ECOLOGICAL INVESTIGATIONS ON THE VEGETATION OF THE SIPALIWINI SAVANNA AREA IN SOUTHERN SURINAM

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UTRECHT 1973

Preface

This paper will be the first of a series of articles on the results of a research on flora, vegetation and soil of the Sipaliwini - savanna area performed during a six month expedition in 1968 - 1969 and supplementary visits in 1970 and 1972[x].

The present article consists of a general introduction and a list of plant species arranged according to the main habitat types. The series will be continued by notes on the phytogeographical aspects of the flora, on classification of vegetation - and soil types, on vegetation - and soil maps, on relations between soil and vegetation. Eventually some general remarks and conclusions about origin and construction of the ecosystem of this savanna complex will be added.

This paper gives an account of work in progress and does not present the author's final views on the subject.

[x]These investigations were financed by the Netherlands Foundation for the Advancement of Tropical Research.

C O N T E N T S

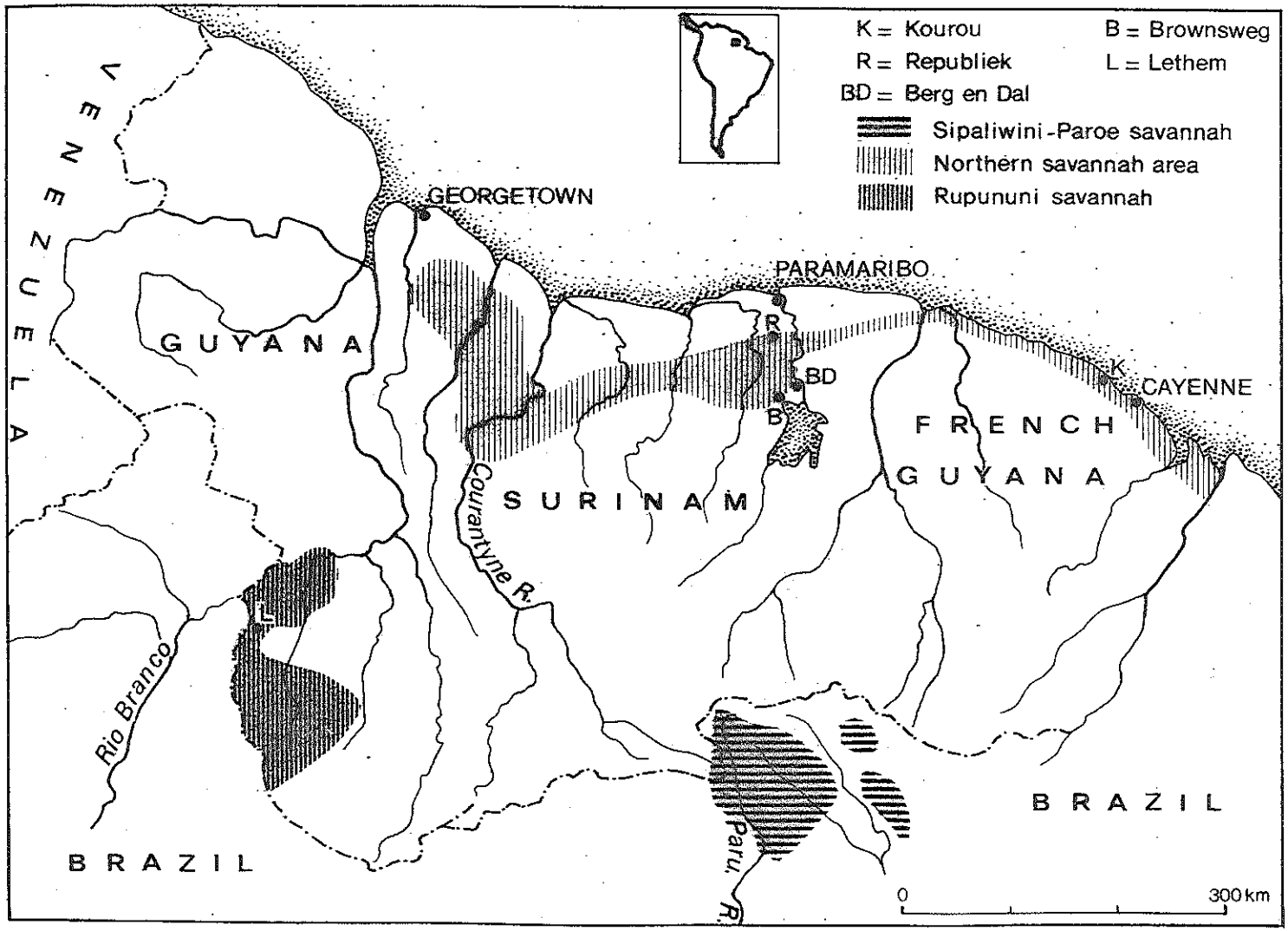

K = Kourou
R = Republiek
BD = Berg en Dal
B = Brownsweg
L = Lethem
Sipaliwini-Paroe savannah
Northern savannah area
Rupununi savannah
VENEZUELA
GUYANA
GEORGETOWN
PARAMARIBO
R
BD
B
K
CAYENNE
SURINAM
FRENCH GUYANA
Courantyne R.
L
Rio Branco
BRAZIL
Paru R.
BRAZIL
0
300 km

FIG. 1

Part I. General introduction to the Sipaliwini-savanna area and a survey of the soil- and vegetation types arranged according to habitat.

CHAPTER I GENERAL PART

I.1. Introduction

The Sipaliwini-savanna area in Southern Surinam (S, Am.) is located at the intersection of the 2°00'northern latitude line and the 56°00' western longitude meridian.

The Sipaliwini-savanna covers an area of about 630 sq. km and is the"smaller part of a large savanna complex situated on both sides of the frontier between Surinam and Brazil. The frontier is formed here by the flat watershed between the West Paru River, a tributary of the Amazon River, and the Sipaliwini River which belongs to the basin of the Courantyne River, one of the major Guianan streams" (van Donselaar 1969). (Fig. 1 & 2).

