On the Vegetational Change in Fallows at a Hamlet in a Northwestern Region of Malaita, the Solomon Islands*

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Abstract

Species compositions of the vegetation in fallows around a hamlet in a northwestern region of Malaita, the Solomon Islands, were quantitatively investigated over time after the abandonment of gardens (swiddens). The study site was situated in a tropical rain forest zone. The secondary succession began prior to the end of harvest activities of the farmers. The initial stage of natural regeneration following abandonment was characterized by very vigorous growth of such pioneer tree species as Euphorbiaceae and *Ficus* (fig). Within several years after abandonment, secondary forests of an early stage were established in the fallows where they were little disturbed by human activities. Many woody ferns grow there. At a stage of older than 10 years after the abandonment of gardens, the species composition was considered roughly similar to that at the stage several years after abandonment, although the relative value of the number of the pioneer trees of Euphorbiaceae plus *Ficus* was considerably decreased and both the quantitative indices of the number of tree individuals and the total area of horizontal breast height sections of their trunks in a plot increased. In the "Sanctuary Forest" which is considered to have been kept almost intact for several decades, not a few species of the common big trees in natural forests in the Solomon Islands were found. Both the foregoing quantitative indices there showed distinctly larger values than for the secondary forest of slightly more than 10 years fallow.

Because of population pressure and, accordingly, the reduction of fallow periods to several years, the expansion of degraded grasslands or "fernlands" in the northwestern region of Malaita in the considerably near future is predictable despite much rainfall.

Key words: Vegetational change, Species composition, Fallows, Solomon Islands.

Introduction

The agricultural system of the Solomon Islands, where tropical rain forests can be ubiquitously seen (WHITMORE, 1966), is based principally on shifting cultivation (SPENCER, 1966) which necessarily results in the abandonment of cultivated land for a definite period of time. The cultivated land for subsistence production is, in the South Pacific islands, usually

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called gardens. Conventionally, therefore, the art of subsistence food production there is not considered agriculture but "horticulture" or "gardening". Recently, some socio-economic factors have shortened the fallow periods of many such a garden (NAKANO, 1983). In an area of northwestern Malaita Island, the Solomon Islands, the fallow periods of 31 gardens for food crops out of the 58 samples were reported to be equal to or less than 10 years (anonymous, 1989a). It is often said that reducing the time of fallow periods too much is one of the causes, even in the very humid tropics, for the expanses of degraded and agriculturally unutilizable grasslands or "fernlands". For the management and conservation of tropical rain forests, therefore, it seems very important to investigate thoroughly the conditions which bring about the foregoing degraded grasslands or "fernlands". As a fundamental step for such investigation, this report is focused on the quantitative description of the vegetational change in a number of fallows around a hamlet in a northwestern region of Malaita. Furthermore, I will consider the vegetational changes of the fallows not only in the northwestern region of this island but also some areas of southeast Asia and Oceania in relation to their circumstances such as climate, topography, soil and socio-economic factors.

Studies of the flora of the Solomon Islands have been pursued by a considerable number of professional and amateur botanists since the last century (WHITMORE, 1966). Their efforts were compiled by WHITMORE (1966), HENDERSON and HANCOCK (1988) and HANCOCK and HENDERSON (1988). Quantitative data of the vegetational changes of fallows, however, are still conspicuously lacking for building up our basic knowledge as to the dynamics of the vegetation in Malaita. This report is also expected to be significant by precisely describing the vegetation in the region. No such studies regarding north Malaita have ever been made.

I owe much to the inhabitants of the Aitea hamlet for their willingness and co-operation. Furthermore, I express my cordial and sincere thanks to Mr. Geoffrey DENNIS (a former Officer, Forestry Division, Ministry of Natural Resources) and Mr. David GLENNY (a Herbarium Officer, Forestry Division) in Honiara (the capital of this country) for the true kindness of these botanists.

Site Description

The location of the study site is shown in Fig. 1. It is situated towards the top of one of the main ridges of Malaita, from which the streams flow eastward and westward, and is on the western side of the slopes of a few peaks whose altitudes are slightly more than 500 m above sea level (anonymous, 1971 and 1972). It is in the territory of a hamlet, Aitea, and near the hamlet site. As shown in Fig. 1., its altitude is approximately 400 m above sea level. Generally speaking, the surrounding slopes are not very steep. Some close to valley bottoms in the study site are, however, in places much more than 30°.

According to WALL and HANSELL (1974), this survey site belongs to Tamba'a Land System which "is the largest and most widespread land system in Malaita". This quoted passage was taken into account when the Aitea area was selected out of several sites to be intensively studied. The upper soil horizons and topsoil there contain small to medium sized stones

