Bull. Mus. natl. Hist. nat., Paris, 4e sér., **17**, 1995,
section B, *Adansonia*, nos 3-4 : 201-226.

Structural and floristic characteristics of a rain forest on schist in New Caledonia : a comparison with an ultramafic rain forest

T. JAFFRÉ & J.-M. VEILLON

Summary : A floristic and structural study of a slope forest on schist was carried out on 12 transects of 2500 m^2 at the Col d'Amieu. This forest is situated between 440 and 500 m altitude in the central mountain region of New Caledonia. The results are compared with those obtained previously for a slope forest on ultramafics of the Southern Massif and with various forests in Malesia and Melanesia.

Stem density per hectare (1256 stems of dbh ≥ 10 cm) is relatively high and superior to that of most forests in Melanesia and Malesia. Whilst small and medium stem diameters (2 ≤ dbh ≤ 30 cm) are less numerous on schists than on ultramafics, the opposite is observed for stems ≥ 30 cm dbh.

The basal area of the forest at Col d'Amieu (55.1 m^2/ha) is greater than in other forests studied in New Caledonia and can be placed among the highest for forests in the south west Pacific.

The floristic richness of the forest on schist (237 phanerogams recorded /3 ha : a mean of 97 species / ha ≥ 10 cm dbh) is notably less than that of the ultramafic forest and significantly less than most Malesian and Melanesian forests.

Increases in species number associated with increases in surface area remain significant above 2.5 ha. If rare species (occurring in less than 4 out of 120 subplots) are excluded, the species number stabilizes between 2 and 2.5 ha.

Specific diversity expressed by the Shannon-Weiner index is relatively high (H' > 5) except for plots dominated by *Pancheria brunhesi* which is a secondary species and an indicator of forest recolonization.

The richest families with more than 10 species each include *Sapindaceae*, *Rubiaceae*, *Myrtaceae* and *Moraceae*. *Sapindaceae*, *Moraceae*, *Myrsinaceae* and *Proteaceae* are more numerous on schists than on ultramafics. The opposite is true for *Myrtaceae*, *Rubiaceae*, *Lauraceae*, *Araliaceae*, *Cunoniaceae* and *Euphorbiaceae*.

Large trees (dbh ≥ 40 cm) belong to 42 species and 20 families : *Myrtaceae* is the best represented with 6 species. This is followed in second position by *Cunoniaceae*, *Guttiferae*, *Lauraceae* and *Sapindaceae* with 4 species each.

The greatest contribution to stem density is made by *Sapindaceae* followed by *Meliaceae*, then *Guttiferae* for stems ≥ 2 cm dbh, and by *Guttiferae* and *Cunoniaceae* for stems ≥ 10 cm dbh.

The greatest contribution to basal area is made by *Cunoniaceae* and then *Guttiferae*. The families *Meliaceae* and *Myrtaceae* make the greatest contribution to stems ≥ 10 cm dbh and for stems ≥ 40 cm dbh the same families but in reverse order.

At the species level, the greatest contribution to basal area is made by *Pancheria brunhesi* (*Cunoniaceae*) which consitutes respectively 17 % and 27.5 % of the basal area of stems dbh ≥ 10 cm and ≥ 40 cm. This is followed by *Calophyllum caledonicum* (*Guttiferae*) in both cases, then *Anthocarapa nitidula* (*Meliaceae*) for stems ≥ 10 cm dbh and *Montrouziera cauliflora* (*Guttiferae*) for dbh ≥ 40 cm.

Résumé : L'étude floristique et structurale d'une forêt de pente sur schistes a été réalisée sur 12 transects de 2500 m^2 dans le massif forestier du Col d'Amieu, situé entre 440 et 500 m d'altitude dans la partie centrale de la Nouvelle-Calédonie. Les résultats sont comparés à ceux obtenus précédemment pour une forêt de pente localisée sur roches ultramafiques dans le Grand Massif du Sud, ainsi qu'à ceux relatifs à différentes forêts de Malaisie et de Mélanésie.
La densité des tiges à l'hectare (1256 tiges de dbh ≥ 10 cm) est relativement élevée, et supérieure à celle de la plupart des forêts de Mélanésie et de Malaisie. Les tiges de petits et moyens diamètres (2 < dbh < 30 cm) sont moins nombreuses sur schistes que sur roches ultramafiques, tandis que l'inverse est observé pour les tiges de dbh ≥ 30 cm. La surface terrière de la forêt du Col d'Amieu (55,1 m^2/ha) est supérieure à celle des autres forêts étudiées en Nouvelle-Calédonie et se situe parmi les surfaces terrières les plus fortes observées pour différentes forêts de la région.
Avec 237 phanérogames recensées sur 3 ha et une moyenne de 97 espèces/ha de dbh ≥ 10 cm, la forêt sur schistes a une richesse floristique nettement inférieure à celle de la forêt sur roches ultramafiques et sensiblement moins élevée que celle de la plupart des forêts de Malaisie et de Mélanésie.
L'augmentation du nombre des espèces avec l'accroissement de la surface inventoriée se poursuit de manière significative au-delà de 2,5 ha, mais lorsque les espèces les plus rares, (représentées dans moins de 4 placettes sur 120) ne sont pas prises en compte, le nombre des espèces se stabilise entre 2 et 2,5 ha.
La diversité spécifique exprimée par l'indice de Shannon-Wiener à partir des densités de tiges est relativement élevée (H' > 5), sauf pour les parcelles dominées par *Pancheria brunhesi*, espèce secondaire marquant la reconstitution de la forêt.
Les familles les plus riches sont, avec plus de 10 espèces chacune, les *Sapindaceae*, les *Rubiaceae*, les *Myrtaceae* et les *Moraceae*. Les *Sapindaceae*, *Moraceae*, *Myrsinaceae*, *Proteaceae* sont plus nombreuses sur schistes que sur roches ultramafiques, tandis que le contraire s'observe pour les *Myrtaceae*, *Rubiaceae*, *Lauraceae*, *Araliaceae*, *Cunoniaceae* et *Euphorbiaceae*.
Les gros arbres (dbh ≥ 40 cm) appartiennent à 42 espèces et 20 familles : les *Myrtaceae* étant avec 6 espèces, la mieux représentée. Viennent ensuite en seconde position avec 4 espèces chacune les *Cunoniaceae*, les *Guttiferae*, les *Lauraceae* et les *Sapindaceae*.
La plus forte contribution à la densité des tiges est apportée par la famille des *Sapindaceae* suivie des *Meliaceae* puis des *Guttiferae* pour les tiges de dbh ≥ 2 cm, et par les *Guttiferae* puis les *Cunoniaceae* pour les tiges de dbh ≥ 10 cm.
Au niveau des familles, la plus forte contribution à la surface terrière revient dans l'ordre aux *Cunoniaceae* et aux *Guttiferae*, suivies, pour les tiges de dbh ≥ 10 cm de celles des *Meliaceae* et des *Myrtaceae*, et pour les tiges de dbh ≥ 40 cm, des mêmes familles dans l'ordre inverse.
A l'échelon spécifique, la plus forte contribution à la surface terrière revient à *Pancheria brunhesi* (*Cunoniaceae*), constituant respectivement 17 % et 27,5 % de la surface terrière des tiges de dbh ≥ 10 cm et ≥ 40 cm. Viennent ensuite *Calophyllum caledonicum* (*Guttiferae*) dans les deux cas, puis *Anthocarapa nitidula* (*Meliaceae*) pour les tiges de dbh ≥ 10 cm et *Montrouziera cauliflora* (*Guttiferae*) pour celles de dbh ≥ 40 cm.

Tanguy Jaffré and Jean-Marie Veillon, Centre O.R.S.T.O.M., B.P. A5, Nouméa, Nouvelle-Calédonie.

INTRODUCTION

New Caledonia is situated between 20 and 23° latitude south, and 164 and 167° longitude east. Approximately 4000 km^2 or 22 % of the archipelago is covered by forest (C.T.F.T., 1975).

Sclerophyll forest (dry forest) covers a surface area of about 350 km^2. Rain forest formations cover an area of about 3560 km^2. The latter occur on calcareous substrates at low altitudes, while at altitudes ranging from 300-800 m (low and mid altitude rain forest) and 800-1000 m (high altitude rain forest) they establish equally on acid and ultramafic rocks (MORAT et al., 1981).

The aim of the present study is to define the structural (density, basal area) and floristic characteristics (species richness, diversity, composition) of a rainforest on acid substrates, and to compare the results with those of rainforests in Malesia and Melanesia, and with an ultramafic slope rainforest at Rivière Bleue Reserve in New Caledonia (JAFFRÉ & VEILLON, 1990).

SITE CONDITIONS

LOCATION

The forest studied, known as " forêt Persan ", is situated on the Col d'Amieu massif in the central region of the main island of New Caledonia (Grande Terre, Fig. 1). Altitudes at the study area range from 400 to 500 m . The forest occurs on moderate to steep slopes (30-50 %) and has been subjected to low intensity selective logging of *Agathis moorei* (*Araucariaceae*), *Montrouziera cauliflora* and *Calophyllum caledonicum* (*Guttiferae*) since the beginning of this century. As at the Rivière Bleue Reserve, logging at the study site ceased 40 years ago. The effects of tree felling are now barely discernable and cannot be distinguished from those resulting from large canopy gaps caused by cyclones.

CLIMATE

The mean annual rainfall at the Col d'Amieu forestry station (450 m altitude) averaged over a 34 years period (1959-1992) is 1800 mm p.a., and ranges from 880 mm p.a. to 2900 mm p.a. Mean annual temperature for the same period is 19.6°C, with February being the hottest month (24°C) and August the coolest month (14.5°C).