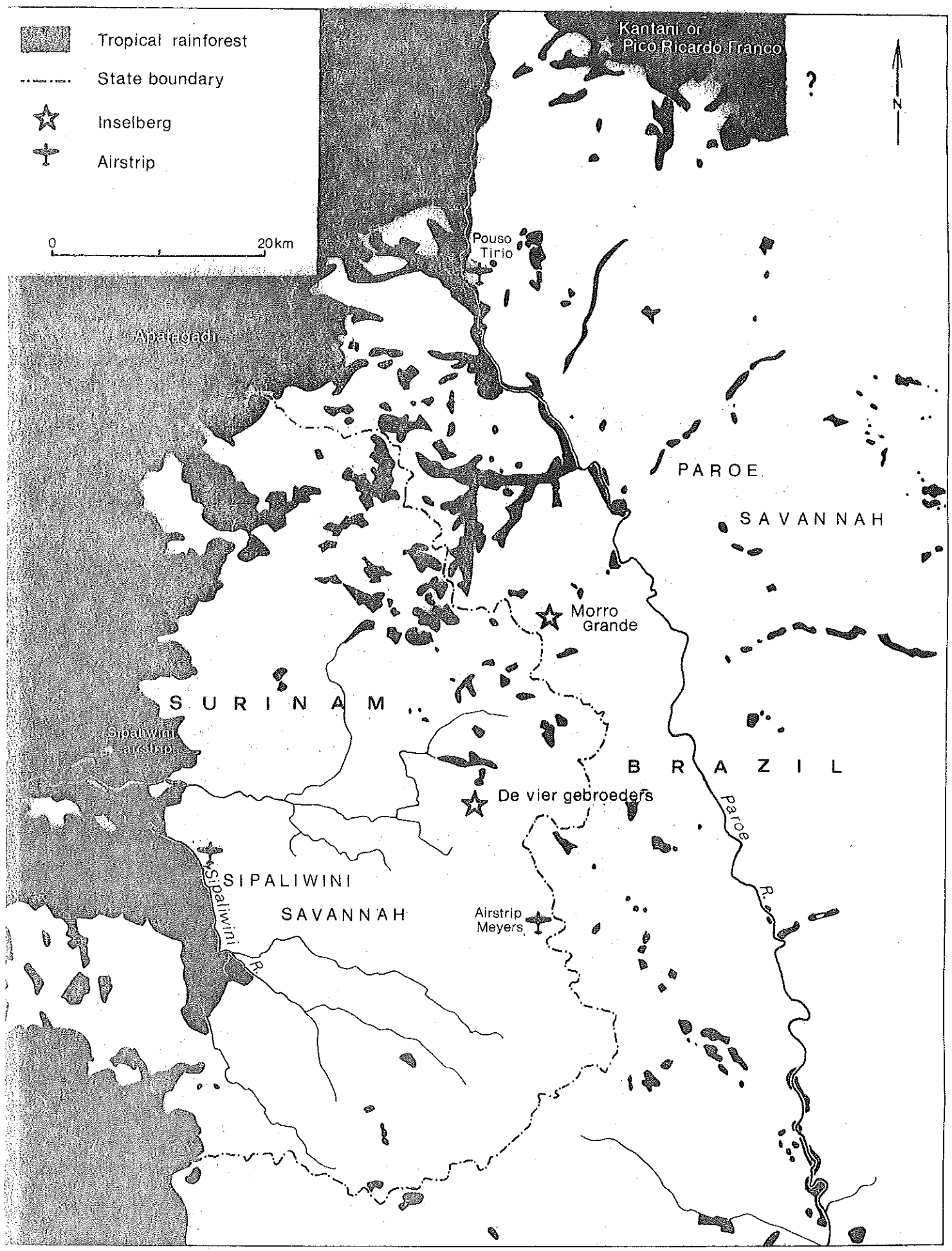
The whole savanna complex may be considered to belong to the savannas of the Amazon basin or "Campos geraes". For the greater part it is an unexplored region. West of the Sipaliwini savanna some smaller isolated savannas are situated. (Fig. 2). These were also included in our research.

I.2. Maps and aerial photographs

No printed maps seem to exist on which the Paru savanna, which forms the Brazilian part of the complex, is marked exactly. It neither occurs on any of the vegetation maps of the concise "Atlas do Brasil" of 1959 (van Donselaar, 1969), nor on the maps of the "Atlas Florestal do Brasil" by Veloso (1966). In the literature we did find a sketch of it - though the borders were only partly delineated - drawn by dr. Benjamin Rondon in "A Flora do Rio Cumina" by De Sampaio (1933).

De Andrade Lima showed the savanna complex concerned on a hand-made map, during the "Symposium on the biota of the Amazon", Belem, 1966 (van Donselaar, 1969).

Maps of the McGill University Savannah Research Project and Bouillenne (1930) suggest the existence of extensive savannas in the region concerned, although location seems to be at random. (cf.


Tropical rainforest
State boundary
Inselberg
Airstrip
0
20km
Kantani or
Pico Ricardo Franco
?
N
Pouso
Tirio
Apalaoadi
PAROE
SAVANNAH
Morro
Grande
SURINAM
Sipaliwini
airstrip
BRAZIL
De vier gebroeders
Paroe R.
SIPALIWINI
SAVANNAH
Sipaliwini R.
Airstrip
Meyers

G. 2

Fig. 1, in Hills & Randall, 1968; and Bouillenne, 1930.)
Dost, who visited the Sipaliwini savanna in 1962, estimated the Paru savanna to be at least several dozen times larger (Dost, 1962).
Since 1957 there exists a good survey of the Surinam part of the savanna, thanks to a complete set of beautifull aerial photographs made by the Central Bureau for Aerial Survey of Surinam (= C.B.L.), sc. 1 : 40.000. Since 1960 there is a topographical map of the Surinam part of the area, sc. 1 : 100.000. Furthermore we had at our disposal a set of detailed topographical maps sc. 1 : 20.000 of the Sipaliwini savanna s.s., specially drawn for our research aims by C.B.L. in the period 1968-1969.

