardianus* Scort.	1	45	17	0.1
	Myrtaceae				
50	*Barringtonia macrostachya* Kurz	2	34	16	0.2
51	*Eugenia dyeriana* King	3	71	35	0.3
52	*griffithii* Duthie.	6	46	19	0.4
53	*longiflora* F. Vill.	1	72	42	0.1
54	aff. *prainiana* King.	1	57	16	0.1
55	*symingtonia* Hend.	3	73	37	0.3
56	*sp.*	1	45	15	0.1

TABLE I (*Continued*)

Index No.	FAMILY Species	No. of trees	Mean height ft.	Mean girth ins.	F. Index
	Rubiaceae				
57	*Diplospora malaccensis* Hk. f.	2	43	20	0.2
58	*Randia densiflora* Benth.	2	35	16	0.2
59	*scortechinii* King	1	61	20	0.1
	Sapotaceae				
60	*Lucuma malaccensis* Dub.	1	56	19	0.1
61	*Palaquium gutta* Burck	1	41	13	0.1
62	*hexandrum* King	1	54	19	0.1
	Ebenaceae				
63	*Diospyros decipiens* Clarke	2	56	16	0.2
64	*pendula* Hassett	1	66	20	0.1
	Styracaceae				
65	*Symplocos sp.*	1	50	14	0.1
	Apocynaceae				
66	*Dyera costulata* Hk. f.	2	45*	38	0.2
67	*Hunteria corymbosa* Roxb.	4	52	20	0.4
	Myristicaceae				
68	*Horsfieldia* aff. *succosa* Warb.	3	58	21	0.3
69	*Knema* aff. *laurina* Warb.	1	53	14	0.1
70	*malayana* Warb.	1	40	14	0.1
71	*stenophylla* (Warb.) Sinclair	1	78	33	0.1
72	*Myristica cinnamomea* King	1	45	18	0.1
73	*gigantea* King	2	51	22	0.2
	Lauraceae				
74	*Endiandra maingayi* Hk. f.	1	68	36	0.1
75	*Litsea megacarpa* Gamb.	6	55	19	0.5
	Thymeleaceae				
76	*Aquilaria malaccensis* Lam.	1	48	13	0.1
	Euphorbiaceae				
77	*Antidesma cuspidatum* Muell.	1	20	14	0.1
78	*Aporosa benthamiana* Hk. f.	1	55	18	0.1
79	*Blumeodendron tokbrai* J.J.S.	2	81	47	0.1
80	*Cheilosa malayana* Com.	1	52	15	0.1
81	*Endospermum malaccense* Muell.	13	63	24	0.5
82	*Macaranga populifolia* Muell.	4	59	22	0.3
83	*triloba* Muell.	1	44	18	0.1
84	*Neoscortechinia kingii* Pax et Hoffm.	1	42	14	0.1
85	*Pimeleodendron griffithianum* Hk. f.	1	73	26	0.1

* One tree broken.

TABLE I (*Continued*)

Index No.	F A M I L Y Species	No. of trees	Mean height ft.	Mean girth ins.	F. Index
86	*Ptychopyxis costata* Miq.	1	64	31	0.1
	Urticaceae				
87	*Artocarpus rigidus D.C.*	1	41	23	0.1
88	*Gironniera nervosa* Planch.	7	43	18	0.5
	Fagaceae				
89	*Pasania kunstleri* Gamb.	5	49	18	0.5
90	*lamponga* Gamb.	1	50	15	0.1
91	*lucida* Gamb.	5	60	18	0.4

ADDENDUM ADJACENT SPECIES

Guttiferae *Calophyllum wallichianum* Planch.	1	50	15	
Sapindaceae *Nephelium costatum* Hiern	1	53	13	
Anacardiaceae *Melanorrhoea torquata* King	1	150	130	
Leguminosae *Koompassia malaccensis* Benth.	2	127	95	
Lauraceae *Alseodaphne peduncularis* Hook.	1	50	23	
Euphorbiaceae *Baccaurea kunstleri* Gage.	1	47	14	
Fagaceae *Castanopis megacarpa* Gamb.	1	49	27	

TABLE II

Percentage representation of the more populous families, genera and species in Table I.