Although the study site at Col d'Amieu is situated at a higher altitude than that at the Rivière Bleue Reserve (160-200 m), it receives a mean annual rainfall more than 1300 mm below that of the Rivière Bleue forest.

EDAPHIC CONDITIONS

The geological substrate is composed of quartzose polymetamorphic mica schist (PARIS, 1981). Soils of the survey area belong to " sols bruns désaturés " (French classification) or chromic dystric combisoils (FAO classification) (LATHAM et al., 1978). The chemical composition of surface soils on the study site is given in Table 1. They have an extremely acid pH in the A1 horizon and a low concentration of exchangeable bases. Potassium is predominant and values for exchangeable Mg are higher than those for exchangeable Ca.

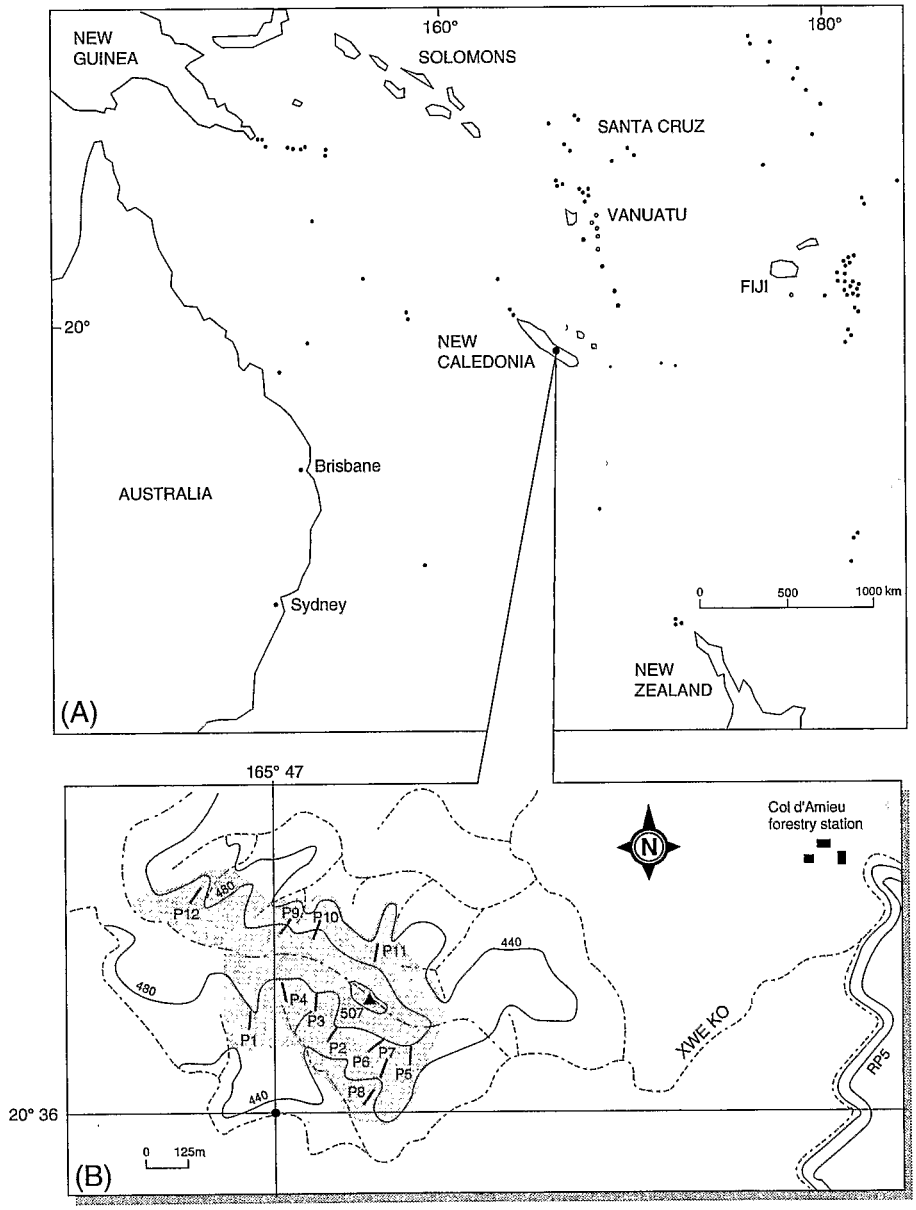

Fig. 1. — Location of forest and transects studied.

TABLE 1 : Chemical composition of soil samples taken from superficial horizon (2-10 cm).

		Total elements %									Exchangeable bases meq/100g			
	pH	N	P	Ca	Mg	K	Na	Mn	Fe	Al	Ca^{++}	Mg^{++}	K^{+}	Na^{+}
Mean (5 analyses)	4.14	0.26	0.045	0.74	2.07	0.36	0.22	0.041	5.04	14.03	0.04	0.38	0.58	0.018
Standard error	±0.17	±0.02	±0.008	±0.55	±0.70	±0.13	±0.08	±0.027	±1.13	±4.82	±0.05	±0.11	±0.39	±0.009

METHODS

The inventory included all phanerogams excluding epiphytes. Measurements of all individuals ≥ 10 cm dbh (including tree ferns) were recorded for 12 transects placed parallel to the slope, each covering an area of 2500 m^2 (100 × 25 m). The survey was carried out in an area of relatively homogenous forest covering a surface area of 32 ha (Fig. 1).

Each transect was divided into 10 subplots of 10 × 25 m (250 m^2). All individuals with 5-10 cm dbh were recorded for 4 of the subplots and all individuals with 2-5 cm diameter were similarly measured for 2 of these subplots.

The total surface area covered by the inventory of stems ≥ 10 cm diameter is 3 ha, 1.2 ha for 5-10 cm diameter size classes and 0.6 ha for 2-5 cm diameter size classes.

Non arborescent ferns were listed for the entire 3 ha site.

Unidentified species were sampled and compared with a fertile specimen deposited in the herbarium (NOU) at Noumea.

RESULTS

STEM DENSITY

Stem density per hectare for the different size classes recorded in this study and comparable data obtained for ultramafic slope rainforest at the Rivière Bleue (JAFFRÉ & VEILLON, 1990) are given in Table 2.

TABLE 2 : Stem density per diameter class and per ha compared with that of a slope forest on ultramafics.

Substrate Locality	Schists Col d'Amieu	Ultramafics Rivière Bleue
Diameter class (cm)	Number of stems/ha	Number of stems/ha
2-5	2830	5846
5-10	1435	2658
10-20	842	1134
20-30	228	242
30-40	97.7	92.5
40-50	43.3	40.9
50-60	18.7	16.1
60-70	12.3	4.66
70-80	7.67	2.15
80-90	2.67	0.36
90-100	1.67	0.36
> 100	1.33	0

Sample area diameter class	2-5 cm	5-10 cm	≥ 10 cm
Col d'Amieu forest	0.6 ha	1.2 ha	3 ha
Rivière Bleue forest	0.5 ha	1.25 ha	2.79 ha

Rainforest of the study area at Col d'Amieu possesses half the number of individuals with a stem diameter 2-10 cm when compared with ultramafic slope forest at Rivière Bleue. In the diameter classes between 10 and 30 cm, the difference is progressively less marked and is reversed for size classes ≥ 30 cm dbh.

These differences in stem density may be explained by the difference in canopy height of the two rainforests. The rainforest canopy at Col d'Amieu is 20-25 m in height and only 15-20 m for ultramafic rainforest at Rivière Bleue.

Stem densities for individuals ≥ 10 cm in diameter at the survey area are significantly less than those for ultramafic slope rainforest at Rivière Bleue Reserve but significantly greater than densities for a rainforest on ultramafic alluvium which is taller than the ultramafic slope forest. Values for stem density at the study site are appreciably higher than for rainforests in Malesia and Melanesia. The only area where recorded stem density exceeds 1000 stems/ha is on ultramafics above 600 m altitude in Sabah (PROCTOR et al., 1988). The value obtained in this study is likewise much higher than the estimated mean for pantropical rainforests of 522 stems/ha (ROLLET, 1983). — Table 3.

TABLE 3 : Density of stems for different tropical rain forests of the Far East.

Localities	Number of stems per hectare			
	Sample area/ha	dbh ≥ 10	dbh ≥ 40	dbh ≥ 60
New Caledonia (this study)	3	1256	87.6	25.7
New Caledonia, ultramafic slope (JAFFRÉ & VEILLON, 1990)	2.79	1533	64.5	7.5
New Caledonia, ultramafic alluvium (JAFFRÉ & VEILLON, 1990)	2.68	1183	74.2	15.7
New Caledonia, ultramafic rocks Dzumac (C.T.F.T., 1975)	15		42.3	7.7
New Caledonia, Amieu (C.T.F.T., 1975)	41.3		54.32	16.6
New Caledonia, Centre Region (C.T.F.T., 1975)	119.4		51.15	14.9
New Guinea (PAIJMANS, 1970)	0.8	435-700		
Sarawak (PROCTOR et al., 1983)	1	615-778		
Sarawak (CHIN & CHUA, 1984)	1	356-407		23-36
Sabah (PROCTOR et al., 1988)	0.04 to 0.40	513-1596		
Sabah (NEWBERY et al., 1992)	4	484-455	61.0-65.3	
Sulawesi (WHITMORE & SIDIYASA, 1986)	1	408	44	
Kalimantan (KARTAWINATA et al., 1981)	1.6	399-541		
Sumatra (KARTAWINATA et al., 1981)	1.6	460		
Java (ROLLET, 1979)	8	521	95	38

Stem densities at the study site for the dbh size classes ≥ 40 cm are greater than those obtained for other rainforests in New Caledonia occurring either on ultramafics (Rivière Bleue Reserve, Dzumac Massif) or on schists (Amieu Massif and the central region which are largely dominated by this substrate). Compared with Malesian rainforests, the study site possesses a higher stem density value for trees ≥ 40 cm dbh than those given by WHITMORE & SIDIYASA (1986) for a forest in Sulawesi and NEWBERY et al. (1992) for a forest in Sabah, but are inferior to those given by ROLLET (1979) for a forest in Java.