I.3. History

By the end of the 19th century only four European explorers, Rob Schomburgk, J.N. Creveaux and H.A. & O. Coudreau had penetrated to the fringe of the Trio territory. And up to 1900 only Schomburgk (1843) and Creveaux (1878) had entered the watershed region occupied by the Trios (Rivière, 1969). In 1899 Mme O. Coudreau reached the Sao João cataract, ± 495 km N. of Obidos, from the South. (see "Voyage au Cumina", 1901). The savanna complex itself in the center remained unexplored.
From 1900 on expeditions penetrated into the territory itself. From the North two Dutch expeditions entered the region. The Tumac Humac expedition of 1907 (De Goeje, 1908) discovered the "Apikollo" savanna (named after the chief of a nearby Amerindian village), and brought back some rock samples (see par. on "geology"). The "Apikollo" savanna is now generally known as Palaime savanna.
A member of the Courantyne expedition of 1910-1911, the physician Hulk, also visited the Apikollo savanna and made a haphazard plant collection, among which the first savanna plants gathered in the area.
Much more important from a botanical point of view was the Brazilian expedition of General Rondon of 1928 along the Cumina River down to the source of the West Paru River. The accompanying botanist De Sampaio gave an extensive account of the voyage and of his floristic impressions in "A Flora do Rio Cumina" (1933), and brought back a plant collection of 970 numbers deposited at the Rio Herbarium of the National Museum. (Prance, 1972). In 1935-'36 the Dutch border expedition of the combined

Brazilian-Dutch Border Commission visited the Sipaliwini savanna for a period of 6 months. During their stay the physician Rombouts made a very substantial collection of savanna plants, 362 no's of 239 species, deposited at the Botanical Museum and Herbarium of the Utrecht State University. This collection proved to be of great value for the preparation of the Sipaliwini 1968-'69 expedition, as an introduction to the flora of the region. The first description of the Sipaliwini savanna itself has been given by van Lynden (1939), the leader of the Sipaliwini savanna survey group.

In 1939 a reconnaissance flight to the Great Sipaliwini savanna was undertaken with the airplane "De Snip" by Stakel and Geyskes to look for a suitable site for an air-strip in connection with planned future botanical research in the area, which project was delayed by the outbreak of World War II.

In 1941 "Baas Schmidt van Gansee" made extensive travels through the Trio territory, of which he gave a detailed account (Schmidt, 1942).

After World War II, some scientists payed short visits to the Sipaliwini territory:

Geyskes, 1952, to the Palaime savanna (botanical collection at the Botanical Museum and Herbarium of the Utrecht State University).

Wessels Boer, 1963, to the Palaime savanna and Sipaliwini airstrip. (botanical collection at the Botanical Museum and Herbarium of the Utrecht State University).

van Donselaar, 1966, to the Great Sipaliwini savanna, the Little Sipaliwini savanna, the Sipaliwini airstrip savanna, the Little Sand savanna, south of the airstrip, (botanical collection at the Botanical Museum and Herbarium of the Utrecht State University).

Van Donselaar also published the first phyto-sociological and plant-geographical studies on the area (van Donselaar, 1968 & 1969).

The first pedological report came from Dost (1962), who made a 10-day reconnaissance survey of the savanna complex.

A passing Dutch geologist, van der Lingen (1964) produced a geological map of the Sipaliwini savanna (see also "geology" par., and Van Donselaar & Schulz 1973). During the main rainy season of 1968 a survey group of the Department for Soil Survey of Surinam visited part of the

area.

In August 1968 the combined Surinam-Dutch scientific Sipaliwini expedition (1968-'69) in which biologists of several disciplines and a pedologist-geomorphologist participated, entered the field. In 1970 and 1972 short additional expeditions of this group took place.

I.4. Climate

Since 1961 meteorological data have been gathered on the Sipaliwini-airstrip, 15 km W. of the centre of the savanna.

Considering the fact that until now data are available on the period 1961 to 1969 only, it is not possible to give a very reliable impression of the climatology of the region.

Yet some remarks can be made.

The mean annual rainfall in the period 1961-1969 amounted 2001,9 mm, most of which fell in the months May, June and July. There is a marked dry season from August until January.

Mean monthly temperatures range from 25,8°C in February to 29,2°C in October, while mean maximum temperatures vary between 29,9°C in February and almost 34°C in September and October. Mean minimum temperatures range from 19.2°C in October to about 21°C in May.

The mean relative humidity reaches its lowest values in October (64%) and its highest values in May (81%).

Since the meteorological station is situated on a small savanna (Sipaliwini-airstrip) within the tropical rainforest that borders on the Sipaliwini-savanna on the W.side, it is probable that the climatological data differ more or less from those of the extended savanna.

I.5. Geology

The geology of the Sipaliwini-savanna is not known in any detail. In 1907 De Goeje and his expedition-team, crossing the region between the Paloemeu River and the Sipaliwini River, discovered a small savanna (probably the Palaime savanna) and took some rock samples, which were described by Grutterink (Grutterink, 1908) and IJzerman (IJzerman, 1931).

Kayser, coming from the Corantyne and Kutari in 1912 visited the same middlestream region of Sipaliwini River (Kayser, 1912).

