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REPORT ON A PRELIMINARY SURVEY OF THE VEGETATION OF THE MARKHAM BASIN

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Introduction

Many aspects of human activities are ecologically related to the vegetation of the region where the people live. Thus the survey of vegetation is indispensable for an ecological study of regional geography. In a great number of tropical regions with the climatic conditions under which forests can be maintained, vast areas of degraded, mostly anthropogenic, grassland is often seen. According to VASEY (1981), the fallows in the Markham valley are grass although the fallow periods are probably very long. These circumstances stimulated us to make a survey of the vegetation in the Markham Basin. We are interested particularly in the factors which remarkably retard the process of vegetational succession there.

Description of the Vegetation

Both the flat and the hilly zones along the upper and the middle courses of the Markham River are covered mostly by grasslands. A considerable percentage of the flat zone along the Highlands Highway is fenced and utilised for beef production. Cattle grazing was begun in the 1950's by both indigenous and European farmers (HOLZKNECHT, 1974). At present, a few farmers are changing their pastures into modernised ones by means of machine cultivators and improved seeds. Thus it is very difficult to find a suitable site for the ecological analysis of the natural processes of the vegetational succession of grasslands in the flat zone. Two types of grasslands may be recognised, these being tall and short grasslands, as HENTY (1982) described. Prominent species in the former (for example, Stand 3 in Fig. 1) are *Imperata* spp. and *Saccharum spontaneum*, and the dominant species in the latter (for example, Stand 4 in Fig. 1) is *Themeda australis* associated with *Capillipedium parviflorum*. In some sites, of course, these species grow side by side. At a small plot (Stand 5 in Fig. 1) on the fan of the Leron River, one of the main tributaries to the Markham River, we found *I. cylindrica, T. australis, Ophiuros tongcalingii, C. parviflorum* and *Sorghum nitidum*.

The hilly zone appears to be covered mostly by *T. australis*. Very often, *Cycas* sp. is conspicuous, though rather sparsely distributed, because it is much taller than the short grass. According to PAIJMANS' (1976) classification, the grassland in the Markham Basin seems to belong to either *Saccharum–Imperata* or *Ischaemum–Themeda* grassland.

The grassland in the Markham Basin is circumscribed by forest. Using the line method, the heights and the girths at breast height of all trees, whose orthographically projected crown images crossed a transect, were measured and recorded in two stands of the peripheral forest.

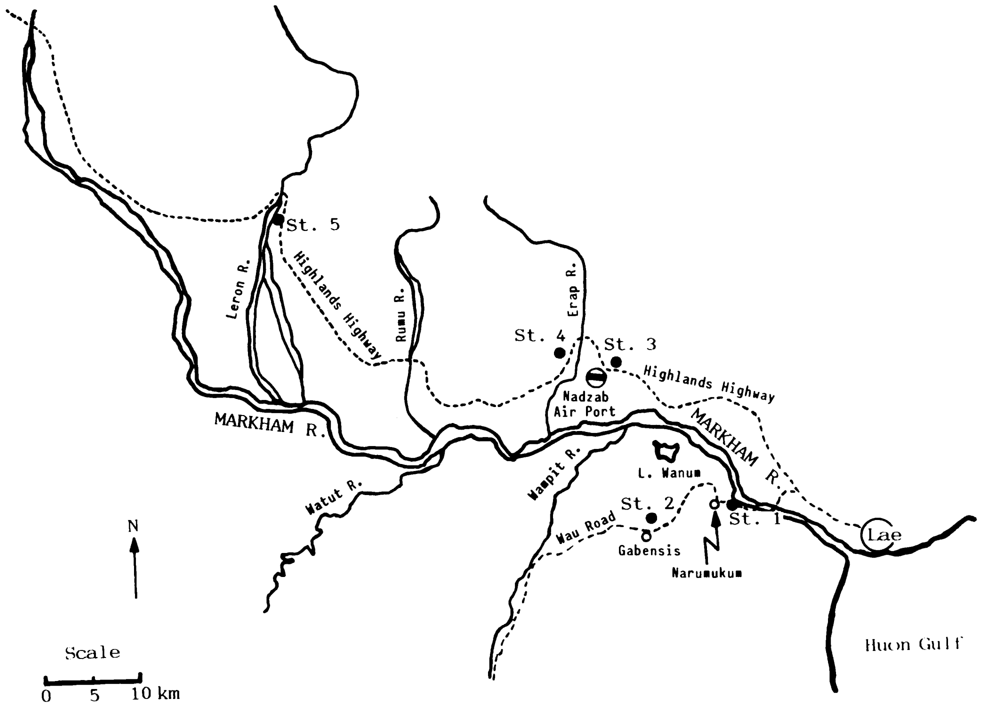


Fig. 1. The locations of the stands (St. 1–5) where careful observations were made.