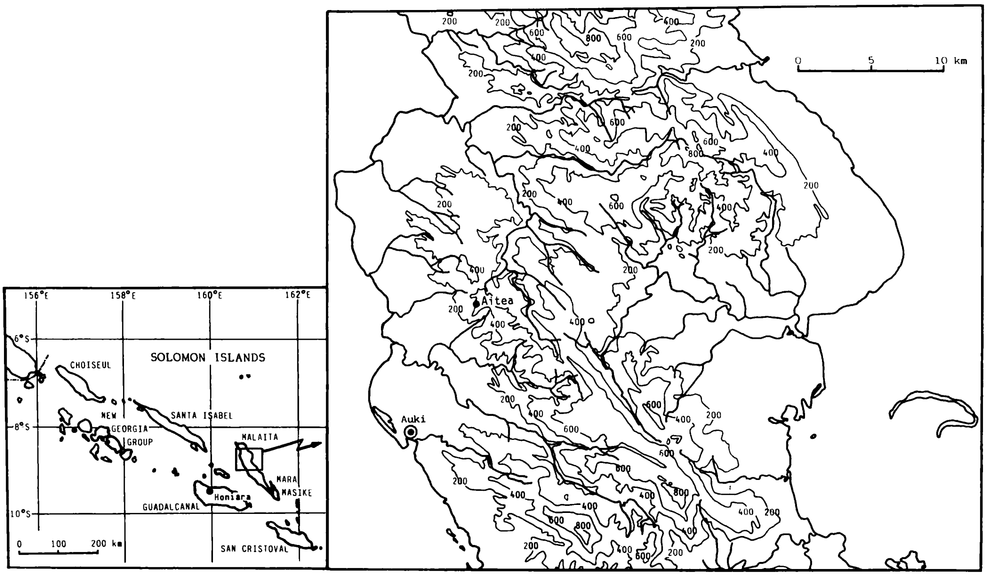

Fig. 1. Map showing the location of the hamlet of Aitea together with the topography around it. The main part of this map was based on anonymous (1976). Auki, where a meteorological station exists, is the administrative centre of Malaita. The figures on the contour lines present the values of altitude above sea level in metre.

which originated from sedimentary rocks. Most of those stones are noncalcarious.

The climatic data at Auki meteorological station 10 km to the south-south-west of the survey site are available to anyone at the office of Solomon Islands Meteorological Service in Honiara. The monthly means of the daily maximum and the minimum temperatures at Auki station for the years from 1954 to 1987 show respectively the annual ranges of 29.2°C (July) to 30.7°C (December) and 22.0°C (August) to 23.6°C (February and December). These values indicate only a little seasonal variation of temperature. Usually, because of nearly 400 m difference in altitude between the survey site and Auki at sea level, the study site has lower temperature values. According to the data having been obtained by myself at the hamlet for 27 successive days from 16 April, 1989, the means of the difference of the daily maximum and the minimum temperatures from the corresponding data at Auki station were, respectively, 3.6°C and 2.0°C. This means that the temperature at the survey site rarely rises up to 30°C and, early in the morning, occasionally drops to slightly lower than 20°C.

As for the annual precipitation pattern at the study site, depending solely on the data at the station, I am obliged to tell an even rougher story than about the temperature. In so far as the average values, the survey site seems to have no months with less than 100 mm of precipitation. At the station, the means of the yearly total and monthly minimum values of precipitation for the above-stated years are, respectively, 3145 mm and 171 mm (June). At any rate, the climate at the survey site is regarded as a typical example of that in the humid tropics with no distinct dry season.

The inhabitants there belong to the people who speak Kwara'ae and mainly produce sweet potatoes (*Ipomoea batatas* (L.) LAMK.) for their own subsistence consumption at their gardens or swiddens around the hamlet site. Sweet potato and other tuberous crops for staple food are hard to store there for a long time following harvest without sophisticated and expensive facilities. They have no custom of drying sweet potatoes. Under a system of subsistence economy, therefore, they always keep their necessary quantity of harvestable sweet potatoes in the soil of those gardens. In addition, inasmuch as the climate there determines neither the season for planting old vines of sweet potato plants nor the season for burning the felled and slashed vegetation, there is no marked and definite annual cycle of horticultural activities. Nevertheless, the majority of the gardens there seems to be prepared in the period between December (the Christmas month) and April (near Easter). The reason of this inclination is considered mainly cultural on the basis of the Christian calendar rather than ecological. According to an old man and a note of hamlet history, although the initial hamlet site was on the main ridge and approximately 1 km to the northeast of the present site, the hamlet was established in 1929 and they were Christianized in the 1930's. They plant no early maturing varieties of sweet potato. After the vines have been planted, their varieties usually need nearly half a year to begin providing harvestable sweet potatoes. During this period, they dig the sweet potatoes in another garden which each household simultaneously manages.

In respect to the sweet potato plant there, normally, the duration of digging up all of its edible potatoes is several months. Deductively, a garden is covered by sweet potato plants for less than one year. In a great many of the cases, a garden is divided into several plots and the planting of vines is carried out at an open plot after the preceding one at an interval of a few months. In fact, therefore, most of the gardens there were finally abandoned after the duration of roughly one year and a half since the burning of the felled or slashed and dried vegetation and are, at present, re-utilized after several years' fallow period. Sometimes, they plant the vines of sweet potato twice before the abandonment of a garden. It is, however, only in very rare cases that they plant three times or more in a garden. In general, the sizes of their gardens are far less than 1 ha.