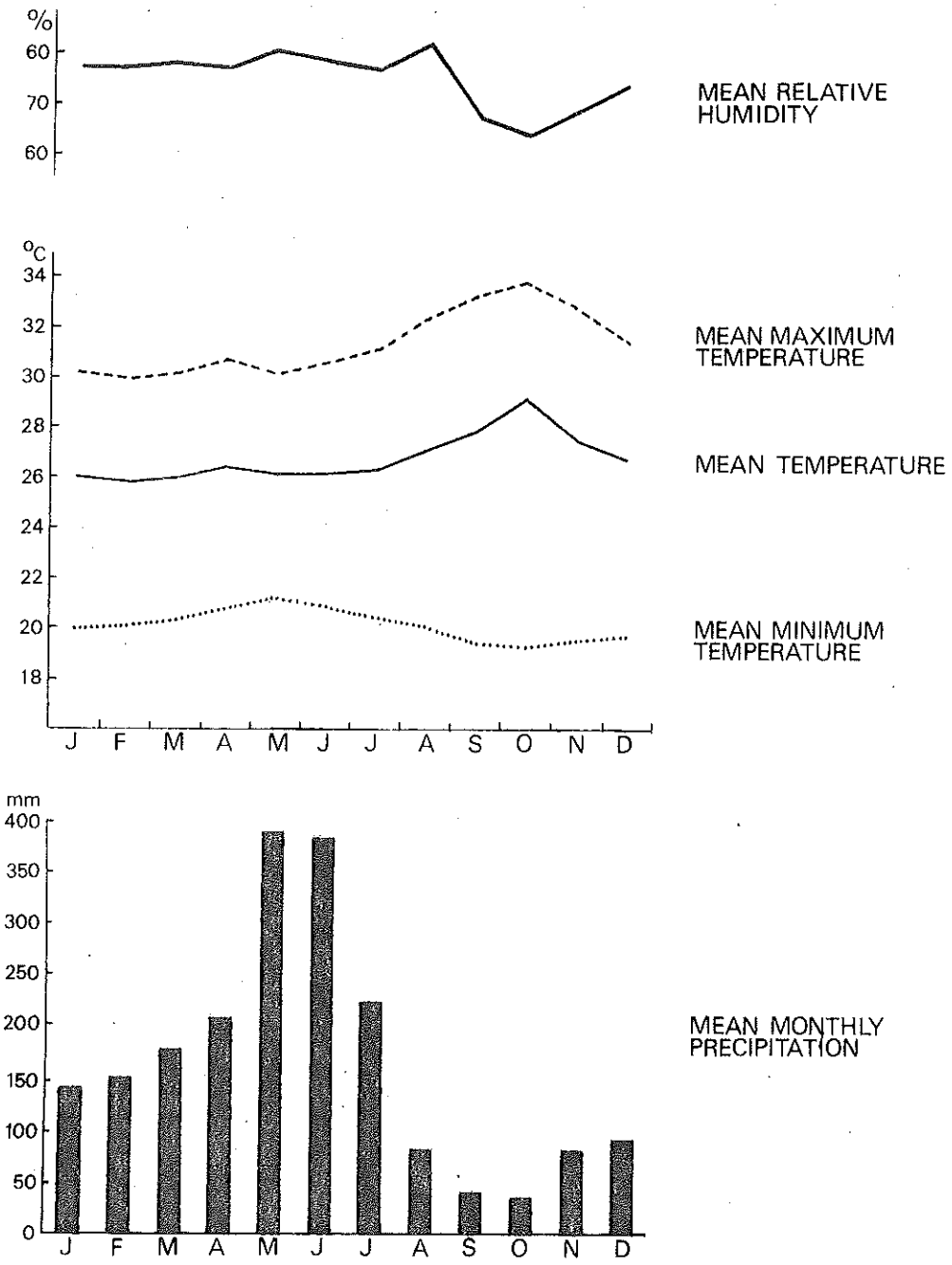

%
60
70
60
MEAN RELATIVE HUMIDITY
°C
34
32
30
28
26
24
22
20
18
MEAN MAXIMUM TEMPERATURE
MEAN TEMPERATURE
MEAN MINIMUM TEMPERATURE
J F M A M J J A S O N D
mm
400
350
300
250
200
150
100
50
0
MEAN MONTHLY PRECIPITATION
J F M A M J J A S O N D

FIG. 3

The Geological and Mining Service of Surinam made a reconnaissance survey of the savanna area a few years ago, the results of which have not yet been published (Geological map by v.d. Lingen). A geological map of the upper Sipaliwini region was compiled by O'Herne.
The essential boundaries given on this map are generally in accordance with the observations of the authors.
Finally some valuable observations were made by Dost (1962) who paid a 3-weeks visit to the Sipaliwini-savanna, making a pedological reconnaissance survey.
On the basis of the literature above mentioned and on the authors' findings a preliminary and limited description of the geology is presented here.
The Sipaliwini- savanna is part of the cristalline Guyana Shield and is drained by the Sipaliwini River, tributary of the Curuni River and forming part of the Corantyne River-basin. The northern, eastern and southeastern parts of the savanna consist of granitic rocks (medium grained hornblende granite, porfitic granite, micro-granite, etc.) whereas in the remaining central, western and southern parts metamorphic rocks and volcanites were found. (quartzites, dacites, rhyolites, andesites, etc.).

I.6. Landscape

I.6.1. General aspect. The Sipaliwini savanna area forms an open undulating and hilly landscape varying in altitude between 275-400 m above sea level. (Pl. 1). To the West it is bordered by forest, to the E., N. and S., it is only separated by the Surinam-Brazilian frontier on the watershed from the more extensive Paru savanna on Brazilian territory.
Many hills are covered with scattered rocks and boulders, for which reason the local Amerindians of the Trio tribe call this area "Diapokoimape", which means "full of stones" (Schmidt, 1942). Some enormous granitic rock blocks are weathered very typically, especially those found in the north-eastern part of the savanna. Dost (1962) named them "dragonteeth"! (Pl. 4).
An other conspicious landscape feature is formed by the "lavakas", amphitheatrical cliffs gorging the hillslopes of high hills.

The sharp forest boundary is formed under fire influence in the current erosion cycle (Zonneveld, 1967) (Pl. 6).
The whole landscape is subject to strong denudational forces and is in an active phase of peneplanisation (Dost, 1962).
Some isolated mountain tops of so called "Inselbergs" emerge above the landscape. In the north-eastern frontier region the "dome" of the "Morro grande", 596m, dominates the scenery (Pl. 2). In the central-eastern part a miniature mountain group, the "Vier gebroeders", 554 m, is the main point of focus (Pl. 3).
In the South a threetopped mountain group, provisionally called "Ultima Sur", 498 m. marks the frontier.
The savanna is crossed by numerous creeks and rivulets. There are mainly tributaries of the Sipaliwini River (Pl. 1 &7). Locally some of these rivulets communicate via swamps with the drainage area of the Paru river system. The creek valleys are varying from narrow valley floors to wide open plains.

I.6.2. Landscape types

The Sipaliwini-savanna includes several types of landscape. The differentiation in landscapes is based on variations of altitude, relief-energy, forms and sizes of valleyfloors, valleywalls, hilltops and striking differences of the vegetation.
On the basis of the analyses of aerial photographs and topographical maps and on observation in the field the following types of landscape could be distinguished provisionally:

Sipaliwini-landscape

The central and southern and western part of the savanna is characterised by almost parallel running, slightly dipping and flat hilltops, generally about 320 m. In a downstream direction the valleyfloors widen and on hilltops and -slopes large "compositions" of stoneblocks occur. The relief energy amounts ca. 30 m (Pl. 1).

Morro-Grande-Landscape

The northeastern part of the savanna, situated at an altitude of 380-420 m is more regular and flatter, and resembles an undulating plain, dissected by rivers and creeks. Relief energy ranges from 60 to 80 m, while the valleyfloors are less wide and V-shaped. Locally isolated hills rise up above the plain and many forest-islands occur.

The presence of stoneblocks is less pronounced since they are generally to be found under the canopy of the forest-islands (Pl. 2).

Vier Gebroeders-landscape

East of the centre of the savanna and extending towards the South a complex of relatively high hilltops is found forming an Inselberg-complex (Pl. 3).

Hillslopes are scattered with large stoneblocks and locally the bare rock (granite) is exposed. Gully-erosion is common, even under rain-forest-islands, which cover on some of the steep slopes.