The density of stems ≥ 60 cm dbh is far greater in rain forest at the study site than in forests occurring on New Caledonian ultramafics and is also superior to values given by C.T.F.T. for the central regions and the total area of the Amieu Massif. Furthermore, these values are of similar magnitude to densities given for a forest in Sarawak (CHIN & CHUA, 1984) and less than those for a forest in Java (ROLLET, 1979).

Before comparing the differing results for rainforests in New Caledonia, the role of the size of the area sampled must be emphasised. Taking into account both the extreme topographic relief and disturbances caused by past and present logging, it is impossible to delimit homogenous surfaces of rainforest above several hectares. Areas greater than several hectares inevitably encompass a variety of forest formations : well developed forest on slopes, ridge top forest, transition forest between the above mentioned, and more or less degraded forests.

BASAL AREA

The basal area of a population of woody plants is defined as the sum of the cross sectional areas of the individual stems measured at 1.30 m height (dbh) or above buttress roots when these are present. Values for basal area were obtained for all individuals ≥ 2 cm dbh.

Basal area measurements by diameter class expressed in m^2/ha and percentage of total basal area are given in Table 4, and are compared with data from the ultramafic slope rainforest at Rivière Bleue Reserve .

TABLE 4 : Basal area (m^2/ha) per diameter class.

Diameter class	Forest on schists (Col d'Amieu)		Forest on ultramafics (Rivière Bleue)	
	Basal area m^2/ha	%	Basal area m^2/ha	%
2-5	2.28	3.62	4.74	7.32
5-10	5.20	8.25	10.48	16.18
10-20	12.73	20.21	16.67	25.74
20-30	10.85	17.22	11.11	17.16
30-40	9.06	14.38	8.67	13.29
40-50	6.98	11.08	6.38	9.85
50-60	4.47	7.10	3.81	5.88
60-70	4.02	6.38	1.49	2.30
70-80	3.41	5.41	0.95	1.47
80-90	1.57	2.49	0.22	0.34
90-100	1.15	1.82	0.24	0.37
>100	1.27	2.02	0	0

Sample area diameter class	2-5 cm	5-10 cm	>10 cm
Col d'Amieu forest	0.6 ha	1.2 ha	3 ha
Rivière Bleue forest	2.5 ha	1.25 ha	2.79 ha

Stems with a dbh between 2 and 10 cm represent 11.87 % of the total basal area against 23.5 % for the same stem size class at Rivière Bleue Reserve. The percentages for diameters from 10 cm to 20 cm are respectively 20.2 % and 25.7 %. Values are more or less similar in the dbh size classes from 20 cm to 30 cm and are reversed above 30 cm dbh. These results reflect the smaller contribution by small diameter class trees to the total basal area at Col d'Amieu.

Trees in the size classes ≥ 40 cm dbh (economically the most important) represent 36.3 % of the forest basal area at Col d'Amieu and only 20.21 % at Rivière Bleue Reserve.

The basal areas of the different dbh size classes for the study site are compared with those of two New Caledonian forests and forests in Malesia and Melanesia in Table 5. Values for the Col d'Amieu forest are greater than those for both New Caledonian forests and are comparable with the highest values recorded for forests in Malesia and Melanesia.

TABLE 5 : Basal area (m^2/ha) for different tropical rain forests of the Far East.

Localities	Basal area m^2/ha			
	Sample area/ha	dbh ≥ 10	dbh ≥ 40	dbh ≥ 60
New Caledonia (this study)	3	55.51	22.87	11.42
New Caledonia, ultramafic slope (JAFFRÉ & VEILLON, 1990)	2.79	49.54	13.09	2.90
New Caledonia, ultramafic alluvium (JAFFRÉ & VEILLON, 1990)	2.68	47.01	15.86	5.71
New Guinea (PAIJMANS, 1970)	0.80	29.2-56.7		
Sarawak (PROCTOR et al., 1983)	1	28-57		
Sarawak (CHIN & CHUA, 1984)	1	31.1-36.0		
Sabah (PROCTOR et al., 1988)	0.04 to 0.40	32.9-46.2		
Sabah (NEWBERY et al., 1992)	4	26.36-26.79	17.29-18.57	
Java (ROLLET, 1979)	8	50.1		

FLORISTIC RICHNESS

NUMBER OF SPECIES (Table 6)

A total of 237 phanerogam species and 17 terrestrial ferns were recorded over the 3 ha covered by the study.

The number of phanerogams per transect of 2500 m^2 ranges from 113 to 147 with a mean of 131. Floristic richness per hectare was determined by analysing 3 groups of 4 contiguous transects. The mean was 186 species/ha.

Considering only the species represented by stems with a dbh ≥ 10 cm, their total number is 143. The mean number of such species for areas of 2500 m^2 is 58 and the mean number per hectare is 97.

The ultramafic slope rainforest at Rivière Bleue Reserve with 209 species for 2500 m^2 and a total of 307 phanerogams recorded for 2.79 ha has a higher species diversity than the rainforest of the study site at Col d'Amieu. By contrast, it contains only 10 terrestrial fern species. Ferns are more numerous, and generally more abundant, in rainforest on acid than on ultramafic rocks.

Table 7 concerns trees with a diameter ≥ 10 cm dbh, and shows that the study forest on schist is less rich in species than the ultramafic slope forest at the Rivière Bleue Reserve and other forests in New Guinea, Kalimantan and Sarawak (except for a forest on limestone) studied by various authors. By contrast, its floristic diversity is similar to that of the rainforest on ultramafic alluvium at the Rivière Bleue Reserve, which is depauperate due to constraining edaphic conditions, and to certain rainforests in Sumatra and Sulawesi.

TABLE 6 : Number of phanerogams of different diameter class for 0.25 ha and 1 ha areas.

Transects N°	Total Phanerogams		Phanerogams dbh ≥ 10 cm	
	Number of species for 0.25 ha	Number of species for 1 ha	Number of species for 0.25 ha	Number of species for 1 ha
1	135		59	
2	144	197	61	103
3	147		64	
4	123		53	
5	135		54	
6	137	180	63	93
7	131		59	
8	128		54	
9	125		62	
10	113	181	55	94
11	126		52	
12	124		58	
mean	131	186	58	97

TABLE 7 : Number of species (dbh ≥ 10 cm) in various tropical forests.

Localities	Plot area	Number of species
New Caledonia		
forest on schist (this study)	1	106/95/96
forest on ultramafic alluvium (JAFFRÉ & VEILLON, 1990)	1.25	103
forest on ultramafic slope (JAFFRÉ & VEILLON, 1990)	1.25	131
New Guinea (PAIJMANS, 1970)	0.8	122/147/145/126
Sarawak (PROCTOR et al., 1983)	1	223/214/123/76
Sulawesi (WHITMORE & SIDIYASA, 1986)	1	109
Kalimantan (KARTAWINATA et al., 1981)	1	149/128
Sumatra (KARTAWINATA et al., 1981)	1	107

Edaphic conditions do not explain the relative species poverty of the rainforest at Col d'Amieu compared to the rainforest at Rivière Bleue Reserve. Certain rainforests on schist in the north east of New Caledonia are floristically very rich. These forests occur in higher rainfall zones and it is likely that the lower rainfall of the Col d'Amieu, coupled with drier periods in the past, may have led to impoverishment of the original forest flora, while those in the wetter north east and south of New Caledonia have remained largely intact.

Relationship between number of species and area inventoried

The species /area curve (Fig. 2) for the entire list of phanerogams recorded shows a rapid increase in species number until a surface area of 7250 m^2 is attained. At this point more than 70 % of the total number of species have been recorded. The species /area curve beyond this becomes more gradual although the curve does not become parallel to the x axis. 8.7 % of the total, or 21 additional species, were recorded between 2 and 3 ha.

If we exclude rare species which are only represented in one subplot of 250 m^2 (10 × 25 m), species number does not increase beyond a surface area of 27500 m^2 or beyond 25000 m^2 if we also exclude species which occur in 2 or 3 of the plots. Furthermore there is only a slight increase, with rare species excluded, for areas greater than 2 ha ; an area which corresponds to the minimal area for the most common species. This value is identical to that obtained by Newbery et al. (1992) for a *Dipterocarpaceae* forest in Sabah.

SPECIFIC DIVERSITY

Several indices which combine species number and their relative importance have been proposed for calculating the specific diversity (Peet, 1974 ; Magurran, 1988).

The Shannon - Wiener index $H' = -\sum_{i=1}^{S} \left(\frac{ni}{N}\right) \log_2 \left(\frac{ni}{N}\right)$ and evenness E = H'/H max (Shannon-Weiner index divided by maximal diversity is equal to $Log_2 S$) which expresses the degree of diversity attained in relation to the possible maximum were calculated and compared to values obtained for the ultramafic slope forest at Rivière Bleue (Jaffré, 1992).

Results given in Table 8 are those of stems with diameters ≥ 2 cm for surfaces of 0.1 ha and stems with diameters of ≥ 5 cm and ≥ 10 cm for surfaces of 0.25 ha. They based on stem densities and basal area.