Survey Procedure and Methods

The field surveys at the Aitea area were conducted twice, from March to May, 1989, and from October to December, 1990. The detailed data of the vegetational change shown by Tables 1–4 were obtained at two places which are stituated on both sides of a very shallow valley, a head of a stream. The distance from one to the other is roughly 200 m. The first area consisted of the part utilized sometimes for crop production, "Old Garden 1", and the other part on an inconspicuous peak, "Sanctuary Forest" which will be explained later. The second area is called here "Old Garden 2".

The vegetation of the gardening part ("Old Garden 1") of the first area was felled and slashed little by little between January and April in 1989 after slightly more than 10 years fallow. When I arrived at the survey site, the "owner" of "Old Garden 1", who had lived in

Honiara for more than 10 years until December, 1988, had already cleared almost completely the land of the fallowed vegetation and yet only one stand in "Old Garden 1" remained unfelled. Consequently, the selection of the survey plot was not free at all and the shape of the stand could not allow me to make a 10 m×10 m quadrat. Nevertheless, a quantitative survey at a 89 m^2 plot, whose shape was not a quadrat but an indeterminate form, could be made. In this plot, the heights and the girths at the breast height (g.b.h.) of all the trees with breast height (b.h.) girths of more than 10 cm were measured and they were identified.

The gardening stage of "Old Garden 1" allegedly ended soon after Easter of 1990. In December, 1990, the regrowth there was quantitatively investigated by three 2 m×2 m quadrats randomly distributed. The above-ground biomass of every species in each quadrat was estimated. The oven-dry weight of a minor species at each quadrat was measured after the whole sample of the species at respective quadrat had been carried to Dodo Creek Research Station in a suburb of Honiara and kept in an oven at 80°C for three days. As for the major species, another method similar to that described by NAKANO *et al.* (1987a) was adopted. Difficulties of transportation of the samples from the survey site to the Research Station and the small capacity of the oven there limited the number of quadrats for the quantitative analyses of the vegetation in "Old Garden 1".

The "Sanctuary Forest" lies beside "Old Garden 1". It had such a small area that only one quadrat with the size of 10 m×10 m could be set when its peripheral zone was excluded. The ground of the centre of the forest was partly higher in terrace than that of the peripheral zone and was circumscribed with an almost vertical stone wall having been artificially built up to about 70 cm at its maximum height. This ground had been allegedly used for the non-Christian ceremonies before the inhabitants were Christianized in the 1930's. After they had terminated such ceremonies, a woman reportedly hanged herself there. Consequently, this forest has been regarded as a "taboo spot" to be kept untouched for a long time. In 1989, my proposal of the study there was not allowed, while, in 1990, it became possible after much negotiation. In the quadrat of this small forest, too, the heights and g.b.h. of all the trees with b.h. girths of more than 10 cm, were measured and they were identified in November, 1990.

The second area is a fallow which was abandoned in the latter half of 1985, though the inhabitants could not accurately recall the month of abandonment because the clues of their striking recognition of calendar for the memory of more than a few years before are only Christmas and Easter in every year, and Cyclone Namu in May, 1986. A survey similar to the foregoing ("Sanctuary Forest") was conducted in two 10 m×10 m quadrats in May, 1989. In addition to this, the horizontal distribution of light intensity at a height of 10 cm above the ground surface was, using a radiation meter (LI-185B), measured in this fallow on a cloudy day. Simultaneously, with another meter, the light intensity at an open and sufficiently large area beside the fallow was also measured for obtaining the data of its relative values under the plant cover.

Tree heights were measured by means of a rod measure and a tool using a principle of trigonometry.

Plant species were identified primarily by combining the local names having been obtained from excellent and reliable informants in the hamlet and the check lists of Kwara'ae–Latin names of plants (WHITMORE, 1966; HENDERSON and HANCOCK, 1988). In collaboration with Mr. G. DENNIS and Mr. D. GLENNY in Honiara, however, not a few species were identified by referring the specimens at the Herbarium of the Forestry Division and Mr. DENNIS' private herbarium in Honiara.

Description of Vegetational Change and Discussion

Soon after planting the sweet potato vines, weeds grow over them. The dominant weeds at this stage are annuals of Compositae (or Asteraceae), such as, *Crassocephalum crepidioides* (BENTH.) S. MOORE, *Erechtites valerianifolia* (WOLF) DC. and *Ageratum conyzoides* L. Those at this early growth stage of sweet potato plants are usually eradicated through farmers' weeding (plucking) activities. A few months after planting, partly on account of weeding, the garden was almost completely covered by the sweet potato vines which grow so vigorously at this stage as to look like a large green carpet until the beginning of harvest, nearly half a year after planting. In the harvest stage, partly because of the human activities for digging up sweet potatoes with short wooden sticks, the density of the sweet potato leaves decreased. The foregoing annual weeds grew again in these gaps and extended their cover. At this stage, however, many tree seedlings and some ferns, for instance, *Nephrolepis biserrata* (Sw.) SCHOTT, *N. hirusutula* (FORST.) PRESL, *N. saligna* CARRUTH., invaded and vigorously grew. In so far as was observed, no sprouted shoots from the stumps of the trees having been felled and burnt by the farmers could be found. During the harvest stage, sweet potatoes are usually dug up a few times. Doing so, at the same time, the farmers weed. Before the abandonment of a garden, wild plants grew very rapidly and covered the whole area. The duration when the foregoing composite annuals were conspicuous was rather short. Those were gradually replaced by the ferns mentioned above, the vines of *Mikania micrantha* H., B. et K. and, finally, tree seedlings and saplings. Table 1 shows biomass of each species in the three quadrats at a stage eight months after the abandonment of "(Old) Garden 1".