Paru-landscape

During an "excursion" to the Paru River in Brasil on September 28, 1968 a landscape was observed, that made the impression of a plain, dotted with low, round and flat topped hills which was called Paru-landscape.

Later on a comparable type of landscape was observed south of the Vier Gebroeders-landscape. Although this landscape is not near the Paru River, it was called Paru-landscape, for the sake of consistency. (Pl. 3). Very wide and flat valley-floors gradually pass into low angle valley-walls and low, flat hilltops.

Rivervalley-landscape

Within some of the landscape-types distinguished above, there are characteristically broad rivervalleys with natural levees and flood-plains. These low relief areas in which rivers meander are completely submerged during the rainy season. Here processes of deposition dominate over erosional processes. Their extensions, hydrological and sedimentological characteristics justify the distinction of these areas as a separate landscape-type.

I.6.3. Vegetation-types

The general aspect of the open landscape is dominated by the hills, which are covered by a more or less continuous groundlayer of mainly grasses with scattered gnarled trees, among which Salvertia convallariodora is the most common species.

This vegetation type can best be characterised as an 'open orchard savanna' or 'open campo cerrado', if this would not be a 'contradictio in terminis' and superfluous at the same time. 'Campo cerrado' means 'close dense, open country' (Cole, 1960), which suggests the conclusion

that in the series of local Brazilian names available to distinguish different types of savanna vegetation, ranging from campo limpo, campo sujo, campo coberto, campo cerrado to cerradao or catanduva, it would be qualified as 'campo coberto' or 'covered plain', a parkland type savanna (Eden 1964; and Hills & Randall 1968) (Pl. 8).

However, "savanna parkland of characteristic form and distinct composition is absent from South America" (Cole, 1963), because this type of vegetation is essentially based on and derived from the Acacia type of savanna parkland, which occurs in Africa & Australia. The local presence on the Sipaliwini savanna of other parkland savanna variants which can be brought under this category will be discussed later.

The savanna types campo limpo, campo sujo, campo cerrado and cerradão can also be observed on the Sipaliwini savanna.

"Campo limpo" or "pure open grassland" occurs in the wide open valleys and depressions which are partly inundated during the rainy season. They are covered by a herb layer mainly consisting of grasses and sedges (Pl. 9). Only in the lowest and wettest parts isolated "Maurisie"-palms (Mauritia flexuosa), "Maurisie"-swamps and swamp-forests indicate the drainage pattern of the watercourses (Pl. 14). The transition from campo limpo to "Maurisie"-swamp is marked by a very distinct herb vegetation with conspicuous flowering herbs like Rhynchanthera grandiflora and Ludwigia rigida, and with tall growing grasses like Coelorachis aurita. This vegetation type is called "kawfutu"- of "cowfeet"-vegetation after the characteristic hog wallow structure of the soil (Pl. 13).

In some wide valleys a campo cerrado-type appears with Tabebuia caraiba, a tree which seems to be adapted to seasonal waterlogging.

"Campo sujo" or "shrub and small tree savanna" can often be associated with the gradient zone from wet to dry at hill feet on colluvium, where Curatella americana is a common and characteristic, contorted savanna tree (Pl. 10 & 11). More specifically it occurs in the disturbance zone in front of the forest boundary, where the fire-influence is relatively recent.

In addition it may be found in the flooding zone on "natural levees" behind the river banks.

Where the distance between the separate savanna trees of the general "campo coberto" savanna type decreases, "campo cerrado" occurs. The spacing of the trees may be still more than the diameter of the canopy but the designation "open" before "orchard savanna" can no longer be maintained (Pl. 12). In fact the general aspect of the Sipaliwini orchard savanna type does fit well into Warming's original description of the "campos cerrados" of Lagoa Santa in 1892:

"A plant formation which mainly and in all its modifications is characterised first and formost by perennial grasses growing in slender tufts at intervals and other herbs, particularly composites (read: "Papilionaceae" for the Sipaliwini savanna) together with subshrubs whose height for the most part is 1/3-2/3 m (1-2 ft), and over whose flower-decked expanse may rise bushes and low crooked and gnarled trees with open crowns and in a more or less close stand (campos cerrados), but never under natural conditions in such a close stand one cannot pass through it unhindered in all directions", as quoted by Beard (1953).

The reason to qualify the Sipaliwini savanna still as "campo coberto", is that the common and predominant gnarled savanna trees do not reach up to the "height-criterium" of 8m, which Cole (1963) gives for savanna woodland or campo cerrado[x].

Based on analysis of aerial photographs a gradual densing of tree stands may be observed at the far south-western edge of the Great Sipaliwini savanna along the Surinam-Brazilian border. Also the trees increase in height, so that even a savanna woodland or cerradão may

[x] Bews (1929) has called attention to a similar shortcoming in 'height' of the South American grasses compared with the African savanna grasses.
This may well be the reason that the important African "High-Grass Savanna" formation type is lacking in South America. Beard recognizes only the two Bunch Grass savannas subformation types (a) Tall Bunch Grass savanna and (b) Short Bunch Grass savanna. "Tall Bunch Grass Savanna is the predominant type in Southern America" (Beard, 1953).
Thus both for trees and for grasses height seems to be the defective objective criterium necessary to bring the South American savanna vegetation types under one denomination with analogous vegetation types in other continents, i.e. in a general savanna classification system which can be used on a world-wide scale. The discussion concerning this matter will be resumed in a later phase.

be designated, though this type of vegetation has not been observed in the field.

The mountain slopes of the "Vier Gebroeders", "Morro Grande" and some higher hill ranges along the Western border and in the South are covered with a dense "shrub-woodland", grading to a "mountain savanna forest" (Lindeman & Molenaar, 1959), though patches of "rain forest" may occur as well.

Around the tops and especially on the exposed north-eastern slopes of the mountains an "a-typical savanna vegetation" appears in small depressions and crevices of nearly bare granitic rock outcrops. This vegetation type has been designated earlier as 'rock savanna' or 'rock pavement vegetation' by Lindeman & Molenaar, 1959. A treatise on this vegetation type with a separate paragraph devoted to the Sipaliwini savanna area rock outcrops is given by Van Donselaar & Schulz, 1973 (manuscript).

The "forest islands" occurring as patches of high forest on steep hill slopes in the N.E.granitic part of the Sipaliwini savanna complex are provisionally characterised as real "Evergreen Rain Forest". This landscape is converging into a "mosaic"-complex of forest and savanna formation types (Warming, 1909; and Sloet, 1965).