	No.	%		No.	%
Euphorbiaceae	26	12.0	*horea*	19	8.8
Dipterocarpaceae	19	8.8	*Eugenia*	15	6.9
Myrtaceae	17	7.8	*Endospermum*	13	6.0
Sapindaceae	17	7.8	*Pasania*	11	5.1
Tiliaceae	13	6.0	*Elaeocarpus*	10	4.6
Faaceae	11	5.1	*Ochanostachys*	9	4.1
Guttiferae	11	5.1	*Nephelium*	8	3.7
Olacineae	11	5.1	*Garcinia*	7	3.2
Myristicaceae	9	4.1	*Gironniera*	7	3.2
Meliaceae	8	3.7	*Litsea*	6	2.8
Urticaceae	8	3.7			
11 families	150	69.1	10 genera	105	48.4
20 families	67	30.9	52 genera	112	51.6
	217	100.0		217	100.0

	No.	%
Endospermum malaccense	13	6.0
Ochanostachys amentacea	9	4.1
Shorea leprosula	9	4.1
Gironniera nervosa	7	3.2
Nephelium lappaceum	7	3.2
Eugenia riffithii	6	2.8
Litsea megacarpa	6	2.8
Shorea parvifolia	6	2.8
Elaeocarpus nitidus	5	2.3
Ixonanthes isocandra	5	2.3
Pasania kunstleri	5	2.3
Pasania lucida	5	2.3
Xerospermum intermedium	5	2.3
13 species	88	40.6
70 species	129	59.4
	217	100.0

Total 31 families, 62 genera, 91 species and 217 trees.

TABLE III

Trees prop-rooted, buttressed or fluted

Name	Prop-rooted	Buttressed	Fluted
Dillenia eximia	2		
Xylopia ferruginea	3		
Xanthophyllum sp.			1
Garcinia eugeniaefolia			1
Kayea sp.		1	
Shorea leprosula		1	
Durio griffithii			1
Elaeocarpus floribundus	1		
aff. *nitidus*	2		
stipularis	1	2	
Ixonanthes icosandra			4
Santiria tomentosa		1	
Ochanostachys amentacea			4
Strombosia javanica	1		
Nephelium lappaceum	1	3	
Xerospermum intermedium		1	1
Melanochyla angustifolia	1		
(*Melanorrhoea torquata*)		1	
Dialium maingayi		1	
(*Koompassia malaccensis*)		1	
Eugenia dyeriana	1	2	
longiflora		1	
aff. *prainiana*	1		
symingtonia		3	
sp.	1		
Lucuma malaccensis	1		
Palaquium hexandrum	1		
Horsfieldia aff. *sucosa*			1
Myristica cinnamomea	1		
gigantea	1		
Endiandra maingayi		1	
Blumeodendron tokbrai			2
Macaranga populifolia	3		
triloba			1
Neoseortechinia kingii			1
Pasania lucida	2	2	

TABLE IV

Girth & height of trees in Table I

Girth class inches	No. of trees	Height class feet	No. of trees
12½—16	68	16—20	1
16½—20	51	21—25	0
20½—24	22	26—30	0
24½—28	20	31—35	7
28½—32	11	36—40	11
32½—36	20	41—45	37
36½—40	5	46—50	27
40½—44	6	51—55	26
44½—48	6	56—60	21
48½—52	2	61—65	25
52½—56	0	66—70	15
56½—60	3	71—75	19
60½—64	0	76—80	15
64½—68	1	81—85	4
68½—72	1	86—90	4
72½—76	1	91—95	4
		96—100	1
	217		217

TABLE V

Trees in Table I with greatest girths and heights
Groups selected at breaks in continuity

Species	Trees with girth 36½" or more	Trees with girth 48½" or more	Trees of Height 68 feet or more	Trees of Height 86 feet or more
Total	25	8	55	9
%	11.5	3.7	25.3	4.1
Xylopia ferruginea			2	
Xanthophyllum sp.	1		1	
Garcinia eugeniaefolia			2	
sp.			1	
Shorea leprosula	1		7	
parvifolia	2		2	
singkawang	1		1	
Durio griffithii	1		2	
Elaeocarpus stipularis	1		3	1
Ixonanthes icosandra	3		2	1
Santiria griffithii			1	
laevigata			1	
tomentosa	1		1	
Ochanostachys amentacea	4	3	7	3
Strombosia javanica	1	1	1	
Nephelium lappaceum	1	1	2	1
Pometia alnifolia			1	
Xerospermum intermedium			1	
Melanochyla angustifolia			1	
Dialium maingayi	1	1	1	1
Eugenia dyeriana	1		2	
longiflora	1		1	
symingtonia	2	1	2	1
Dyera costulata	1			
Horsfieldia aff. *succosa*			1	
Knema stenophylla			1	
Endiandra maingayi			1	
Litsea megacarpa			1	
Blumeodendron tokbrai	2	1	2	
Endospermum malaccense			3	
Pimeleodendron griffithianum			1	