It shows that 92% of the mean value of the total dry weight in the quadrats is the weight of saplings, half of whose weight is that of the pioneer species of Euphorbiaceae plus *Ficus*. According to KARTAWINATA *et al.* (1980), the most frequent genus of the early invaders into a plot having been clear-cut and burnt in East Kalimantan, which is also in the humid tropics with no distinct dry season, is *Macaranga* which belong to Euphorbiaceae. The data by SAULEI (1984) indicate that the frequency of *Macaranga quadriglandulosa* A. SHAW (no other species of this genus is noted in his Table 1) is the second largest and its relative value is 27% among all the tree species of secondary forest in the natural regrowth vegetation in a cleared forest in Gogol Valley, Papua New Guinea, at the stage of six months after clear felling. On the other hand, no *Macaranga* species can be found in Table 1. As will be shown later, this does not necessarily mean that the species of this genus are inconspicuous in the secondary forests of the fallows in the northwestern region of Malaita at their earlier stages.

Table 1. Biomass of each species (above the ground surface) in 3 quadrats (2 m×2 m each) in "Old Garden 1" at a stage of 8 months after abandonment; the dates of sampling, 10 and 11 December, 1990.

Plant species	g dry weight*/m^2
Quadrat 1:	
Melochia umbellata (HOUTT.) STAPF {Sterculiac.} #	306.8 (34.7%)
Acalypha grandis BENTH. {Euphorbiac.} #	169.0 (19.1%)
Premna corymbosa (BURM. f.) R. et W. {Verbenac.} #	83.33 (9.4%)
Antidesma sp. 1 [o'a] {Euphorbiac.} # or *Glochidion* sp. [o'a] {Euphorbiac.} #	58.68 (6.6%)
Ficus sp. 1 [aidadala] #	57.28 (6.5%)
Commersonia bartramia (L.) MERR. {Sterculiac.} #	46.25 (5.2%)
Flagellaria indica L. {Flagellariac.}	34.13 (3.9%)
Angiopteris evecta (FORST. f.) HOFFM. {Angiopteridac.}	31.15 (3.5%)
Mikania micrantha H., B. et K. {Compos.}	30.75 (3.5%)
Pipturus argenteus (FORST. f.) WEDD. {Urticac.} #	29.65 (3.4%)
Paspalum conjugatum BERG.	7.87 (0.9%)
Schleinitzia novo-guineensis (WARB.) VERDC. {Legumin.} #	6.11 (0.7%)
Oplismenus undulatifolius var. *imbecillis* (R. BR.) HACK. {Gramin.}	5.93 (0.7%)
Ficus septica BURM. f. #	4.20 (0.5%)
Dioscorea nummularia LAMK.	4.00 (0.5%)
Stenochlaena laurifolia PRESL {Blechnac.}	3.70 (0.4%)
Lygodium sp. {Schizaeac.}	1.86 (0.2%)
Ipomoea batatas (L.) LAMK.	1.34 (0.2%)
Nephrolepis saligna CARRUTH. {Oleandrac.}	1.12 (0.1%)
Dioscorea bulbifera L.	0.57 (0.1%)
Cyperus cyperoides (L.) O. KUNTZE	0.16 (0.0%)
Total of Quadrat 1	883.9 (100.1%)
Maximum height, 3.3 m	
Quadrat 2:	
Homalanthus sp. {Euphorbiac.} #	1030.7 (51.9%)
Trichospermum fauroensis KOST. {Tiliac.} # or *T. psilocladum* MERR. et PERRY #	489.0 (24.6%)
Artocarpus altilis (PARK.) FOSB. {Morac.} #	145.8 (7.3%)
Ficus sp. 1 #	122.3 (6.2%)
Alphitonia incana (ROXB.) T. et B. ex KURZ {Rhamnac.} #	47.50 (2.4%)
Mikania micrantha	44.58 (2.2%)
Rubus moluccanus L.	25.98 (1.3%)
Dioscorea bulbifera	19.39 (1.0%)
Trema cannabina LOUR. {Ulmac.} # or *T. orientalis* (L.) BL. #	15.59 (0.8%)
Phyllanthus reticulatus POIR. {Euphorbiac.} #	12.75 (0.6%)
Ficus nodosa T. et B. # or *F. variegata* BL. #	9.21 (0.5%)
Antidesma sp. 1 # or *Glochidion* sp. #	7.33 (0.4%)
Ficus sp. 2 [samota] #	4.04 (0.2%)
Borreria laevis (LAMK.) GRISEB. {Rubiac.}	3.42 (0.2%)
Oplismenus undulatifolius var. *imbecillis*	2.01 (0.1%)
Paspalum conjugatum	1.97 (0.1%)
Ficus verticillaris CORNER #	1.20 (0.1%)
Callicarpa pentandra ROXB. {Verbenac.} #	1.16 (0.1%)
Alpinia pulchra [kakara] {Zingiberac.}	0.45 (0.0%)
Dioscorea nummularia	0.41 (0.0%)
Total of Quadrat 2	1984.8 (100.0%)
Maximum height, 5.5 m	
Quadrat 3:	
Trichospermum fauroensis # or *T. psilocladum* #	486.5 (56.4%)
Ficus sp. 1 #	245.5 (28.4%)
Commersonia bartramia #	28.00 (3.2%)