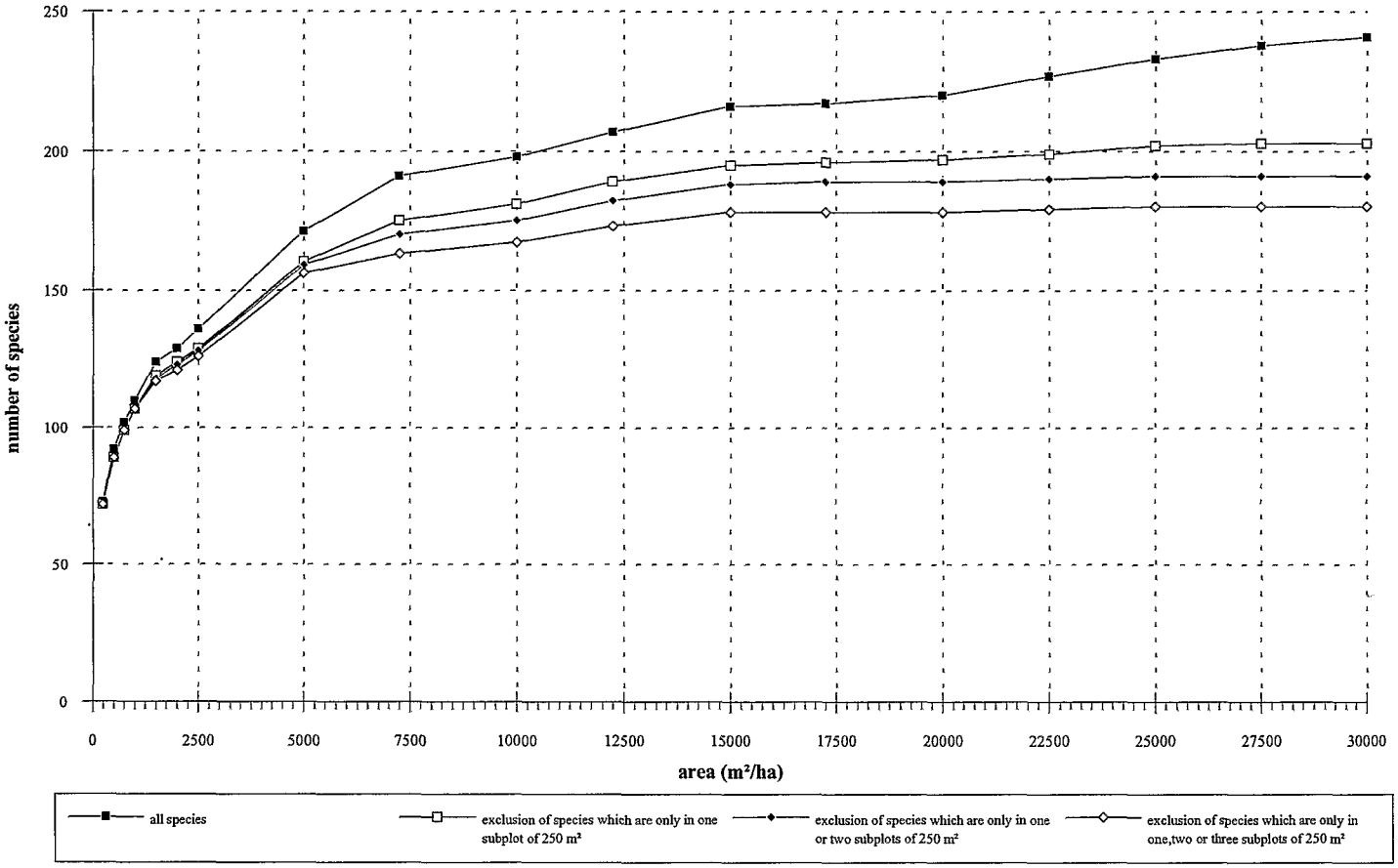

Fig. 2. — Cumulative increase in number of species with plot area.

TABLE 8 : Comparison of number of species and floristic diversity (H' Shannon Wiener index and E evenness) in schist forest at the Col d'Amieu and in the ultramafic slope forest in the Parc de la Rivière Bleue.

					Index based on numbers of stems		Index based on areas occupied at breast height (1.3 m)	
Diameter class	Localities	Sample area (ha)	Replication	Number of species	H' mean (range)	E mean (range)	H' mean (range)	E mean (range)
≥ 2 cm	Col d'Amieu	0.1	6	92 ± 7	5.70 (5.47-4.88)	0.87 (0.85-0.88)	4.75 (4.54-5.08)	0.72 (0.68-0.79)
	Rivière Bleue	0.1	5	136 ± 7	6.03 (5.87-6.46)	0.88 (0.83-0.90)	5.18 (4.71-5.73)	0.73 (0.68-0.78)
≥ 5 cm	Col d'Amieu	0.25	4	97 ± 8	5.69 (5.56-5.88)	0.86 (0.86-0.87)	4.94 (4.46-5.15)	0.75 (0.67-0.79)
	Rivière Bleue	0.25	5	116 ± 4	5.76 (5.61-5.81)	0.84 (0.83-0.84)	5.22 (4.98-5.39)	0.76 (0.74-0.77)
≥ 10 cm	Col d'Amieu	0.25	12	58 ± 4	4.96 (4.37-5.33)	0.84 (0.76-0.88)	4.33 (2.57-4.99)	0.73 (0.44-0.83)
	Rivière Bleue	0.25	5	69 ± 2	5.14 (4.81-5.46)	0.85 (0.81-0.89)	4.79 (4.52-5.03)	0.78 (0.76-0.81)

$$H' = -\sum_{i=1}^{S} pi \log_2 pi \qquad E = H' / H \max \qquad H \max = Log_2 S$$

The values obtained for forest at the study site are relatively high for the given diameter classes, but they are below those of the forest at the Rivière Bleue.

Important differences for H' and E values between plots arose when calculated for basal areas of stems ≥ 10 cm in diameter. The lowest values (2.57 for H' and 0.44 for E) are from a transect where a secondary tree species *Pancheria brunhesi* (*Cunoniaceae*) is dominant with 77 stems ≥ 10 cm dbh.

FLORISTIC COMPOSITION

The 237 species recorded at the study site belong to 70 families and 147 genera compared with the 73 families and 146 genera for the 307 species recorded for the forest at the Rivière Bleue. The number of species per family averages at 3.38 for the schist forest and 4.2 for the ultramafic rainforest at the Rivière Bleue.

The importance of the most common families in number of genera and species in the forest at Col d'Amieu and Rivière Bleue Reserve are given in Table 9.

Families with the greatest representation at the species level are *Sapindaceae* and *Rubiaceae* with 15 and 14 species respectively. These are followed in order by the families *Myrtaceae*, *Moraceae*, *Apocynaceae*, *Myrsinaceae*, *Lauraceae*, *Araliaceae*, *Rutaceae*, *Sapotaceae*, *Elaeocarpaceae* and *Proteaceae*, which among them possess half of the species recorded.

In comparison to forest at Rivière Bleue Reserve, there is a significant decrease in both the relative importance and species number for *Myrtaceae* at the Col d'Amieu. This decrease is also found to a lesser degree in the *Rubiaceae*, *Lauraceae*, *Araliaceae*, *Cunoniaceae*, *Euphorbiaceae* to the benefit of families such as *Sapindaceae*, *Moraceae*, *Myrsinaceae*, *Proteaceae* and *Meliaceae*.

At Col d'Amieu, the palm family is represented by only one species and the *Podocarpaceae* are absent. In contrast there are 5 species of palm belonging to 5 genera and 5 species of *Podocarpaceae* belonging to 4 genera in the slope forest at the Rivière Bleue.

A floristic comparison of phanerogams between the two forests indicates that only 52 species (corresponding to 22 % of the flora of this forest at Col d'Amieu) are shared. This may be explained by the fact that these forest types occur on different geological substrates 200 km apart in distinct geographic regions.

The specific richness per family offers further evidence of the differences observed between the forest flora found generally on these two substrates (MORAT et al., 1984). Families which are strongly represented on acid rocks include *Sapindaceae*, *Moraceae* and *Myrsinaceae*. However, contrary to their generally greater importance on acid rocks than on ultramafics, *Rubiaceae* and *Palmae* exhibit a marked reduction in species richness in the forest on schist at the Col d'Amieu. These 2 families are strongly represented on acid rocks of massifs in the north east of the Grande Terre, as highlighted by JAFFRÉ & VEILLON (1989) for the *Palmae*.

TABLE 9 : Comparison of the importance of the principal families (with at least 4 species in one of the forests) in a forest on schists and in a forest on ultramafics.

Families	Schist forest (Col d'Amieu)			Ultramafic slope forest (Rivière Bleue)		
	Number of genera	Number of species	%	Number of genera	Number of species	%
Sapindaceae	7	15	6.33	3	12	3.88
Rubiaceae	7	14	5.91	11	25	8.09
Myrtaceae	7	12	5.06	11	32	10.36
Moraceae	3	12	5.06	2	3	0.97
Apocynaceae	5	9	3.80	9	14	4.53
Myrsinaceae	3	9	3.80	2	5	1.62
Lauraceae	2	9	3.80	3	14	4.53
Araliaceae	5	8	3.38	4	14	4.53
Rutaceae	5	8	3.38	8	11	3.56
Sapotaceae	5	8	3.38	9	14	4.53
Elaeocarpaceae	2	7	2.95	2	8	2.59
Proteaceae	5	7	2.95	4	4	1.29
Cunoniaceae	4	6	2.53	5	10	3.24
Euphorbiaceae	6	6	2.53	5	10	3.24
Guttiferae	3	6	2.53	3	7	2.27
Orchidaceae	4	5	2.11	5	7	2.27
Pandanaceae	1	5	2.11	2	6	1.94
Meliaceae	2	5	2.11	1	3	0.97
Celastraceae	3	4	1.69	1	1	0.32
Pittosporaceae	1	4	1.69	1	4	1.29
Verbenaceae	2	4	1.69	2	3	0.97
Ebenaceae	1	3	1.27	1	5	1.62
Flacourtiaceae	3	3	1.27	4	7	2.27
Palmae	2	2	0.84	5	5	1.62
Podocarpaceae	0	0	0	4	5	1.62

The importance of families in terms of number of genera and species for the stem size classes ≥ 2 cm and ≥ 10 cm recorded at Col d'Amieu is given in Table 10.