TABLE VI

A. Trees which appear to be associated with *Endospermum malaccense* in the tree quadrats and the converse.

Associated with	Not associated with
Endospermum	*Endospermum*
Shorea leprosula	*Shorea parvifolia*
Shorea singkawang	
Litsea megacarpa	*Elaeocarpus nitidus*
Macaranga populifolia	*Nephelium lappaceum*

B. Trees which appear to be associated with *Ochanostachys malaccense* in the tree quadrats.

Elaeocarpus aff. *nitidus*
Eugenia dyeriana
Kayea sp.
Nephelium lappaceum
Pasania kunstleri
(*Pasania lucida*)

TABLE VII

PLANTS IN THE 'POLE' SAMPLES

FAMILY Species	No.	FAMILY Species	No.
Dilleniaceae		*S. sp.*	1
Dillenia indica L.	2		
D. reticulata King	1		
D. sp.	8	*Malvaceae*	
		Durio griffithii Bakh.	19
Annonaceae			
Alphonsea cylindrica King	2	*Sterculiaceae*	
Cyathocalyx pruniferis Sinclair	1	*Leptonychia glabra* Turcz	2
Goiothalamus tenuifolius King	3	*Scaphium longiflorum* Ridl.	2
G. sp.	1	*Sterculia laevis* Wall.	5
Phaeathus ophtalamis Sinclair	4	*S. parviflora* Roxb.	1
P. sp.	2	*S. rubiginosa* Vent.	1
Polyalthia sp.	1		
Pseudouraria macrophlla Merr.	1	*Tiliaceae*	
Xylopia ferruginea Hk. f. et Th.	1	*Elaeocarpus barnardii* Busk.	1
X. subdehiscens Sinclair	2	*E. glabrescens* Mast.	1
		E. jackianus Wall.	1
Polygalaceae		*E. nitidus* Jack	6
Xanthophyllum glaucum Wall.	1	*Pentace triptera* Mast.	1
X. griffithii Benn.	3		
X. maingayi Hk. f.	4	*Linaceae*	
X. palembanicum Miq.	2	*Ixonathes icosandra* Jack	32
X. rufum Benn.	15		
X. wrayi King.	13	*Rutaceae*	
X. sp.	11	*Evodia glabra* Bl.	1
Hydnocarpus sp.	1		
		Ochnaceae	
Flacourtiaceae		*Gomphia oblongifolia* Ridl.	6
Ryparosa sp.	1	*Gomphandra lanceolata* King	2
Hydnocarpus sp.	1		
Guttiferae		*Burseraceae*	
Calophllum rubiginosum Hend.et Wn.	7	*Canarium littorale* Bl.	2
Garcinid eugeniaefolia Wall.	1	*C. rufum* Benn.	3
G. parvifolia Miq.	3	*C. tomentosum* Bl.	1
G sp.	1	*Dacryodes floribunda* H.J. Lam	3
Kayea sp.	2	*D. sp.*	1
Mesua lepidota Anders.	1	*Santiria apiculata* Benn.	1
		S. griffithii Engl.	22
Dipterocarpaceae		*S. laevigata* Bl.	11
Shorea hyprocra Hance	13	*S. mollissima* Ridl.	1
S. pauciflora King	1	*S. rubra* Ridl.	8
S. rugosa Heim	1	*S. wrayi* King.	1
S. singkawang Burck	2		
		Meliaceae	
		Aglaia glabriflora Hiern.	38
		A. odoratissima Bl.	29
		Amoora malaccensis Ridl.	1

TABLE VII (*Continued*)