Table 1. (continued)

Plant species	g dry weight*/m^2
Rubus moluccanus	26.75 (3.1%)
Scleria polycarpa BOECK. {Cyperac.}	19.38 (2.2%)
Mikania micrantha	18.02 (2.1%)
Melochia umbellata #	6.92 (0.8%)
Oplismenus undulatifolius var. *imbecillis*	6.20 (0.7%)
Nephroleips saligna	4.72 (0.5%)
Borreria laevis	4.23 (0.5%)
Trema cannabina # or *T. orientalis* #	4.01 (0.5%)
unidentified Compositae	3.39 (0.4%)
Corymborchis veratrifolia (REINW.) BL. {Orchidac.}	3.01 (0.3%)
Dioscorea bulbifera	2.36 (0.3%)
Ficus septica #	2.16 (0.3%)
Ficus sp. 2 #	1.82 (0.2%)
Total of Quadrat 3 Maximum height, 4.2 m	863.0 (99.9%)

Mean of biomass (dry weight/m^2) of 3 quadrats$=$1243.9 g/m^2
Variance$=(S.D.)^2=(641.7)^2=$411808.81
* Excluding withered parts of those plants.
# Woody species.
The words in [ ] present the local names of the plants.

In some regions in southeast Asia (NAKANO, 1978) and India (KUSHWAHA *et al.*, 1981), a great number of fallows at an early stage are covered by *Chromolaena odorata* (L.) KING et ROB., which was reportedly introduced there from tropical America in relatively recent years (KUSHWAHA *et al.*, 1981) and often remains dominant for some years. In the region with which this paper is concerned, no abandoned garden covered by it was found. The reason of such difference is felt interesting. At any rate, it should be noted that the growth rate of saplings in Malaita is so high that they surpass most of the herbs in height at a very early stage of the fallow period.

In comparison with other data obtained in the lowlands of tropical rain forests all over the world (UHL, 1987), the mean of the total of the dry weight above the ground surface in the quadrats of "Old Garden 1", as well as the data by MOEKIYAT *et al.* (1980) in East Kalimantan, belongs to the group which is characterized by very high values. This is also noticeable.

Table 2 shows quantitative data of the vegetation of "Old Garden 2" at a stage of approximately 3 years and a half after abandonment. Nearly half of the total number of trees in Quadrats 1 plus 2 were those of *Ficus* plus Euphorbiaceae including *Macaranga* spp. This aspect is still similar to what is observed in Table 1. Besides *Ficus* and Euphorbiaceae, notable species with regard to, respectively, the number of individuals and very rapid growth evident from both the height and the area of the horizontal b.h. sections of its trunk (a.b.h.) were *Cyathea vittata* COPEL., whose trunk is edible according to the inhabitants and WHITMORE (1966) though they do not usually eat it, and *Albizia falcataria* (L.) FOSB. Sometimes, farmers do not cut large individuals of woody ferns when they clear fallows for preparing gardens. We must, therefore, take account of the possibility that some larger ones in Quadrat 1 may not have begun growing after the abandonment of the garden but remained

Table 2. Quantitative analysis of species composition of the trees (with more than 10 cm of b.h. girths) in 2 quadrats (10 m × 10 m each) in "Old Garden 2" at a stage of approximately 3 years and a half after abandonment; the date of measurement, 10 May, 1989.

Plant species	No. of individ.	(Max.) height m	(Total) a.b.h.* cm^2
Quadrat 1:			
Cyathea vittata COPEL. {Cyatheac.}	13	5.9	1284 (45.8%)
Trichospermum fauroensis KOST. {Tiliac.} or *T. psilocladum* MERR. et PERRY	4	11	671.6 (23.9%)
Macaranga clavata WARB. {Euphorbiac.} or *M. tanarius* (L.) MUELL.-ARG.**	3	8.1	407.3 (14.5%)
Albizia falcataria (L.) FOSB. {Legumin.}	1	13	309.9 (11.0%)
Macaranga aleuritoides F. MUELL.	1	7.2	95.2 (3.4%)
Ficus sp. 3 [mangomango]	1	6.7	25.8 (0.9%)
Premna corymbosa (BURM. f.) R. et W. {Verbenac.}	1	5.7	10.7 (0.4%)
Total	24		2805 (99.9%)
Quadrat 2:			
Homalanthus sp. {Euphorbiac.}	5	16	658.8 (36.0%)
Albizia falcataria	1	13	332.1 (18.2%)
Melochia umbellata (HOUTT.) STAPF {Sterculiac.}	5	8.1	227.2 (12.4%)
Macaranga clavata or *M. tanarius***	1	11	98.6 (5.4%)
Macaranga aleuritoides	1	9.0	92.0 (5.0%)
Trichospermum fauroensis or *T. psilocladum*	1	9.8	87.7 (4.8%)
Acalypha grandis BENTH. {Euphorbiac.}	4	5.9	69.8 (3.8%)
Ficus sp. 3	4	6.6	64.5 (3.5%)
Antidesma sp. 1 [o'a] {Euphorbiac.} or *Glochidion* sp. [o'a] {Euphorbiac.}	3	7.1	54.5 (3.0%)
Cyathea vittata	1	2.3	24.6 (1.3%)
Premna corymbosa	1	6.1	21.4 (1.2%)
Ficus septica BURM. f.	1	6.4	20.9 (1.1%)
Antidesma sp. 2 [boborama] or *Bridelia penangiana* HOOK. f. [boborama] {Euphorbiac.}	1	4.6	17.4 (1.0%)
Rhus taitensis GUILL. {Anacardiac.}	1	6.2	15.6 (0.9%)
Dendrocnide sp. {Urticac.}	1	4.9	14.5 (0.8%)
Phyllanthus reticulatus POIR. {Euphorbiac.}	1	4.9	14.5 (0.8%)
Artocarpus vriesianus MIQ. {Morac.}	1	5.4	13.4 (0.7%)
Total	33		1828 (99.9%)