TABLE 10 : Comparison of the importance of the principal families (with at least 4 species in the diameter class ≥ 2 cm) for dbh ≥ 2 cm and dbh ≥ 10 cm.

Families	dbh ≥ 2 cm		dbh ≥ 10 cm	
	Number of species	%	Number of species	%
Sapindaceae	15	8.02	13	8.90
Myrtaceae	11	5.88	11	7.53
Moraceae	10	5.35	8	5.48
Lauraceae	9	4.81	7	2.05
Apocynaceae	8	4.28	3	4.79
Araliaceae	8	4.28	7	4.79
Myrsinaceae	8	4.28	6	4.11
Proteaceae	7	3.74	6	2.74
Rubiaceae	7	3.74	4	4.11
Sapotaceae	7	3.74	7	4.79
Cunoniaceae	6	3.21	6	4.11
Elaeocarpaceae	6	3.21	6	4.11
Euphorbiaceae	6	3.21	5	3.42
Rutaceae	6	3.21	3	2.05
Guttiferae	5	2.67	5	3.42
Meliaceae	5	2.67	4	2.74
Pittosporaceae	4	2.14	1	0.68

Taking out of consideration stems ≥ 2 cm dbh results in the elimination of all herbaceous monocotyledon families (*Orchidaceae*, *Cyperaceae*, *Liliaceae*, *Araceae*) and reduces the number of species for several dicotyledon families. Shrubs belonging to the genera *Psychotria* (*Rubiaceae*), *Melicope* (*Rutaceae*), *Austromyrtus* (*Myrtaceae*), *Graptophyllum* (*Acanthaceae*) and small diameter lianas : *Freycinetia* (*Pandanaceae*), *Oxera* (*Verbenaceae*), *Morinda* (*Rubiaceae*), *Hoya* and *Marsdenia* (*Asclepiadaceae*) are among those likewise eliminated.

If size classes ≥ 10 cm in diameter are excluded, there is a reduction in species number for families such as *Apocynaceae*, *Rubiaceae*, *Rutaceae* and *Pittosporaceae* with only 3, 4, 3 and 1 species respectively. The understorey component which is eliminated belong mainly to genera such as *Psychotria* (*Rubiaceae*), *Tapeinosperma* (*Myrsinaceae*), *Cupaniopsis* (*Sapindaceae*), *Ficus* (*Moraceae*) and lianas : *Balgoya* (*Polygalaceae*), *Alyxia* and *Melodinus* (*Apocynaceae*).

Only 20 families involving 33 genera and 42 species are represented in diameter classes ≥ 40 cm (Table 11). *Myrtaceae* are the most numerous with 6 species followed by *Cunoniaceae*, *Guttiferae*, *Lauraceae* and *Sapindaceae* with 4 species each. *Meliaceae* is represented by 3 species, *Elaeocarpaceae*, *Icacinaceae* and *Sapotaceae* by 2 species each, and 10 families are represented by a single species.

TABLE 11 : Families and genera with diameter of dbh ≥ 40 cm.

Families Genera	Number of species	Families Genera	Number of species	Families Genera	Number of species
Myrtaceae	**6**	**Meliaceae**	**3**	**Araucariaceae**	**1**
Caryophyllus	2	*Anthocarapa*	1	*Agathis*	1
Piliocalyx	2	*Dysoxylum*	2	**Balanopaceae**	**1**
Syzygium	2	**Elaeocarpaceae**	**2**	*Balanops*	1
Cunoniaceae	**4**	*Elaeocarpus*	1	**Hernandiaceae**	**1**
Acsmithia	2	*Sloanea*	1	*Hernandia*	1
Cunonia	1	**Icacinaceae**	**2**	**Leguminosae**	**1**
Pancheria	1	*Apodytes*	1	*Archidendropsis*	1
Guttiferae	**4**	*Citronella*	1	**Myrsinaceae**	**1**
Calophyllum	1	**Sapotaceae**	**2**	*Tapeinosperma*	1
Garcinia	2	*Niemeyera*	1	**Proteaceae**	**1**
Montrouziera	1	*Pycnandra*	1	*Kermadecia*	1
Lauraceae	**4**	**Anacardiaceae**	**1**	**Rhizophoraceae**	**1**
Cryptocarya	2	*Euroschinus*	1	*Crossostylis*	1
Endiandra	2	**Aquifoliaceae**	**1**	**Rutaceae**	**1**
Sapindaceae	**4**	*Ilex*	1	*Xanthoxylum*	1
Cupaniopsis	2	**Araliaceae**	**1**		
Elattostachys	1	*Schefflera*	1		
Harpullia	1				

Of the 40 species, only 10 species : *Dysoxylum roseum* (*Meliaceae*), *Calophyllum caledonicum*, *Garcinia neglecta* and *Montrouziera cauliflora* (*Guttiferae*), *Ilex sebertii* (*Aquifoliaceae*), *Schefflera gabriellae* (*Araliaceae*), *Piliocalyx laurifolius* (*Myrtaceae*), *Apodytes clusiifolia* (*Icacinaceae*), *Elaeocarpus angustifolius* (*Elaeocarpaceae*) and *Niemeyera balansae* (*Sapotaceae*) were also recorded in ultramafic rainforest on slopes at the Rivière Bleue. Only four of these (*D. roseum*, *C. caledonicum*, *G. neglecta* and *S. gabriellae*) were represented by trees > 40 cm dbh.

TAXON CONTRIBUTION TO STEM DENSITY

DENSITY PER FAMILY

The number of stems per ha (dbh ≥ 2 cm and ≥ 10 cm) and the percentage per family is given in Table 12 for the principal families (represented by at least 20 stems/ha with a dbh ≥ 2 cm). The

different percentages are compared with the results of previous work by JAFFRÉ & VEILLON (1990) for the forest on an ultramafic slope at the Rivière Bleue.

TABLE 12 : Density per hectare and percentage of the total density of the main families for dbh ≥ 2 cm and dbh ≥ 10 cm for schist forest (Col d'Amieu) and comparison with the percentage of the total density for the Rivière Bleue forest.

Families	Col d'Amieu forest				Rivière Bleue forest	
	dbh ≥ 2 cm		dbh ≥ 10 cm		dbh ≥ 2 cm	dbh ≥ 10 cm
	Number of stems/ha	%	Number of stems/ha	%	%	%
Sapindaceae	731	13.25	158	12.45	3.06	2.02
Meliaceae	589	10.67	93	7.33	1.20	0.78
Guttiferae	492	8.92	142	11.20	6.53	10.43
Lauraceae	387	7.01	61	4.80	8.51	3.20
Myrtaceae	287	5.20	61	4.80	5.60	3.65
Monimiaceae	241	4.37	49	3.86	0.25	0
Araliaceae	236	4.28	43	3.39	8.05	5.02
Annonaceae	232	4.20	71	5.58	0.53	0.05
Rubiaceae	208	3.77	47	3.69	7.26	4.83
Cyatheaceae	176	3.19	62	4.89	0.69	0.52
Euphorbiaceae	167	3.03	24	1.89	1.56	0.46
Cunoniaceae	165	2.99	119	9.38	3.55	6.78
Myrsinaceae	153	2.77	21	1.66	0.75	0.20
Apocynaceae	130	2.36	18	1.41	6.12	3.59
Sapotaceae	137	2.48	34	2.68	5.78	5.67
Palmae	125	2.27	62	4.89	9.23	14.55
Moraceae	111	2.01	40	3.15	2.17	2.74
Ebenaceae	107	1.94	30	2.36	3.94	4.83
Rutaceae	90	1.63	24	1.89	1.38	0.33
Linaceae	75	1.36	1.3	0.09	0.35	0
Winteraceae	71	1.29	6	0.47	0.62	0
Leguminosae	67	1.21	36	2.83	3.13	7.24
Rhamnaceae	66	1.20	0.7	0.05	0.92	2.22
Verbenaceae	64	1.16	0	0	0.09	0
Proteaceae	52	0.94	14	1.10	0.54	0.85
Flacourtiaceae	50	0.91	0.3	0.03	2.87	2.09
Violaceae	44	0.80	1.3	0.09	0.02	0
Celastraceae	25	0.46	0.7	0.05	0.12	0
Pittosporaceae	22	0.40	0.3	0.03	0.12	0
Symplocaceae	21	0.38	6.7	0.53	0.49	0.26
Phellinaceae	20	0.36	2	0.16	1.11	0.05
other families	177 (1)	3.21	43 (2)	3.39	(3)	(3)

(1) 24 families.
(2) 18 families.
(3) main other families in Rivière Bleue forest : Bignoniaceae (2.66-3.52) ; Alangiaceae (2.03-0.65) ; Icacinaceae (1.71-2.28) ; Flindersiaceae (0.96-2.09) ; Pandanaceae (0.84-0.26) ; Araucariaceae (0.76-1.57) ; Anacardiaceae (0.63-0.52) ; Sterculiaceae (0.56-0.90).

Sapindaceae possesses the highest stem density for the two diameter classes concerned. Next in importance for the diameter class ≥ 2 cm are the families *Meliaceae*, *Guttiferae*, *Lauraceae*, *Myrtaceae*, *Monimiaceae*, *Araliaceae*, *Annonaceae* which each represent more than 4 % of the total stem density. These families grouped together make up nearly 58 % of the stem density in this category.