FAMILY Species	No.	FAMILY Species	No.
Chisocheton pauciflora King.	7	*Rosaceae*	
C. erythrocarpus Hiern.	2	*Parinari sp.*	
C. laxiflorus King	1	*Pygeum polystachium* Hk.f.	11
Dysoxy'on arborescens Miq.	3	*P. stipulaceum* King.	1
D. costulatum Miq.	12	*P. sp.*	2
Sandoricum koetjape Merr.	1		
		Legnotidae	
Chailletiaceae		*Gynotroches axillaris* Bl.	3
Chailletia griffithii Hk. f.	1	*Pellacalyx axillaris* Korth.	1
		P. saccardianus Scort.	1
Olacaceae			
Ochanostachys amentacea Mast.	4	*Anisophyllaceae*	
Scorodocarpus borneensis Becc.	2	*Anisophyllea scortechinii* King.	2
Strombosia rotundifolia King.	1		
S. javanica Bl.	1	*Myrtaceae*	
		Barringtonia macrostachys King	5
Ilicaceae		*B. sp.*	3
Ilex cymosa Bl.	3	*Eugenia fastigiata* Koord. et Val.	1
Celastraceae		*E. filiformis* Wall.	46
Lophopetalum oblongifolium King	1	*E. griffithii* Duthie	9
L. oblongum King.	1	*E. oblata* Roxb.	17
Microtropis filiformis King	4	*E. prainaria* King	1
		E. symingtonia Hend.	10
Rhamnaceae		*E. tetraptera* (Miq.) c.n.	8
Ventilago sp.	1	*E. valdevenosa* Duthie	34
		E. sp.	9
Sapindaceae			
Guioa sp.	1	*Cornaceae*	
Nephelium costatum Hiern.	10	*Alangium javanicum* Wang.	23
N. glabrum Noronh.	3		
N. aff. *hamulatum* Radlk.	1	*Melastomaceae*	
N. lappaceum L.	6	*Memecylon acuminatum* Sm.	1
N. sp.	2	*M. edule* Roxb.	1
Pometia sp.	1	*M. wallichii* Ridl.	2
Xerospermum intermedium Radlk.	69	*Rubiaceae*	
		Amaracarpus caudatus Ridl.	1
Anacardiaceae		*Chasalia curviflora* Thw.	20
Dracontomelon mangiferum Bl.	1	*Diplospora malaccensis* Hk.f.	8
Melanochyla angustifolia Hk. f.	1	*D. sp.*	5
M. kunstleri King	27	*Ixora congesta* Roxb.	6
Swintonia sp.	8	*I. kingstonia* Hk.f.	2
		I. lobbii Loud.	15
Leguminosae		*I. pendula* Jack	13
Dialium platysepalum Baker	4	*I. sp.*	1
Koompassia malaccensis Maing	1	*Lasianthus tubiferus* S.K.F.	1
Sindora echinocalyx Prain	5	*Nauclea junghuhnii* Merrill	1

TABLE VII (*Continued*)