* A.B.H. (or. a.b.h.) is an abbreviation for the "area of the horizontal section of trunk at the breast height".

** This is locally called "reremba" or "reberebe". There exists another unidentified species which is also called "reberebe" there. The latter belongs to neither the genus *Macaranga* nor the family Euphorbiaceae. It appears in Table 4.

The words in [ ] present the local names of the plants.

uncut before and throughout the gardening stage. *Albizia falcataria* is well known for its very rapid growth (WHITMORE, 1966).

Although direct comparison with the results in Amazonian lowland (UHL and JORDAN, 1984) is impossible, the data in Table 2 suggest that the number of tree species in 100 m^2 of "Old Garden 2" was probably somewhat less than that in Amazonia. This might be due to the difference of various conditions between a relatively small island and a continent. According to the data in Amazonia (UHL and JORDAN, 1984), the b.h. diameters of the largest trees respectively in their intensive and nonintensive sites at a stage of year 5 after cut-and-burn treatment are 12.6 cm and 13.9 cm. On the other hand, even if the woody ferns are excluded, the b.h. diameter of the largest tree in the two quadrats (Table 2), namely, 20.6 cm (the *Albizia falcataria* in Quadrat 2) is much larger than the foregoing. In addition, eight individuals there excluding the woody ferns had diameters of more than 13.9 cm, the higher value of the two mentioned above.

The results of the measurement of relative light intensity at 10 cm above the ground surface at 105 points in "Old Garden 2" on a cloudy day are as follows: the arithmetic mean ± the standard deviation was 1.24% ± 0.67 and the geometric mean, which may be more meaningful than the former as the representative value of relative light intensity in a forest (OGAWA, 1967), was 1.08%. These values suggest that the floor of the juvenile stage of the secondary forest had become already considerably dark. The data in Table 2 and these values seem to indicate a smooth recovery of the vegetation in the fallows in my survey site.

Table 3 presents the data similar to those in Table 2. It is concerned with "Old Garden 1" at the stage just before felling and slashing the vegetation which had recovered during slightly more than 10 years fallow. That is, the data in Table 3 were obtained in an identical old garden where those in Table 1 were obtained eight months after abandonment. Both the total number of the trees with b.h. girths of more than 10 cm and the total a.b.h. in the plot of an indeterminate form in "Old Garden 1" were larger than the corresponding values in the respective quadrats of "Old Garden 2" (Table 2). The number of species appearing in Table 3 (more than 10 years fallow), however, was not more than that in Quadrat 2 of Table 2

Table 3. Quantitative analysis of species composition of the trees (with more than 10 cm of b.h. girths) in a plot (89 m^2) of an indeterminate form in "Old garden 1" at a stage of slightly more than 10 years after abandonment; the date of measurement, 28 April, 1989.

Plant species	No. of individ.	(Max.) height m	(Total) a.b.h.* cm^2
Cyathea vittata COPEL. {Cyatheac.}	6	8.1	1111 (31.3%)
Cyathea whitmorei BAKER	5	8.5	796.0 (22.4%)
Macaranga clavata WARB. {Euphorbiac.} or *M. tanarius* (L.) MUELL.-ARG.**	3	9.4	440.1 (12.4%)
Euodia elleryana F. MUELL. {Rutac.}	3	8.8	296.0 (8.3%)
Claxylon microcarpum A. SHAW {Euphorbiac.} or *Croton amplifolius* A. SHAW {Euphorbiac.}	1	4.7	200.5 (5.6%)
Phyllanthus reticulatus POIR. {Euphorbiac.}	2	7.4	191.9 (5.4%)
Premna corymbosa (BURM. f.) R. et W. {Verbenac.}	4	5.8	130.5 (3.7%)
Callicarpa pentandra ROXB. {Verbenac.}	1	6.5	128.6 (3.6%)
Sterculia parkinsonii F. MUELL. {Sterculiac.}	3	4.2	59.4 (1.7%)
Ficus septica BURM. f.	1	4.4	43.9 (1.2%)
Ficus verticillaris ssp. *robusta* CORNER	1	7.5	40.3 (1.1%)
Litsea perglabra C. K. ALLEN {Laurac.}	1	3.6	33.4 (0.9%)
Rhus taitensis GUILL. {Anacardiac.}	1	4.4	25.8 (0.7%)
Pleomele angustifolia (ROXB.) N. E. BROWN {Liliac.}	1	3.6	20.8 (0.6%)
Ficus wassa ROXB.	1	2.7	15.6 (0.4%)
unidentified [afugua] {Euphorbiac.?}	1	2.0	10.5 (0.3%)
unidentified [kwa]	1	2.8	9.6 (0.3%)
Total	36		3554 (99.9%)

* See the first note of Table 2.
** See the second note of Table 2.
The words in [ ] present the local names of the plants.