Families other than *Sapindaceae* which make up at least 4 % of the stem density for the size class ≥ 10 cm dbh are in order *Guttifereae*, *Cunoniaceae*, *Meliaceae*, *Annonaceae*, *Cyatheaceae*, *Palmae*, *Myrtaceae* and *Lauraceae*. The percentage of these families grouped together is 65 % of the total.

Comparisons of stem density with the forest at the Rivière Bleue show that the Col d'Amieu forest possesses a greater abundance of *Sapindaceae*, *Meliaceae*, *Monimiaceae*, *Annonaceae*, *Cyatheaceae*, *Euphorbiaceae* and *Myrsinaceae*. However other families are poorly represented. For example, palms are poorly represented at the study site, but they occur in abundance in forest at Rivière Bleue, as do families such as *Rubiaceae*, *Apocynaceae*, *Sapotaceae*, *Ebenaceae* and *Leguminosae.* Stem densities for *Guttiferae*, *Lauraceae*, *Myrtaceae*, *Cunoniaceae* are relatively important in both forest types.

Density per species

The distribution of stem densities for the different size class diameters ≥ 2 cm dbh of the 25 most abundant species is given in Table 13.

Among these species, several are found in the canopy and attain diameters ≥ 40 cm. This is notably the case for 3 of the most abundant species : *Dysoxylum roseum* (*Meliaceae*), *Cupaniopsis petiolulata* (*Sapindaceae*) and *Calophyllum caledonicum* (*Guttiferae*). Medium size classes are represented by species such as *Burretiokentia vieillardii* (*Palmae*), *Dicksonia thyrsopteroides* (*Cyatheaceae*), and the *Sapindaceae* genera *Harpullia*, *Cupaniopsis* and *Guioa*. Small tree and shrub species with more than 60 stems/ha > 2 cm dbh include *Hedycarya engleriana* (*Monimiaceae*), *Gardenia mollis* (*Rubiaceae*), *Rapanea sp.* (*Myrsinaceae*), *Cyathea vieillardii* (*Cyatheaceae*) and liana species *Hugonia jenkinsii* (*Linaceae*), *Ventilago pseudocalyculata* (*Rhamnaceae*) and *Oxera morierii* (*Verbenaceae*).

For the majority of species, the number of stems per diameter class decreases from small to large diameters. This is not always the case for *Burretiokentia vieillardii* (*Palmae*) and *Dicksonia thyrsopteroides* (*Cyatheaceae*) which are stemless when young and were not recorded as they are less than 1.3 m in height.

The number of stems per diameter class for *Pancheria brunhesi* increase until the size class 30-40 cm is reached then decreases. This size distribution may result from aging in the population as this species reproduces poorly under closed canopy conditions. It establishes in canopy gaps in the forest. A vicarious *Cunoniaceae*, *Codia arborea,* plays this role in association with several palm species in the ultramafic rainforest on slopes at the Rivière Bleue. *Codia incrassata* is a third example of this in forests on acidic rocks on massifs in the northern part of the territory.

TABLE 13 : Density per hectare of the 25 more abundant species for different diameter classes.

Species (Families)	≥ 2	2-10	10-20	20-30	30-40	40-50	50-60	≥ 60
Dysoxylum roseum (Meliaceae)	424	376	40.7	5.3	1.0	0.7	0	0.3
Cupaniopsis petiolulata (Sapindaceae)	333	278	39.3	11.7	3.7	0.3	0	0
Calophyllum caledonicum (Guttiferae)	260	187	37.7	16.0	9.0	4.3	1.0	5
Hedycarya engleriana (Monimiaceae)	225	183	39.7	2.3	0	0	0	0
Xylopia vieillardii (Annonaceae)	205	137	57.3	9.3	1.7	0	0	0
Syzygium sp. 1 (MK 18480) (Myrtaceae)	141	124	8.7	2.7	2.3	0	0.3	2.7
Cryptocarya odorata (Lauraceae)	140	130	6.7	1.7	1.0	0	0.7	0.3
Harpullia austrocaledonica (Sapindaceae)	122	113	6.3	1.7	0	0.3	0	0
Burretiokentia vieillardii (Palmae)	120	58	61.7	0.3	0	0	0	0
Garcinia puat (Guttiferae)	106	93	10	2.3	0.7	0	0	0
Pancheria brunhesi (Cunoniaceae)	99	13	16.7	18.3	22.7	16.7	5.3	6
Niemeyera balansae (Sapotaceae)	99	74	15.0	6.0	1.7	1.3	1.0	1
Gardenia mollis (Rubiaceae)	93	61	31.0	1.0	0	0	0	0
Anthocarapa nitidula (Meliaceae)	93	62	8.0	10.0	7	2.0	2.0	1.7
Dicksonia thyrsopteroides (Cyatheaceae)	85	29	54.0	1.7	0	0	0	0
Endiandra sp. 1 (P-L 31) (Lauraceae)	85	66	14.3	2.3	1.3	0.7	0	0
Cupaniopsis macrocarpa (Sapindaceae)	83	63	13.7	4.7	2.3	0	0	0
Hugonia jenkinsii (Linaceae)	75	73	1.3	0	0	0	0	0
Rapanea sp. 2 (MK 12277) (Myrsinaceae)	69	65	4.3	0	0	0	0	0
Archidendropsis streptocarpa (Leguminosae)	67	31	14.3	15.0	4.7	0.7	1.0	0
Dysoxylum rufescens (Meliaceae)	67	54	8.0	3.3	1	0.7	0.3	0.3
Ventilago pseudocalyculata (Rhamnaceae)	67	66	0.7	0	0	0	0	0
Cyathea vieillardii (Cyatheaceae)	65	60	5.3	0	0	0	0	0
Oxera morierii (Verbenaceae)	63	63	0	0	0	0	0	0
Guioa glauca (Sapindaceae)	61	33	27.3	1.0	0	0	0	0

CONTRIBUTION OF THE DIFFERENT TAXA TO BASAL AREA

BASAL AREA PER FAMILY

The basal area for the principal families represented by stems ≥ 10 cm dbh and ≥ 40 cm dbh, which represent respectively 88.1 % and 36.3 % of the total basal area for stems ≥ 2 cm dbh, and their contribution to this total basal area, are given in Table 14. For comparative purposes, previous data on the contribution of the principal families found in the ultramafic slope rain forest at the Rivière Bleue have been included in the table.

For the two diameter classes concerned, *Cunoniaceae* and *Guttiferae* play the most important role in relation to basal area. Next in order for size classes ≥ 10 cm are the families *Meliaceae* and *Myrtaceae*. These four families account for 55 % of the basal area occupied by stems ≥ 10 cm dbh and 78 % of those ≥ 40 cm dbh.

TABLE 14 : Basal area per hectare and percentage of the total density of the main families for dbh ≥ 10 cm and dbh ≥ 40 cm for schist forest (Col d'Amieu) and comparison with the percentage of the total basal area for the Rivière Bleue forest.

Families	Col d'Amieu forest				Rivière Bleue forest	
	dbh ≥ 10		dbh ≥ 40		dbh ≥ 10	dbh ≥ 40
	m^2/ha	%	m^2/ha	%	%	%
Cunoniaceae	12.30	22.15	7.83	34.23	8.13	10.82
Guttiferae	9.15	16.48	5.12	22.40	10.63	8.25
Meliaceae	4.65	8.37	2.00	8.77	1.21	2.59
Myrtaceae	4.60	8.29	2.92	12.77	5.06	5.72
Sapindaceae	4.29	7.73	0.21	0.91	1.17	0
Lauraceae	2.44	4.39	0.80	3.49	1.73	0
Sapotaceae	1.98	3.56	0.98	4.28	13.56	18.59
Leguminosae	1.75	3.15	0.32	1.41	10.53	9.12
Annonaceae	1.56	2.80	0	0	0.06	0
Araliaceae	1.40	2.52	0.17	0.75	3.23	0.51
Rutaceae	1.21	2.18	0.45	1.98	0.14	0
Moraceae	0.97	1.74	0	0	1.61	0
Cyatheaceae	0.94	1.69	0.11	0.50	0.17	0
Proteaceae	0.88	1.58	0.38	1.67	1.07	0.82
Ebenaceae	0.85	1.53	0	0	3.43	0.53
Monimiaceae	0.78	1.41	0	0	0	0
Rubiaceae	0.66	1.18	0	0	2.24	0
Myrsinaceae	0.62	1.11	0.09	0.41	0.10	0
Palmae	0.60	1.07	0	0	5.61	0
Elaeocarpaceae	0.60	1.07	0.45	1.96	0.008	0
Euphorbiaceae	0.48	0.87	0	0	0.50	0.83
Apocynaceae	0.41	0.74	0	0	2.93	2.67
Hernandiaceae	0.36	0.66	0.11	0.47	0	0
Araucariaceae	0.33	0.59	0.30	1.33	4.82	12.32
Rhizophoraceae	0.31	0.55	0.18	0.78	0	0
Icacinaceae	0.30	0.54	0.24	1.05	6.46	17.23
Gesneriaceae	0.21	0.38	0	0	0	0
Symplocaceae	0.18	0.33	0	0	0.11	0
Balanopaceae	0.14	0.25	0.07	0.30	0.007	0
Winteraceae	0.12	0.22	0	0	0	0
Anacardiaceae	0.10	0.18	0.08	0.37	0.85	0.89
other families	0.37 (1)	0.70	0.04 (2)	0.19	(3)	(4)

(1) 17 families.
(2) Aquifoliaceae.
(3) 22 families with : Flindersiaceae 3.00 ; Dilleniaceae 2.26 ; Bignoniaceae 1.67 ; Rhamnaceae 1.53 ; Burseraceae 1.43 ; Oncothecaceae 1.36.
(4) 5 families with : Burseraceae 3.99 ; Flindersiaceae 3.46.