FAMILY Species	No.	FAMILY Species	No.
Pavetta graciliflora Wall.	5	*Lauraceae*	
P. indica L.	2	*Actinodaphne sesquipedalis* Hk f.	1
Prismatomeris sp.	1	*Alseodaphne peduncularis* Hk f.	7
Psychotria rostrata Bl.	5	*Beilschmiedia foxiana* Gamb.	2
Randia densiflora Benth.	15	*Cinnamomum iners* Bl.	1
R. macrophylla Hk. f.	40	*Dehaasia curtisii* Gamb.	1
R. scortechinii King.	1	*D. nigrescens* Gamb.	1
Stylocoryne mollis Wall.	3	*D. sp.*	23
Timonius wallichianus Valeton	1	*Litsea artocarpifolia* Gamb.	4
Myrsineae		*L. castanea* Hk f.	4
Ardisia solanacea Roxb.	11	*L. grandis* Hk .f.	1
Sapotaceae		*L. megacarpa* Gamb.	1
Madhuca utilis H.J.L.	4	*L. sp.*	2
Palaquium hexandrum King	4	*Euphorbiaceae*	
Ebenaceae		*Antidesma coriaceum* Tul.	2
Diospyros subrhomboidea King.	1	*A. cuspidatum* Muell.	52
D. sumatrana Miq.	64	*A. montanum* Bl.	4
D. wallichi King	8	*Aporosa maingayi* Hk. f.	4
D. sp.	2	*A. stellifera* Hk. f.	1
Styracaceae		*A. symplocoides* Gage	18
Styrax benzoin Dryand.	1	*A. sp.*	5
Oleaceae		*Baccaurea brevipes* Hk. f.	1
Linociera sp.	1	*B. parviflora* Muell.	4
Apocynaceae		*Blumeodendron kurzii* Smith	2
Alstonia scholaris Br.	1	*Breynia sp.*	1
Hunteria corymbosa Roxb.	2	*Drypetes pendula* Ridl.	1
Kopsia ridleyana King	1	*D. sp.*	5
. sp.	1	*Endospermum malaccense* Muell.	4
Verbenaceae		*Epiprinus malayanus* Griff.	2
Clerodendron deflexum Wall.	2	*Galearia affinis* Hk. f.	3
Myristicaceae		*G. fusca* Ridl.	3
Gymnacranthera farquhariana Warb.	2	*Glochidion laevigatum* Hk.f.	1
Horsfieldia subglobosa Warb.	1	*Macaranga triloba* Muell.	3
H. suacosa Warb.	8	*Microdesmis casearifolia* Planch.	4
H. superba Warb.	3	*Neoscortechinia kingii* Pax et Hoffm.	7
Knema furfuracea Warb.	7	*Pimeleodendron griffithianum* Hk f.	25
K. malayana Warb.	4	*P. sp.*	8
K. missionis Warb.	4	*Ptychopyxis costata* Miq.	4
Myristica maxima Warb.	1	*Urticaceae*	
		Artocarpus gomeziana Wall.	4
		A. sp.	2

TABLE VII (*Continued*)

FAMILY Species	No.	FAMILY Species	No.
Ficus sp.	1	*Liliaceae*	34
Gironniera hirta Ridl.	1	*Dracaena robusta* Ridl.	
G. nervosa Planch.	3	*Palmae*	
G. subaequalis Planch.	12	*Calamus sp.*	1
Hulletia dumosa King	9		
Fagaceae		*Total: FAMILIES*	45
Pasania kunstleri Gamb.	6		
P. lamponga Gamb.	1	*GENERA*	115
P. lucida Gamb.	1	*SPECIES*	207
Dicots		*PLANTS*	1321
Unidentified	62	*Excluding unidentified*	

TABLE VIII

Percentage representation of the more populous families, genera and species in Table VII

	No.	%		No.	%
Euphorbiaceae	164	12.4	*Eugenia*	135	10.2
Rubiaceae	156	11.8	*Diospyros*	75	5.7
Myrtaceae	143	10.8	*Xerospermum*	69	5.2
Meliaceae	94	7.1	*Aglaia*	67	5.2
Sapindaceae	93	7.0	*Antidesma*	58	4.4
Ebenaceae	75	5.7	*Randia*	56	4.2
Burseraceae	54	4.1	*Xanthophyllum*	49	3.7
Polygalaceae	49	3.7	*Santiria*	44	3.2
Lauraceae	48	3.6	*Ixora*	37	2.8
Anacardiaceae	37	2.8	*Dracaena*	34	2.6
Liliaceae	34	2.6	*Pimeleodendron*	33	2.5
Linaceae	32	2.4	*Ixonanthes*	32	2.4
Urticaceae	32	2.4	*Aporosa*	28	2.1
Myristicaceae	30	2.3	*Melanochyla*	28	2.1
Cornaceae	23	1.7	*Dehaasia*	25	1.9
Malvaceae	19	1.4	*Nephelium*	22	1.7
Dipterocarpaceae	18	1.4	*Chasalia*	20	1.5
Annonaceae	18	1.4	*Durio*	19	1.4
			Shorea	18	1.4
18 *families*	1119	84.7	19 *genera*	849	64.3
Xerospermum intermedium	69	5.2	*Santiria griffithii*	22	1.7
Diospyros sumatrana	64	4.8	*Chasalia curviflora*	20	1.5
Antidesma cuspidatum	52	3.9	*Durio griffithii*	19	1.4
Eugenia filiformis	46	3.5	*Aporosa symplocoides*	18	1.4
Randia macrophylla	40	3.0	*Eugenia oblata*	17	1.3
Aglaia glabriflora	38	2.9	*Ixora lobbii*	15	1.1
Eugenia valdevenosa	34	2.6	*Pavetta graciliflora*	15	1.1
Dracaena robusta	34	2.6	*Randia densiflora*	15	1.1
Ixonanthes icosandra	32	2.4	*Xanthophyllum rufum*	15	1.1
Aglaia odoratissima	29	2.2	*Ixora pendula*	13	1.0
Melanochyla angustifolia	27	2.0	*Shorea hypochra*	13	1.0
Pimeleodendron griffithianum	25	1.9	*Xanthophyllum wrayi*	13	1.0
Alangium javanicum	23	1.7	26 *species*	731	55.3
Dehaasia sp.	23	1.7			