Locally fringing "gallery forests" accompany the main creeks and watercourses. In general, the creek bank vegetation can often better be designated as a "gallery woodland" because of the poorly developed structure and general height of the trees. Besides, in floristic composition this vegetation shows some affinity with a dense thicket of scrub and wet marshy woodland vegetation, known as "muri-muri" or "muri-bush" occurring west of the Sipaliwini savanna border (see also Beard, 1955).

Marliera montana has been observed along the "Vier Gebroeders" creek bank and is considered characteristic species of the "muri-bush" vegetation, which borders small patches of edaphic sand savannas, appearing like sun-rayed lakes (Beard, 1953), amidst the surrounding closed rain forest belt, extending west from the Great Sipaliwini savanna boundary.

The little sand savanna, south of the Sipaliwini airstrip, offers the aspect of a special variant of the "Savanna parkland" type, described for South America as occurring in the High Pantanal of Paraguay and

Brazil (see plate 10, Cole, 1963). In this variant the characteristic isolated savanna trees are replaced by little savanna bush islands from which occasionally in the Sipaliwini savanna area, a for Surinam unique white stemmed slender palm species may arise, Mauritia martiana.

With reference to Beard's, 1955, "Note on gallery forests" which says that "Gallery forests, where they are not on swampy sites, represent the climatic climax", it may be remarked that the "gallery woodland" of the Sipaliwini region may represent a kind of edaphic climax related to the extra watersupply of the creekbank sub soil. The sparse "gallery forests" s.s. differ slightly from each other in floristic composition and aspect. Some are flooded during the rainy season. Otherones located near the forest belt in the West represent isolated patches of it. The inventarisation and analysis of the forest vegetation types fell beyond the scope of the authors' investigations and was delegated as a research subject to Dr. J.P. Schulz of the Surinam Forest Service (= L.B.B.).

Eventually the results will be described in a separate paper. The forest zone bordering the Sipaliwini savanna in the West has been characterised provisionally as a "semi evergreen seasonal forest" (see Beard, 1955) in contrast with the forest islands on the savanna in the N.W. area, having already been classified previously as real "evergreen rain forests". Richards (1964) distinguishes a similar difference of forest types in the Rupununi savanna region of Guyana (Br.G.), based on the data of Myers (1933) and Davis (1933). These savanna territories, those of the Rupununi-Rio Branco and those of the Sipaliwini-Paru show great resemblances in ecological conditions.

I.6.4. Seasonal aspects

During the main rainy season (optimum: May-June) the savanna offers quite a different aspect compared to the dry season. The depressions are for the greater part inundated. Floodmarks found in the dry season still indicate the high water levels of the last major rainy season.

On the hills the precipitation is carried off rapidly by superficial run off. The water hardly infiltrates into the soil, which remains dry except for the uppermost 10 cm.

At the end of the main dry season (optimum: September-October), the valleys are dry; even some "Maurisie-swamps"may dry out and a great part of the bone dry vegetation will be burnt off over extensine areas.

I.6.5. Anthropogenic influences

These enormous fires are set intentionally for pleasure by the local Trio Amerindians who live near the forest boundary of the Paru savanna at the other side of the frontier in the Brazilian part of the savanna complex. Myers (1936) already called the South American Amerindians "inveterate burners" and the Trios form no exception to this rule. They inhabit some semi-permanent settlements of which Pousou Tirio a missionary post on the Paru riverbank, hidden in an extensive forest island, is functioning since the 1960's as a focus of convergence for all neighbouring Trio subgroups (Rivière, 1969).

At the moment the Sipaliwini savanna itself is uninhabited but there are numerous indications of a former dense occupation. On several sites workshops were found for the manufacturing of obsidian and quartzitic artefacts as arrowheads, javalinpoints, knives etc. Also the finds of huge quantities of potsherds on the top of the Morro Grande and elsewhere on hilltops, ritual stoneaxes on the "Vier Gebroeders" (1968), as well as the discovery by Bubberman in 1971 of a cave with artefacts of both kinds, near the top of a hillgroup in the Southern Sipaliwini savanna strewn with "dragon-teeth", are obvious indications of a vanished culture. Geyskes assumes that the legendarian Tarumas might have occupied the region (see Dost, 1962).

An other perhaps archaic culture concomitant Manihot melanobasis or "wild cassave", already mentioned by Schmidt in 1942, was found around hilltops in the West, and on Ultima Sur in the South, where it grew between rocks and boulders on the superficial soil layer which surrounded the granitic outcrops. "The same species locally abounds on the banks of several creeks in the savanna" (Van Donselaar & Schulz, 1973). Bubberman, who in 1969 discovered a striking stone block with Amerindian inscriptions (Pl. 15) on a low hill near the watershed in the West, assumes that in earlier

times the area played an important role as a transit for population flow of groups migrating from the Amazon river system to the Courantyne basin and vice versa (Bubberman, 1973). The routes of "Baas Schmidt van Gansee" in 1941, who followed Amerindian trails between Trio villages situated on both sides of the watershed between the Amazon river system and the Courantyne and Maroni basins can only sustain this hypothesis (Schmidt, 1942).

It is reasonable to assume that this agelong occupation of the area by Amerindians with their practice of annually setting fire to the savanna, has exercised a strong influence on the vegetation and especially on the extent of the savanna territory.

This and other causal ecological factors which may lay at the origin of birth and growth of this savanna ecosystem under consideration, will be discussed in more detail in a following paper.

I Tall bunch-grass formation on hill tops and slopes.
II High-grass formation on colluvium.
III Sedge and short-grass formation in valleys.
IV Hygromorphic high-grass and shrub formation with palms in depressions.
V Shrub-woodland formation on "Inselbergs"-slopes.
VI Xeromorphic herb and shrub formation on granitic outcrops.
VII Gallery forest and -woodland formation on riverbanks.
IX Hydromorphic herb formation in creeks.
X Adventive herb formation on sites disturbed by man.