(between 3 and 4 years fallow), though attention should be paid to the fact that the plot area (89 m^2) in "Old Garden 1" was a little smaller than a quadrat (100 m^2) in "Old Garden 2". The tallest tree in this plot belongs to *Macaranga*. In respect of the number of individuals, however, Table 3 seems to indicate that the ratio of the number of the pioneer tree species of Euphorbiaceae plus *Ficus* spp. to the total number there becomes considerably less than that in the quadrats at a juvenile stage of secondary forest (Table 2). Still, Table 3 contains none of species names which constitute the common big trees in fully matured forests in the Solomon Islands (WHITMORE, 1966). In the secondary forest whose species composition is shown in Table 3, too, many woody ferns were found. Most of them, even though it is impossible to say, "all", are considered to have begun growing after the abandonment of the garden. It was perhaps due partly to the damage from Cyclone Namu that no tree in the plot was more than 10 m in height. Actually, a few live ones with bigger trunks were found having been broken at the height of several metres above the ground.

Table 4 presents the results of "Sanctuary Forest". Some ecological characteristics shown in older forests in the Solomon Islands are found in Table 4, where only two individuals of pioneers of Euphorbiaceae and *Ficus* species, namely, one *Macaranga clavata* WARB. or *M. tanarius* (L.) MUELL.-ARG. and one *Ficus wassa* ROXB. exist. Although both *Neoscortechinia forbesii* (HOOK. f.) C. T. WHITE and *Pimeleodendron amboinicum* HASSK. belong to Euphorbiaceae, these are common big trees in natural forests in the Solomon Islands (WHITMORE, 1966). *Canarium indicum* L., which has a local name of ngali and produces very delicious nuts, is included in the list of such big tree species (WHITMORE, 1966). As written by WHITMORE (1966) himself, however, "We have never found Ngali growing genuinely wild in the Solomons, apparently all the many trees have been planted". Therefore, the dollar mark is, by intention, not added to the species name of the small tree of *C. indicum* in Table 4, because the tree in the quadrat is considered to have probably begun growing through some human activities including unconscious ones. Although this forest has not yet fully matured, at any rate, it must be noted that not a few species of big trees in natural forests in the Solomon Islands exist in Table 4. Furthermore, it is noticeable that both totals of the number of tree individuals with b.h. girths of more than 10 cm and the a.b.h. in the quadrat are markedly larger than those in Table 3 even if the factor that the plot shown by Table 3 is somewhat smaller than this quadrat is taken into account and the possibility that the two big trees, the *Dracontomelon dao* (BL.) MERR. et ROLFE? and the *Burckella obovata* (FORST.) PIERRE, had already isolatedly grown before this plot became a "taboo spot" cannot be ruled out. Table 4 has none of the names of woody ferns though a few rotten trunks of those lay on the floor of the quadrat.

With regard to the fallows where the surveys for this report were made, rapid growth of saplings in a very early stage following the abandonment of gardens should be featured. Actually, no degraded grasslands or "fernlands" were seen around the hamlet of Aitea. In the swiddening regions in Southeast Asia and Oceania, a great number of vast areas of degraded grasslands or "fernlands" have spread out. The majority of them are in the regions under the climate with distinct dry season for more than a few successive months in a year even though annual precipitation there is more than the minimum level which is

Table 4. Quantitative analysis of species composition of the trees (with more than 10 cm of b.h. girths) in a quadrat (10 m×10 m) in a small sanctuary forest beside "Old Garden 1"; the date of measurement, 13 November, 1990.