TABLE IX

Erect plants in the 'ground flora' quadrats

FAMILY Species	No.	FAMILY Species	No.
Dilleniaceae		*Dacryodes floribunda* H.J.L.	1
Dillenia sp.	1	*Santiria griffithii* Engl.	2
		S. rubra Ridl.	3
Annonaceae			
Alphonsea cylindrica King	1	*Meliaceae*	
A. maingayi Hk. f.	1	*Aglaia odoratissima* Bl.	14
Phaeanthus ophtalmus Sinclair	12	*Chisocheton pauciflora* King	1
Polyalthia hookeriana King	1		
P. sp.	2	*Chailletiaceae*	
Xylopia subdehiscens Sinclair	1	*Chailletia griffithii* Hk. f.	6
Polygalaceae		*Olacaceae*	
Xanthophyllum griffithii Benn.	2	*Gomphandra lanceolata* King	12
X. kingii Chodat	1	*G. penangiana* Wall.	1
X. maingayi Hk. f.	1	*Ochanostachys amentacea* Mast	2
X. rufum Benn.	6		
X. verrucosum Chodat	5	*Celastraceae*	
X. wrayii King	1	*Lophopetalum pallidum* Laus	2
		L. oblongifolium King	7
Flacourtiaceae		*Microtropis filiformis* King	2
Hydnocarpus sp.	1		
		Rhamnaceae	
Guttiferae		*Zizyphus affinis* Hemel	2
Calophyllum rubiginosum Hend. et W.S.	1	*Sapindaceae*	
Garcinia eugeniaefolia Wall.	7	*Guioa sp.*	1
		Nephelium sp.	2
Dipterocarpaceae		*Xerospermum intermedium* Radlk.	25
Shorea hypochra Hance	10		
		Anacardiaceae	
Malvaceae		*Melanochyla angustifolia* Hk.f.	3
Durio oblongus Mast.	1	*M. kunstleri* King	11
		Swintonia sp.	2
Sterculiaceae			
Strculia sp.	1	*Anisophyllaceae*	
		Anisophylla griffithii Oliver	1
Linaceae			
Ixonanthes icosandra Jack	41	*Myrtaceae*	
		Barringtonia sp.	4
Rutaceae		*Eugenia filiformis* Wall.	6
Evodia glabra Bl.	2	*griffithii* Duthie	1
Murraya exotica L.	1	*oblata* Roxb.	16
		symingtonia Hend.	5
Simarubaceae		*tetraptera* (Miq) c.n.	6
Eurycoma longifolia Jack	2	*valdevenosa* Duthie	2
		sp.	22
Burseraceae			
Canarium rufum Benn.	2		

TABLE IX (*Continued*)