Topographical features, soil profiles down to 30 cm, estimated tree height and the average ratios of canopy cover to the ground area were also noted for the survey plots. The direction and inclination of the plots were measured using clinometer.

The locations of the two surveyed forest stands (Stands 1 and 2) are shown respectively in Fig. 1. Stand 1 is situated in a back swamp of the Markham River. The forest floor there is very flat and had large areas of bare ground in places. Since it is under the water by approximately 1 m in the rainy season, this stand seems to have hardly been disturbed by human impact. Termites' nests more than 70 cm high were observed. Although there were few large trees, the biggest one stood at more than 30 m with a diameter at breast height (DBH) of over 2 m. Two types of soils were distinguished, these being clayey and sandy. These formed a mosaic on the forest floor.

Stand 2 lies on a colluvial slope, about 250 m above sea level. The annual precipitation there is not more than 2,000 mm (GARRETT-JONES, 1979). The heights of the emergent trees there appeared to be roughly 40 m. Although this stand is considered, of course, to have undergone changes from its original condition of virgin forest, it did not appear to have been much disturbed by human impact. DBH of the biggest tree in this stand is more than 3 m. Except for some large trees, the majiority of the ones had small DBH and looked still young. The forest floor litter was 2–5 cm thick. Many small clastic rocks were found in the soil as is typical of colluvial slopes. A survey of this stand had previously been made by Papua New Guinea Forest Research Institute, Lae Botanical Garden. No report, however, has been published yet.

Survey results from this study for the two stands are shown respectively in Tables 1 and

Table 1. Line method data for Stand 1 (swamp forest) in Fig. 1.

Line Distance m	Species name	DBH cm	Height m
0.6	*Celtis latifolia*	2.5	20
1.0	*Elaeocarpus* sp.	120	>30
1.2	*Myristica* sp.	1.9	3
1.5	*Listea* sp.	-	1
2.3	*Semecarpus* sp.	1.6	1.5
3.3	*Myristica* sp.	2.5	4
3.3	*Dysoxylum* sp.	2.2	5
3.3	*Litsea* sp.	9.2	15
3.8	*Cryptocarya* sp.	-	0.7
4.2	unidentified tree sp.	45	30
5.5	*Pterocarpus indicus*	12	15
5.8	*Schefflera* sp.	3.8	4
5.8	*Ficus* sp.	-	1.2
6.0	*Myristica* sp.	1.9	1
7.3	*Aglaia* sp.	2.9	4
7.7	*Myristica* sp.	2.2	5
9.0	*Elaeocarpus* sp.	25	30
9.2	*Litsea* sp.	5.7	12
9.4	*Celtis latifolia*	25	20

Notes of the stand:

Location name, Narumukum. Altitude, 5 m above sea level. Maximum tree height, 45 m. Ratio of the orthographic projection area of canopy to the whole ground area, 97%. Area of bare ground, 20%. The inclination of slope, 0 degree. Soil character, muddy.

2. Since Stand 2 has a number of big trees and abundant in tree species, this forest seems to have a great quantity of biomass and high productivity. High soil moisture content and continuous litter fall indicate that soil fertility is good to fair. Although Stand 1 also has a very large number of trees and a great quantity of biomass, the productivity there is considered rather low. This inference is based on our observation that the physical and chemical conditions of the soil appeared poor.

We owe much to Mr. Karl KERENGA and his colleagues, Papua New Guinea Forest Research Institute, Lae, for identification of some species unknown to us. We deeply appreciate their kindness.

Table 2. Line method data for Stand 2 (ordinary lowland forest) in Fig. 1.