Plant species	No. of individ.	(Max.) height m	(Total) a.b.h.* cm^2
Dracontomelon dao (BL.) MERR. et ROLFE? [aisina] {Anacardiac.}	1	25	7073 (41.0%)
Burckella obovata (FORST.) PIERRE {Sapotac.} $	1	20–25	5052 (29.2%)
Calophylum vitiense TURRILL {Guttifer.} $	1	15–20	1127 (6.5%)
Pimeleodendron amboinicum HASSK. {Euphorbiac.} $	5	>10	880.5 (5.1%)
Sterculia shillinglawii F. MUELL. {Sterculiac.}	6	>10	723.7 (4.2%)
*Prunus schlechteri (*KOEHNE) KALKMAN [aimangelo] $ or *Pygeum salomonense* MERR. et PERRY [aimangelo] {Rosac.}	1	>10	598.3 (3.5%)
Neoscortechinia forbesii (HOOK. f.) C. T. WHITE {Euphorbiac.} $	2	>10	533.9 (3.1%)
Horsfieldia sp. {Myristicac.}	4	>10	306.7 (1.8%)
Semecarpus brachystachys MEER. et PERRY {Anacardiac.} or *S. forstenii* BL.	1	>10	167.4 (1.0%)
Elaeocarpus sphaericus (GAERTN.) K. SCHUM. {Elaeocarpac.} $	2	>10	141.0 (0.8%)
Areca macrocalyx ZIPP. ex BL. {Palm.}	4	7.1	122.5 (0.7%)
Gulubia macrospadix (BURRET) H. E. MOORE {Palm.} or *G. niniu* H. E. MOORE	1	>10	103.9 (0.6%)
Sterculia parkinsonii F. MUELL.	3	8.2	82.8 (0.5%)
Macaranga clavata WARB. {Euphorbiac.} or *M. tanarius* (L.) MUELL.-ARG.**	1	8.4	67.9 (0.4%)
Pandanus solomonensis B. C. STONE {Pandanac.}	1	2.5	59.4 (0.3%)
Dendrocnide sp. {Urticac.}	1	4.4	33.2 (0.2%)
Terminalia sp. {Combretac.} $	1	7.5	32.2 (0.2%)
Ficus wassa ROXB.	1	6.3	28.3 (0.2%)
Pleomele angustifolia (ROXB.) N. E. BROWN {Liliac.}	2	4.3	26.6 (0.2%)
Euodia elleryana F. MUELL. {Rutac.}	2	4.5	20.9 (0.1%)
Planchonella thyrsoidea C. T. WHITE {Sapotac.} $	2	7.4	20.6 (0.1%)
Myristica kajewskii A. C. SM. {Myristic.}	2	2.8	18.8 (0.1%)
Canarium indicum L. {Burserac.}	1	5.8	16.6 (0.1%)
Celtis sp. {Ulmac.} $	1	1.7	15.9 (0.1%)
Gomphandra montana (SCHELL.) SLEUM. [ai alo] {Icacinac.} or *Medusanthera* sp. [ai alo] {Icacinac.}	1	3.9	10.2 (0.1%)
unidentified [reberebe]***	1	3.9	9.1 (0.1%)
Total	49		17272 (100.2%)

* See the first note of Table 2.

** See the second note of Table 2.

*** This botaically unidentified species which is also locally called "reberebe" is obviously different from *Macaranga* spp.

$ The species of the common big trees in natural lowland forests of the Solomon Islands (WHITMORE, 1966).

The words in [ ] present the local names of the plants.

considered necessary for maintaining forests. Northern Thailand (NAKANO, 1978), western Luzon (BROSIUS, 1982), southernmost Sumatra (EUSSEN and WIRJAHARDJA, 1973), the Markham Basin in Papua New Guinea (NAKANO *et al.*, 1990), the northern plain and foothills of Guadalcanal of the Solomon Islands (HANCOCK and HENDERSON, 1988) and the northwestern half of Viti Levu of Fiji (NAKANO, 1985) exemplify those regions. Some reports such as NAKANO *et al.* (1987a) and NAKANO *et al.* (1987b), however, describe such grasslands or "fernlands" in the very humid tropics with no distinct dry season. Therefore, an idea that their appearance and expansion in the northwestern region of Malaita is hindered solely by the climatic conditions there cannot be approved.

Most of the degraded grasslands or fernlands in the very humid tropics seem to have undergone very intensive cultivation which was brought about mainly by population pressure (NAKANO *et al.*, 1987b) and, in addition, the penetration of a market economy (NAKANO *et al.*, 1987a). Furthermore, despite much total rainfall, seral vegetation is sometimes burnt, during relatively dry months, for various reasons which include having a fun with fire itself (NAKANO *et al.*, 1987b). At any rate, human disturbance against fallows, in which grazing or browsing by domestic animals is included, is considered the chief factor hindering natural recovery of secondary forests there. In the case of the survey site so far described, most fallows are not much disturbed, although the duration of fallow periods tends to be shortened to several years and a small number of domestic and feral pigs prowl there everyday. Another important factor related to the vigour of the regenerating forests in the fallows is considered soil condition or fertility. If the population density becomes higher, the fallow periods will be further shortened. In consequence, before secondary forests will have fully recovered, fallows will be re-utilized for crop production and soil condition or fertility there will decline.

According to the data of 1986 census (anonymous, 1989b), the average population density of the administrative district of Malaita (Malaita Island and other small islands around it) was 18.9 persons/km^2, which was the highest of all the districts, except for the City of Honiara, of the Solomon Islands and seems to be rather high for a region on the basis of shifting cultivation. The annual rate of population increase there was 2.7% (anonymous, 1989b), which is considered very high. In addition, the distribution of population is not uniform, but has already become and is becoming even patchier (NAKANO, 1983). Therefore, the expansion of degraded grasslands or "fernlands" in the considerably near future is predictable unless appropriate measures for preventing their expansion are taken very soon. Investigations of various aspects of what appropriate measures are in the northern part of Malaita Island should be the urgent tasks for the researchers who are engaged in the problems of nature conservation in the Solomon Islands, because the nature of this relatively small island is, at least partly, on the brink of devastation.

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