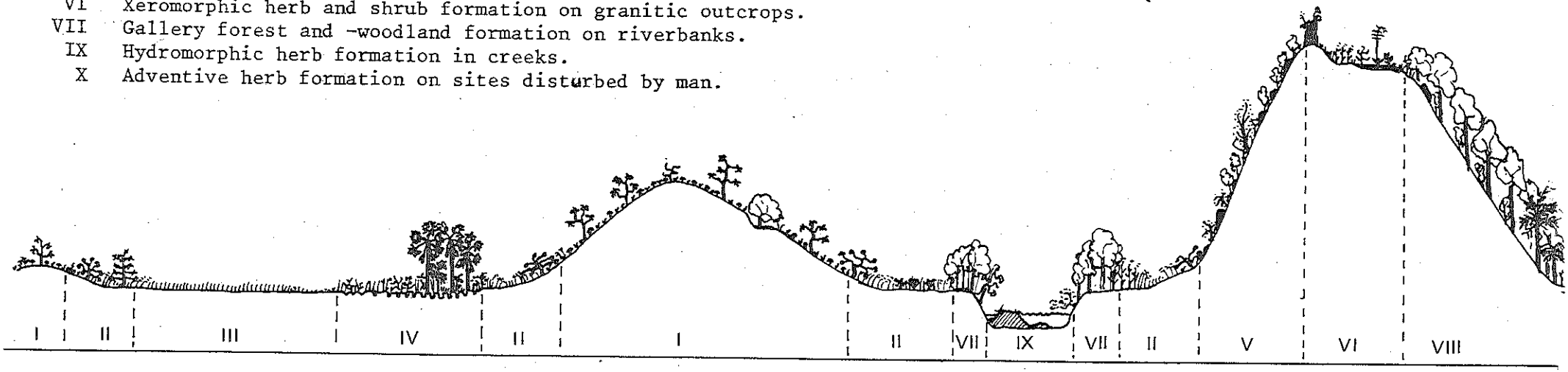


FIG. 4

CHAPTER II HABITAT AND FORMATION TYPES

"Merely to classify plants according to the habitats they occupy is a straight forward business". "The Worlds Grasses", Bews, 1929.

Definitions

In the words of Du Rietz (1962) we define a formation as "an abstract type of association based upon physiognomy", which in sequence is correlated to habitat and can be located by site (see diagram of Fig. 6 and also Beard 1944 & 1955). "Habitat" in contrast with site includes all external environmental factors (cf. formation definition of Warming, 1909) while "site" may be confined to the substrate of the vegetation stand.
Within the Sipaliwini landscape provisionally 10 formations are distinguished, which certainly do not all stand on the same level of integration and complexity. Most are of complex nature.

II.1. Tall bunch-grass formation on hill tops and slopes

II.1.1. Habitat

Composed of valleywalls and a generally flat summit level, the interfluvia are those parts of the landscape which are always above the highest floodlevel of creeks and rivers. The higher hills, 30-70 m above the valleyfloors, are characterised by valleywalls which have a slope of 20-45%, whereas the lower hillsides dip with slopes ranging from 3 to 10%.

Morphologically the valleywalls have either a convex-concave form, or a concave-rectilinear form.

Related to the savanna vegetation the erosional and denudational processes play an important role on the hillslopes, as follows from the very widespread features like gullies (rill wash), 1-4 m deep, and lavaka's (amphitheatrical cliffs in the valleywalls on the upper side of the gullies).

Another important feature frequently occurring on hills, is the presence of "tor"-like stone-blocks in all sizes between boulders of a few c.dm. and blocks of several cubic m. Due to geomorphological processes the soils of the hills are decapitated. The rather sandy toplayer, which is still present under the forest vegetation has been eroded. Generally the weathering mantle of red, or orange-red silty clay comes to the surface.

Pluvial processes (e.g. the impact of raindrops on the thinly

vegetated soil) and the scarceness of biological activity result in a decrease of the pore-space in the toplayer of the soils. The relative impermeability of the soils accelerates the process of erosion by run-off from the hillslopes.

II.1.2. Formation

The hills are covered by a formation formed by a continuous herblayer, varying in height between 15-70 cm and consisting mainly of grasses, with scattered gnarled trees, h. 2-5 m, 4-20 m apart.
Characteristic species[x]:
Herb-layer: Gram.: Aristida tincta, Mesosetum tenuifolium, Paspalum albidulum (dominant on the hills S. of "Vier Gebroeders" creek), Pasp. contractum, Schizachyrium riedeli, (Sporobolus cubensis); Cyp.: Bulbostylis spadicea (very characteristic!), Scleria cyperina; Melast.: Tibouchina aspera; Rub.: Palicourea rigida.
Tree-layer: Malp.: Byrsonima crassifolia; Pap.: Bowdichia virgiloides; Vochys.: Salvertia convallariodora (most common).

II.2. High-grass formation on colluvium

II.2.1. Habitat

A consequence of the superficial run-off is the sedimentation of eroded material at the foot of the hillslopes.
Where the valleyfloor is wide, the lower part of the valleywalls has a concave profile. The red colluvial sediment can be several meters thick. In the wet season this zone is inundated and during drier periods the soils stay moist longer, because of their better structure, compared with the structure of the soils from the former formation.

II.2.2. Formation

The formation on colluvium at hill feet forms a transition zone on the gradient field from a dry to a relatively wet habitat, and is

[x]Dominant & co-dominant species are underlined. Species occurring also in other enumerated formations - are put between brackets ( ).

characterised by a dense herb-layer with some tall growing grasses, while the distance between the gnarled trees is generally increased, as compared with formation I. Locally though their stands may offer an orchard aspect to the savanna through an increase in coverage percentage.

Characteristic species:

Herb-layer: Gram.: Axonopus gentilis, (Leptocoryphium lanatum), (Panicum cyanescens), Paspalum plicatulum, (Trachypogon plumosus); Cyp.: Scleria bracteata; Comp.: Elephantopus angustifolius, Riencourtia oblongifolia; Lab.: Hyptis lantanaefolia; Myrt.: Psidium guineense; Pap.: (Centrosema pubescens), Desmodium cajanifolium, Eriosema rufum, Stylosanthes guianensis; Polyp.: Adiantum serrato-dendatum.

Tree-layer: Bign.: Tabebuia caraiba; Dill.: Curatella americana; Till.: Luehea paniculata.

II.3. Sedge and short-grass formation in valleys

II.3.1. Habitat

When a high-water bed is present, as it is in wide flat valleys, a layer of light-coloured, bleached silt and fine sand covers the weathering clay of the bedrock. The thickness of this sedimentary layer varies from a few cm to almost one m. The material has a loose structure and is very dry in the dry season. This sediment of silt and fine sand is not only characteristic of the wide, flat valleyfloors, but also of the small and generally wet tree-savannas lying south of Sipaliwini-airstrip within the tropical rainforest.

II.3.2. Formation

This formation is formed by a low herb-layer, h. 10-30 cm with a coverage of 30-100%, in the composition of which the Cyperaceae play a main role, while a tree-laying is lacking.