Line Distance m	Species name	DBH cm	Height m
1.0	*Pterocarpus indicus*	250	>30
2.0	*Celtis latifolia*	95	2.5
6.0	*Dysoxylum* sp.	25	>30
7.2	unidentified woody vine sp.	3.2	>20
9.0	*Antiaris toxicaria*	0.3	5
10.2	*Dysoxylum* sp.	8.0	8
11.5	*Cryptocarya rolensii*	29	25
12.6	*Pterocarpus indicus*	-	1.5
13.4	Solanaceae sp.	-	1
14.8	Euphorbiaceae sp.	-	1.2
16.2	*Dysoxylum* sp.	-	1.1
18.0	*Pangium edule*	30	20
18.8	*Litsea timoriana*	2.9	3
20.0	*Pterocarpus indicus*	121	>30
22.0	*Dysoxylum* sp.	-	1.1
24.0	*Eugenia meteicea*	1.9	3.5
26.0	*Pisonia longirostris*	2.9	2
27.5	*Calamus* sp.	4.1	4
28.5	*Pterocarpus indicus*	51	>30
28.5	*Leea* sp.	1.9	5
30.0	*Donax canniformis*	1.0	3
30.5	*Papualthia auriculata*	-	1.1
31.7	*Antiaris toxicaria*	-	1.5
32.0	*Picrasma javanica*	4.8	6
32.5	*Ficus* sp.	16	20
34.1	*Antiaris toxicaria*	3.2	5
34.2	*Aglaia* sp.	3.5	4
34.4	*Papualthia auriculata*	1.3	2
34.8	*Cryptocarya medicinalis*	1.6	4
35.5	*Calamus* sp.	-	2
37.0	*Celtis latifolia*	-	1.7
37.5	*Glochidion* sp.	14	15

Notes of the stand:

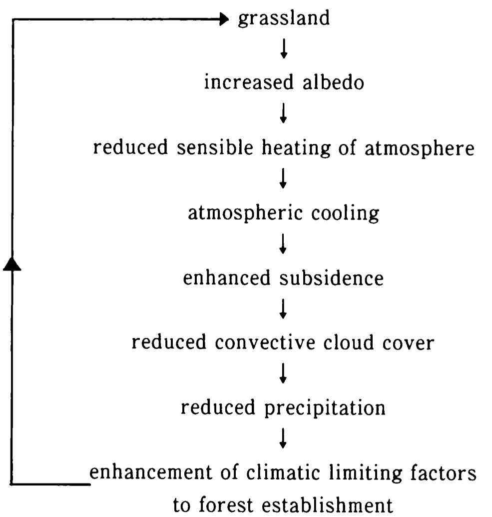
Location name, Gabensis. Altitude, 250 m above sea level. Maximum tree height, 35 m. Ratio of the orthographic projection area of canopy to the whole ground area, 80%. Area of bare ground, 5%. The inclination and the feature of slope, 5-7 degree and colluvial. The shape and the sizes of rocks, angular and 5-30 cm.

Comments on the Vegetational Changes in the Markham Basin

According to the maps by GARRETT-JONES (1979), the grassland vegetation in the Markham basin very roughly coincides with the region with less than 2,000 mm of mean annual precipitation. Still, one should pay attention to the fact that considerable areas with precipitation amounting to less than 2,000 mm is coverded by not only 'alluvium' or swamp forests but also lowland forests as described for Stand 2 (Table 2). Additionally, vast areas of grassland stretch beyond the 2,000 mm isohyet along the upper courses of the river. This means that, though rainfall is certainly one of the main factors which determine the grassland vegetation, it may not account entirely for the distribution of glassland. In many other regions of the tropics, forest grows in regions with annual precipitation of 1,500 mm and with severe dry seasons. GARRET-JONES (1979) concluded from his pollen analyses that, in the Markham Basin, the last vegetational change from forest into grassland began 1,500–2,000 years ago. PAIJMANS (1976, p. 57) reviewed as follows: "The origin of the *Ischaemum–Themeda* grassland is uncertain. REINER and ROBBINS (1964) suggest that they are an old and stable disclimax resulting from the clearing of forest and subsequent burning and gardening by people migrating northwards, and that tall mixed grassland further north is relatively dynamic and indicates a shorter period of biotic interference. HAANTJENS et al. (1965) accepted the man-made origin of the two types of grassland through shifting cultivation, but stress their differing edaphic and climatic conditions and point out that these are at least as important as biotic interference in determining their character. ROBBINS (pers. comm.) now believes the *Ischaemum–Themeda* grasslands are a true edaphic climax."