Sapindaceae which occupies the 5th position for diameters ≥ 10 cm, is of little importance above 40 cm dbh (0.91 %). *Sapotaceae* and *Lauraceae* share the following two places for both size classes. The families *Leguminosae*, *Annonaceae*, *Araliaceae* and *Rutaceae* are next in terms of stem density for stems ≥ 10 cm dbh and a basal area per hectare of more than 1 m^2/ha. Families with individuals ≥ 40 cm dbh that occupy a basal area of at least 0.3 m^2/ha include *Rutaceae*, *Elaeocarpaceae*, *Proteaceae*, *Leguminosae* and *Araucariaceae*.

Compared with the forest at the Rivière Bleue, that at the Col d'Amieu possesses for the two dbh categories, a much greater relative importance in certain families (*Cunoniaceae*, *Guttiferae*, *Meliaceae*, *Myrtaceae*, *Lauraceae*) and a much reduced relative importance for other families (*Sapotaceae*, *Leguminosae*, *Araucariaceae* and *Icacinaceae*). In other words, for the diameter limit of 10 cm, *Sapindaceae* have a greater relative importance in forest at Col d'Amieu than at the Rivière Bleue Reserve. The opposite is the case for *Palmae*.

Half of the Col d'Amieu forest basal area is dominated by 4 families for stems ≥ 10 cm dbh and 2 families for stems ≥ 40 cm dbh. The same percentage of basal area at the Rivière Bleue is dominated by 6 and 4 families respectively for diameters ≥ 10 cm and ≥ 40 cm.

Basal area by species

The basal areas per hectare occupied by the principal species and their relative importance in their families are given for the diameter limits 10 cm and 40 cm in Table 15.

For diameter classes ≥ 10 cm, *Pancheria brunhesi* occupies 9.68 m^2/ha which represents 78 % of the basal area occupied by *Cunoniaceae* and more than 17 % of the total basal area. The importance of this family is largely related to the abundance of this species. The next *Cunoniaceae* species, *Cunonia austrocaledonica* and *Acsmithia pubescens*, represent only a total basal area of 19.2 % for this family.

In the family *Guttiferae*, *Calophyllum caledonicum* occupies 5.3 m^2/ha which represents 58 % of the basal area for this family. *Montrouziera cauliflora* (2.05 m^2/ha) and *Garcinia* (1.48 m^2/ha) share between them 39 % of the remaining basal area occupied by this family.

Anthocarapa nitidula (2.81 m^2/ha), *Dysoxylum roseum* (1.12 m^2/ha) and *Dysoxylum rufescens* (0.67 m^2/ha) represent nearly 99 % of the total basal area for the family *Meliaceae*.

Syzygium sp.1 (1.86 m^2/ha) is 5th in species importance and represents 40 % of the basal area occupied by the *Myrtaceae* which also includes *Caryophyllus sp. 1* (1.10 m^2/ha) and *Piliocalyx laurifolius* (0.90 m^2/ha). These three species comprise 84 % of the basal area occupied by *Myrtaceae*. The remaining 16 % is shared among 8 other species.

Archidendropsis streptocarpa, the only representative in the family *Leguminosae*, has a surface area of 1.75 m^2/ha. It is followed by *Niemeyera balansae* (1.65 m^2/ha) which represents 83.3 % of the surface area occupied by *Sapotaceae*. *Cupaniopsis petiolulata* (1.60 m^2/ha) possesses the most important basal area coverage for the *Sapindaceae* followed by *Elattostachys apetala* (1.18 m^2/ha) and *Cupaniopsis macrocarpa* (0.63 m^2/ha). These three species comprise 79.5 % of the basal area for this family. The remaining 20.5 % is divided among 10 other species. With more than 1 m^2/ha we find *Xylopia vieillardii* (*Annonaceae*) and *Zanthoxylum sp.* (*Rutaceae*) representing 96.8 % and 92.6 % respectively for their families.

TABLE 15 : Basal area per hectare and percentage of the basal area of the family for the most important species for dbh ≥ 10 cm and dbh ≥ 40 cm.

Species (family)	dbh ≥ 10 cm		dbh ≥ 40 cm	
	Basal area m^2/ha	% of the basal area of the family	Basal area m^2/ha	% of the basal area of the family
Pancheria brunhesi (Cunoniaceae)	9.68	78.7	6.30	71.3
Calophyllum caledonicum (Guttiferae)	5.30	57.9	3.07	60.0
Anthocarapa nitidula (Meliaceae)	2.81	60.4	1.49	74.3
Montrouziera cauliflora (Guttiferae)	2.05	22.4	1.84	35.9
Syzgium sp. 1 (MK 18480) (Myrtaceae)	1.86	40.4	1.37	46.9
Archidendropsis streptocarpa (Leguminosae)	1.75	100.0	0.32	100.0
Niemeyera balansae (Sapotaceae)	1.65	83.3	0.93	95.0
Cupaniopsis petiolulata (Sapindaceae)	1.60	37.3	0.05	25.7
Xylopia vieillardii (Annonaceae)	1.51	96.8	0	0
Cunonia austrocaledonica (Cunoniaceae)	1.50	12.2	1.35	17.2
Elattostachys apetala (Sapindaceae)	1.18	27.5	0.06	26.9
Dysoxylum roseum (Meliaceae)	1.12	24.1	0.23	11.5
Zanthoxylum sp. 1 (V 2785) (Rutaceae)	1.12	92.6	0.45	100.0
Caryophyllus sp. 1 (McP 5264) (Myrtaceae)	1.10	23.9	0.75	25.7
Schefflera gabriellae (Araliaceae)	0.93	66.4	0.17	100.0
Piliocalyx laurifolius (Myrtaceae)	0.90	19.6	0.49	16.9
Acsmithia pubescens (Cunoniaceae)	0.86	7.0	0.12	1.5
Garcinia neglecta (Guttiferae)	0.83	9.1	0.12	2.4
Diospyros olen (Ebenaceae)	0.83	96.5	0	0
Endiandra sp. 2 (MK 39466) (Lauraceae)	0.76	31.2	0.38	47.3
Dicksonia thysopteroides (Cyatheaceae)	0.76	80.9	0	0
Dysoxylum rufescens (Meliaceae)	0.67	14.4	0.29	14.2
Kermadecia sinuata (Proteaceae)	0.66	75.0	0.38	100.0
Garcinia virgata (Guttiferae)	0.65	7.1	0.10	1.8
Cupaniopsis macrocarpa (Sapindaceae)	0.63	14.7	0	0
Hedycarya engleriana (Monimiaceae)	0.63	80.8	0	0
Burretiokentia vieillardii (Palmae)	0.60	100.0	0	0
Endiandra sp. 1 (P-L 31) (Lauraceae)	0.55	22.5	0.10	12.4
Cryptocarya odorata (Lauraceae)	0.49	20.1	0.23	29.1
Sloanea ramiflora (Elaeocarpaceae)	0.45	75.5	0.39	86.8
other species	10.098(1)	18.2	1.89 (2)	8.3

(1) 117 species.

(2) 19 species, including with more than 0.1 m^2/ha : *Agathis moorei* (Araucariaceae) 0.3 m^2. *Citronella macrocarpa* (Icacinaceae) 0.1 m^2. *Crossostylis multiflora* (Rhizophoraceae) 0.18 m^2. *Cyathea novaecaledoniae* (Cyatheaceae) 0.11 m^2. *Hernandia cordigera* (Hernandiaceae) 0.11 m^2.

Among the most important families, two species of *Endiandra* and *Cryptocarya odorata* total basal areas of 1.8 m^2/ha, 73.8 % of the family *Lauraceae*. *Schefflera gabriellae* (0.93 m^2/ha) occupies 66.4 % of the basal area for *Araliaceae* and *Hedycarya engleriana* (0.63 m^2/ha) occupies 80.8 % of the basal area for the family *Annonaceae*.

For diameter classes ≥ 40 cm, *Pancheria brunhesi* with 6.3 m^2/ha represents 71.3 % of the basal area of *Cunoniaceae*, but also occupies 27.5 % of the total basal area. This is followed by *Calophyllum caledonicum*, *Montrouziera cauliflora* (95 % of the *Guttiferae*) and *Anthocarapa nitidula*. The basal area values for these three species combined with those above for *Pancheria brunhesi* encompass 55 % of the total basal area. Species which have a basal area coverage of more than 1 m^2/ha include *Syzygium sp. 1* (1.37 m^2/ha or 46.7 % of the basal area of *Myrtaceae*) and *Cunonia austrocaledonica* (1.35 m^2/ha). To obtain 80 % of the total basal area *Niemeyera balansae* (0.93 m^2/ha and 95 % of *Sapotaceae*), *Caryophyllus sp. 1* (0.75 m^2/ha), *Piliocalyx laurifolius* (0.46 m^2/ha), *Zanthoxylum sp. 1* (0.45 m^2/ha) and *Sloanea ramiflora* (0.39 m^2/ha) must be added. The two last species represent 100 % and 86,8 % respectively of the basal areas of the *Rutaceae* and *Elaeocarpaceae*.