FAMILY Species	No.	FAMILY Species	No.
Melastomaceae		*Euphorbiaceae*	
Memceylon wallichii Ridl.	5	*Antidesma coriacea* Tul.	1
		A. cuspidatum Muell.	5
Cornaceae		*Aporosa symplocoides* Gage	7
Alangium javanicum Wang.	3	*A. sp.*	1
		Baccaurea brevipes Hk. f.	5
Rubiaceae		*B. parviflora* Muell.	12
Amaracarpus caudatus Ridl.	8	*Drypetes longifolia* Pax.	4
Canthium horridum Bl.	1	*Epiprinus malayanus* Griff.	2
Chasalia curviflora Thw.	28	*Microdesmis casearifolia*	
C. pubescens Ridl.	3	Planch.	14
Diplospora sp.	11	*Neoscortechinia kingii*	
Ixora congesta Roxb.	8	Pax et Hoffm.	1
I. lobbii Loud.	7	*Phyllanthus angustifolia*	
I. pendula Jack	4	Hoffm.	4
I. sp.	2	*P. sp.*	2
Pavetta graciliflora Wall.	7	*Pimeliodendron griffithianum*	
Psychotria rostrata Bl.	11	Hk. f.	1
P. viridiflora Reinwdt.	1	*Trigonostemon sp.*	1
P. sp.	1		
Randia macrophylla Hk. f.	33	*Urticaceae*	
Stylocoryne mollis Wall	1	*Artocarpus sp.*	1
		Ficus sp.	2
Myrsinaceae		*Gironniera nervosa* Planch.	1
Ardisia solanacea Roab.	2	*Hulletia dumosa* King	7
villosa Roxb.	4		
Labisia pothoina Lindl.	8	*Dicots*	
		Unidentified	720
Sapotaceae			
Madhuca utilis H.J.L.	1	*Zingiberaceae*	
		Ginger 1.	25
Ebenaceae		Ginger 2.	5
D. nutans King	1		
D. sumatrana Miq.	56	*Liliaceae*	
D. wallichii King	5	*Dracaena robusta* Ridl.	17
Diospyros sp.	1	*Smilax calophylla* Wall.	7
Styracaceae		*Commelinaceae*	
Styrax benzoin Dryand.	1	*Forrestia gracilis* Ridl.	8
Apocynaceae		*Palmaceae*	
Ervatamia peduncularis King	15	*Licuala sp.*	
		Pinanga disticha Bl.	12
Acanthaceae			
Lepidagathis sp.	1	*Aroideae*	
		Homalomena sagittaefolia	
Verbenaceae		Jungh.	2
Clerodendron deflexum Wall.	8		
		FAMILIES	40
Myristicaceae		*GENERA*	80
Horsfieldia superba Warb.	2	*SPECIES*	110
		PLANTS	656
Lauraceae			
Dehaasia sp.		(*excluding unidentified*)	
Litsea artocarpifolia Gamb.	1		

TABLE X

Percentage representation of the more populous families, genera and species in Table IX

	No.	%
Rubiaceae	126	19.2
Ebenaceae	63	9.6
Myrtaceae	62	9.4
Euphorbiaceae	60	9.1
Linaceae	41	6.2
Zingiberaceae	30	4.6
Sapindaceae	28	4.3
Liliaceae	24	3.7
Annonaceae	18	2.7
Anacardiaceae	16	2.4
Polygalaceae	16	2.4
Meliaceae	15	2.3
Olacaceae	15	2.3
Myrsinaceae	14	2.1
Palmae	14	2.1
Urticaceae	11	1.7
Celastraceae	11	1.7
Dipterocarpaceae	10	1.5
18 *families*	574	87.4

	No.	%
Diospyros	63	5.6
Eugenia	58	9.6
Ixonanthes	41	2.8
Randia	33	8.2
Chasalia	31	5.0
Xerospermum	25	4.7
Ginger 1	25	3.8
Ixora	21	3.8
Baccaurea	17	3.2
Dracaena	17	2.6
Xanthophyllum	16	2.6
Ervatamia	15	2.4
Aglaia	14	2.3
Melanochyla	14	2.1
Microdesmis	14	2.1
Gomphandra	13	2.1
Psychotria	13	2.0
Phaeanthus	12	1.0
Pinanga	12	1.8
Diplospora	11	1.8
Shorea	10	1.7
21 *genera*	475	72.3

	No.	%
Diospyros sumatrana	56	8.5
Ixonanthes icosandra	41	6.2
Randia macrophylla	33	5.0
Chasalia curviflora	28	4.3
Xerospermum intermedium	25	3.8
Ginger 1	25	3.8
Eugenia sp.	22	3.4
Dracaena robusta	17	2.6
Eugenia oblata	16	2.4
Ervatamia peduncularis	15	2.3
Aglaia odoratissima	14	2.1

	No.	%
Microdesmis calcarifolia	14	2.1
Baccaurea parviflora	12	1.8
Gomphandra lanceolata	12	1.8
Phaeanthus ophtalmus	12	1.8
Pinanga disticha	12	1.8
Diplospora sp.	11	1.7
Melanochyla kunstleri	11	1.7
Psychotria rostrata	11	1.7
Shorea hypochra	10	1.5
20 *species*	397	60.5