We often saw the burning of grasslands during our survey. HOLZKNECHT (1974) mentions the high efficiency of burning for bagging game for traditional and communal events. It is also frequently said, however, that people set fire to the grass just for the fun of it. At any rate, burning is certainly considered to be one of the main factors to retard the vegetational succession toward the forest stage unless one accepts ROBBINS' view quoted above. The climatic factor of less annual rainfall and a severely dry season for, at least, four months annually in the middle courses of the Markham River Valley (GARRET-JONES, 1979) seems to be a further factor to successional retardation. Such circumstances have been hindering the regeneration of forest despite very long fallow periods (VASEY, 1981) although the fallow periods of some commercial peanut swiddens without fertilisation were found to be rather short. If one adopts the view of edaphic climax, with all other factors being non-limitlng, then the soil physical and chemical properties will be the main factors limiting the attainment of forest climax. At present, the surface soil of grassland on slopes in the Markham Basin appear to have been noticeably degraded because of erosion and leaching for a very long time. Yet, soil conditions of the flood plain cannot be necessarily considered very poor though more precise and detailed investigation is needed to conclude ultimately so. At some protected sites in the low and flat zones of the basin, indigenous and/or alien tree species including pine forest were noted to be growing well. However, despite the healthy nature of the introduced species they are not always very favourable for the restoration of a degraded ecosystem.

From the knowledge having been obtained so far, most grasslands in the Markham Basin can be concluded to be basically anthropogenic and degraded ones. Many plant ecologists will hold the view that a considerably large area of the glassland on the flood plain might change, without any special measures, into forests in the very long run if the vegetation is perfectly rid of human impact. Alternatively if climatic factors are the main controls on the re-establishment of forest, the grasslands of the Markham Valley may not completely to revert to forest, given removal of all human impact and the cessation of burning. This theory can be illustrated below:



Although the grasslands may have been initially established because of anthropogenic activities, they may be maintained, or forest re-establishment limited by positive climatic feedback mechanisms especially in areas with less than 2,000 mm rainfall as explained above.

Obviously, further research is required to elucidate precisely the underlying causes that have brought about the present state of the vegetation in the Markham Basin. Such research is needed before further "economic development", such as modernised beef production, ultimately transforms the vegetation. Particular urgent attention should be given to those remnant lowland forests such as Stand 2 described in the previous section.

References

GARRETT-JONES, S. E. 1979. Evidence of changes in holocene vegetation and lake sedimentation in the Markham Valley, Papua New Guinea. 420 pp. Ph. D. Dissertation, Australian National University, Canberra.

HAANTJENS, H. A., MABBUTT, J. A. & PULLEN, R. 1965. Pacif. Viewpoint, 6: 215–219.

HENTY, E. E. 1982. "Grasslands and grassland succession in New Guinea." Biogeography and ecology of New Guinea (ed. GRESSITT, J. L.), 459–473. Monographiae Biologicae vol. 42, Dr W. Junk Publishers, The Hague, Boston & London.

HOLZKNECHT, H. A. 1974. Anthropological research and associated findings in Markham Valley. DASF (Department of Agriculture, Stock & Fisheries) Research Bulletin no. 15, 98 pp. DASF, Port Moresby, Papua New Guinea.

PAIJMANS, K. 1976. "Vegetation." New Guinea vegetation (ed. PAIJMANS, K.), 23–105. Australian National University Press, Canberra.

REINER, E. J. & ROBBINS, R. G. 1964. Geogr. Rev., 54: 20–44.

VASEY, D. 1981. "Agricultural systems in Papua New Guinea: adapting to the humid tropics." A time to plant and a time to uproot: a history of agriculture in Papua New Guinea (ed. DENON, D. & SNOWDEN, Cantherine), 17–32. Institute of Papua New Guinea Studies, Port Moresby, Papua New Guinea.