Among the species that have been exploited, *Calophyllum caledonicum* with a basal area of 5.07 m^2/ha (stems ≥ 10 cm dbh) exhibits strong regeneration with 73 stems recorded for the site (10 stems ≥ 40 cm dbh). Despite its basal area of 2.05 m^2/ha (stems ≥ 10 cm dbh), regeneration of *Montrouziera cauliflora* is markedly less important with only 11 stems recorded (6 stems ≥ 40 cm dbh). *Agathis moorei* shows no regeneration within the study area. The basal area of this species (0.3 m^2/ha) is represented by only three trees (30, 60 and 89 cm dbh respectively) for the 3 ha inventoried.

CONCLUSION

The schist rainforest of the study area at Col d'Amieu is representative of this type of formation found elsewhere on acid substrates in the central part of Grande Terre. As with other forests studied in New Caledonia, it is characterised by a high stem density (dbh ≥ 2 cm and dbh ≥ 10 cm). However, it is less rich in stems < 40 cm dbh than ultramafic slope forest at the Rivière Bleue Reserve, but has a greater stem density in diameter classes ≥ 40 cm and ≥ 60 cm.

The abundance of mid and large diameter trees results in a high total basal area similar to that observed for forests in Malesia and Melanesia. Structurally, it differs from the rain forests in Malesia and Melanesia mainly in having a greater stem density. This may be explained by height of the forests and the structure of the forest canopy in New Caledonia which is less dense than those of other forests in the region.

Despite its greater abundance of ferns, the flora of the study site is less rich than that of the ultramafic rainforest at the Rivière Bleue Reserve.

The floristic richness of New Caledonia (more than 3000 native species for 19000 km^2) is well known. Although this richness is not always evident in individual forests, the formation as a whole has the highest overall species diversity in New Caledonia.

The very different floristic compositions from one forest type to another lends support to the idea (JAFFRÉ, 1980 ; JAFFRÉ et al., 1987) that the floristic richness of New Caledonia is largely due to the diversity of habitats.

Despite having a floristic richness average for rainforest in the Malesian region, the forest of the study site has a diversity index and especially an evenness index which is relatively high, except in large canopy gaps where regeneration is dominated by *Pancheria brunhesi*. Even if the values obtained for the ultramafic rainforest at the Rivière Bleue are somewhat higher, those of the study forest still illustrate its well balanced nature.

The increases in species number with increases in surface area above 2 hectares are negligible if we subtract species which occur in only one or two of the subplots. Once these rare species are excluded from the analysis, the 2 hectares area can be taken as the minimum area required to study the principal characteristics of the forest.

In contrast to the floristic composition of forests at Rivière Bleue, which is dominated by the families *Myrtaceae* and *Rubiaceae* (18 % of total species diversity), the forest at Col d'Amieu is characterised by the predominance of several families (*Sapindaceae*, *Rubiaceae*, *Myrtaceae*, *Moraceae*, *Apocynaceae*, *Myrsinaceae*, *Lauraceae*...).

The families *Sapindaceae*, *Moraceae* and *Myrsinaceae* are strongly represented in the forest at the Col d'Amieu. The opposite is the case for the *Myrtaceae* and the *Palmae*, and the *Podocarpaceae* are absent.

Stem density for the study site forest is characterised by the abundance, in order of the families *Sapindaceae*, *Meliaceae*, *Guttiferae*, *Lauraceae*. The family *Cunoniaceae* is added to this list for stem diameters ≥ 10 cm. A comparison with forest at Rivière Bleue brings to light the poor representation of *Palmae*, *Araliaceae*, *Rubiaceae*, *Apocynaceae*, and *Sapotaceae*. This is compensated for by the greater abundance of *Sapindaceae*, *Meliaceae*, *Monimiaceae*, *Annonaceae*, *Cyatheaceae* and *Myrsinaceae*.

The basal area of forest at Col d'Amieu is largely dominated by the families *Cunoniaceae* and *Guttiferae* followed by *Meliaceae*, *Myrtaceae* and *Sapindaceae* for stems ≥ 10 cm dbh. *Sapindaceae* is poorly represented at diameter classes ≥ 40 cm while the two other families occupy 3rd and 2nd positions respectively.

The contribution of different families to basal area is notably different for the two forests studied.

The families *Cunoniaceae*, *Guttiferae* and *Myrtaceae*, which contribute largely to the basal area of both rainforests have a higher relative importance for the forest at Col d'Amieu. The families *Meliaceae* and *Sapindaceae* have an equally dominant role in the basal area composition of this forest. *Sapotaceae*, *Icacinaceae*, *Araucariaceae*, *Leguminosae*, which occur in important numbers in forest at Rivière Bleue, are of less importance in forest of the study site.

ACKNOWLEDGEMENTS : We give our thanks to Mr J. FAVIER for his participation in the field survey work and to Mr F. RIGAULT for computation, treatment of data and tabulation of results. We also acknowledge our thanks to Mr S. MCCOY and Dr J. W. DAWSON for their translation of the text into English.

REFERENCES

C.T.F.T., 1975. — *Inventaire des ressources forestières de la Nouvelle-Calédonie*. Fasc. 2, 227 p, Nouméa.

CHIN, S. C., & CHUA, T. H., 1984. — The impact of man on a southeast Asian tropical forest. *Malayan Nat. J.* 36 : 253-269.

JAFFRÉ, T., 1980. — *Etude écologique du peuplement végétal des sols dérivés de roches ultrabasiques en Nouvelle-Calédonie*. Trav. Doc. O.R.S.T.O.M., n° 124, 274 p.

JAFFRÉ, T., 1992. — Floristic and Ecological diversity of the vegetation on ultramafic rocks in New Caledonia : 101-107, *in* A. J. M BAKER, J. PROCTOR & R. REEVES (eds), *The Vegetation of Ultramafic (Serpentine) Soils*. Intercept Ltd., Andover, U.K.

JAFFRÉ, T., MORAT, Ph.,VEILLON, J. M., MACKEE, H. S., 1987. — Changements dans la végétation de la Nouvelle-Calédonie au cours du tertiaire : La végétation et la flore des roches ultrabasiques. *Bull. Mus. natn. Hist. nat., Paris*, 4e ser., 9, section B, *Adansonia*, n° 3 : 273-288.

JAFFRÉ, T. & VEILLON, J. M., 1989. — Morphology, Distribution and Ecology of Palms in New Caledonia : 158-169, *in* J. L. DOWE (ed), *Palms of the South West Pacific*. MILTON : *Palm and Cycad Societies of Australia*.

JAFFRÉ, T. & VEILLON, J. M., 1990. — Etude floristique et structurale de deux forêts denses humides sur roches ultrabasiques en Nouvelle-Calédonie. *Bull. Mus. natn. Hist. nat., Paris,* 4e ser., 12, section B, *Adansonia*, nos 3-4 : 243-273.

KARTAWINATA, K., ABDULHADI, R. & PARTOMIHARJO, T., 1981. — Composition and structure of a lowland Dipterocarp forest at Wanariset East Kalimantan. *Malayan Forester* 44 : 297-406.

LATHAM, M., QUANTIN, P. & AUBERT, G., 1978. — *Etude des sols de Nouvelle-Calédonie. Notice explicative n° 78 de la carte pédologique de la Nouvelle-Calédonie*. O.R.S.T.O.M., Paris.

MAGURRAN, A. E., 1988. — *Ecological diversity and its measurements*. Croom Helm, London.

MORAT, Ph., JAFFRÉ, T., VEILLON, J. M. & MACKEE, H. S., 1981. — Les formations végétales, Pl. 15, *in Atlas de la Nouvelle-Calédonie*. O.R.S.T.O.M., Paris.

MORAT, Ph., VEILLON, J. M. & MACKEE, H. S., 1984. — Floristic Relationships of New Caledonia Rain Forest : 71-128, *in* RADOVSKY, RAVEN & SOHMER (eds.), *Biogeography of the Tropical Pacific*. Association of Systematics Collections and Bernice P. Bishop Museum, Honolulu, Sp. Public., n° 72.

NEWBERY, D. McC., CAMPBELL, E. J. F., LEE, Y. F., RIDSALE, C. E. & STILL, M. J.,1992. — Primary lowland dipterocarp forest at Danum Valley, Sabah, Malaysia : structure, relative abundance and family composition : 341-356, *in* A.G. MARSHALL & M.D. SWAINE (eds.), *Tropical Rain Forest Disturbance and Recovery*. The Royal Society, London.

PAIJMANS, K., 1970. — An analysis of four tropical rain forest sites in New Guinea. *J. Ecol.* 58 : 77-101.

PEET, R. K., 1974. — The measurement of species diversity. *Ann. Rev. Ecol. Syst.* 5 : 285-307.

PARIS, J. P., 1981 — *Géologie de la Nouvelle-Calédonie. Un essai de synthèse*. Orléans, B.R.G.M.

PROCTOR, J., ANDERSON, J. M., CHAI, P. & VALLACK, H. W., 1983. — Ecological studies in four contrasting lowland rain forests in Gunung Mulu National Park, Sarawak. I. Forest environment, structure and floristics. *J. Ecol.* 71 : 237-260.

PROCTOR, J., LEE, Y., LANGLEY, A. M., MUNRO, W. R. C. & NELSON, T., 1988. — Ecological studies on Gunung Silam, a small ultrabasic mountain in Sabah, Malaysia. I. Environment forest structure and floristics. *J. Ecol.* 76 : 320-340.

ROLLET, B., 1979. — Application de diverses méthodes d'analyse de données à des inventaires forestiers détaillés levés en forêt tropicale. *Œcol. Plant.* 14 (3) : 319-344.

ROLLET, B., 1983. — La régénération naturelle dans les trouées. *Bois et Forêts des Tropiques* 201 : 3-31.

WHITMORE, T. C. & SIDIYASA, K., 1986. — Comparison and structure of a lowland rain forest in Taraut, Northern Sulawesi. *Kew Bull.* 41 : 747-756.