Characteristic families: Burmaniaceae, Eriocaulaceae, Gentianaceae, Lentibulariaceae, Ochnaceae, Xyridaceae.

Characteriatic exclusive families: Droseraceae, Lycopodiaceae, Polygalaceae.

Characteristic species: Herb-layer: Gram.: Paspalum pulchellum, Pasp. stenodoides; Cyp.: Bulbostylis lanata, Rhynchospora armerioides,

(Rynch. barbata), (Rhynch. globosa), (Rhynch. graminea), (Scleria hirtella); Gent.: Schultesia pohliana; Melast.: genus Acisanthera, genus Comolia; Orch.: genus Habenaria; Rub.: Perama hirsuta.

II.4. Hygromorphic high-grass and shrub formation with palms in depressions

II.4.1. Habitat

This habitat and formation type encompasses "Kawfutu"-valleys, "Maurisie"-swamps and forests and "mokko-mokko swamps". The kawfutu (cow-foot) valleys are characterised by the occurrence of a micro-relief called hog wallow structure by Beard, 1953. The valleyfloor shows a dense network of narrow (5-20 cm wide and shallow (10-30 cm deep) gullies which are interconnected and have a U-formed profile. As the kawfutu-zone is generally bordering the swamps, soils are moist, even in the dry season. They are richer in organic matter than the soils of the sedge and short-grass area.

The 'Maurisie'-swamps are always moist, mostly even wet. However the alluvial soils, consisting of dark-grey sandy clay with relatively high contents of organic matter, do not show a kawfutu-micro-relief. The dept of the soils is generally over one meter, below weathering clay or fresh rock is present.

II.4.2. Formation

The formation is formed by a closing herb-layer, consisting of tall growing grasses, intermingled with some shrubby herbs.

In the "Maurisie"-swamps the herb-layer is completely closed, dense and rich in species.

In the "Maurisie"-forests the undergrowth is less dense, ombrophile, with very tall growing species. In kawfutu scattered "Maurisie"-palms, Mauritia flexuosa may occur. In "Maurisie"-swamps, "Maurisie"-palms reach a coverage of 60%, whereas "Maurisie"-forests may be characterised by a coverage of 100% of the treelayer, often with an absolute dominance of Mauritia flexuosa.

'Mokko-mokko' swamp is characterised by pure stands of the Aracae: Montrichardia linifera in a shallow inundated habitat. The soil is more or less permanently waterlogged.

Characteristic species: Herb-layer: Gram.: (Coelorachis aurita),

Erianthus trinii, Ischaemum guianense, Leersia hexandra; Cyp.: Cyperus haspan, Cyp. pseudodistans, genus Eleocharis, Rhynchospora corymbosa; Comp.: (Clibadium armani); Hydroph.: (Hydrolaea spinosa); Malv.: Hibiscus furcellatus, Pavonia sessiliflora; Mus.: (Heliconia psittacorum); Onagr.: genus Ludwigia; Sterc.: Melochia villosa; Zing.: costus arabicus.

Tree-layer: Palmae: Mauritia flexuosa.

II.5. Shrub-woodland formation on "Inselberg" slopes

II.5.1. Habitat

Since slopes are steeper on the "Inselbergs"(± 70%), the soils are more seriously influenced by superficial run off and erosion. Decapitation is a rule here and commonly the alterated granite comes to the surface[x)].

The regolith is a sandy weathering product. At some places depths of over 8 meters occur as was observed in a canyon-like, deep gully. Scattered over the surface there are many great blocks of granite which influence the soil- and microclimate as well as the hydrology of the "Inselberg"slopes.

The soil, containing very little organic matter, is covered by a pavement of coarse gravel.

II.5.2. Formation

The formation occurring on the "4-Gebroeders"-slopes and on other high hills and Inselbergs, is formed by an almost closed shrub-layer, and by a tree-layer with a coverage percentage of 80%. For that reason the herb-layer occurring between the rock-blocks has a low coverage percentage.

Characteristic species: Herb-layer: Gram.: Raddiella nana; Cyp.: (Scleria cyperina).

Shrub- and tree-layer: Apoc.: (Himatanthus articulatus); Euph.:

x) The Inselbergs occurring on Sipaliwini-savanna, all lie within the zone of porfiric granite, in the eastern part, near the Brasilian border.

Pera intida; Hum.: Humiria balsamifera var. balsamifera, Sacoglottis guianensis; Melast.: Miconia ciliata; Prot.: (Roupala montana); Ros.: genus Hirtella; Simar.: Simarouba amara; Symploc.: Symplocos guianensis var. guianensis.

II.6. Xeromorphic herb and shrub formation on granitic outcrops

II.6.1. Habitat

On Inselbergs and sometimes on hillslopes too, the bare rock comes to the surface (locally).
Apart from weathering-residua in cracks, crevices and depressions, the granite-slabs are bare. They represent an environment with extremely varying temperatures and hydrological conditions.
During rainfall the depressions are filled up with water which can be held for several days by the weathering residu on the bottom, whereas the greater part of the outcrop is wet only during rainfall because of the superficial run-off and rapid evaporation.

II.6.2. Formation

On granitic outcrops a typical vegetation has been found of scattered herbs and shrubs. Many plants show specific adaptations to the extreme habitat both in life-forms and in growth-patterns.
Life-forms: disproportional rootsystems are developed to preserve access to the watersupply: Philodendron acutatum; to capture and store watersupply as reserve for times of severe drought succulence occurs: Amar., Cact., Brom., Melast. : Ernestia spec., Port.: Portulaca sedifolia; tubers are formed: Orch., Apoc.: Mandevilla tenuifolia; thorns and hairiness are developed: Mimos: Mimosa plumaeifolia, Cact., Euph.: Jatropha urens; to reduce transpiration micro- and sclerophyllie is observed. Grow patterns: to meet the challenge of limited spatial conditions and, when established, to keep control of their environment: facies and hummock forming is observed: Axonopus ramosus.
Some species to be reckoned to this formation as Melocactus occur with preference on the "dragonteeth", mentioned before. These granitic rock-blocks in the savanna often occur near the forest edge of forest islands.

Characteristic species: Herb-layer: Gram.: Aristida capillacea, Axonopus ramosus; Amar.: Furcraea foetida; Arac.: Philodendron acutatum; Brom.: Pitcairnea geyskesii; fam. Cact., Erioc.: Paepalanthus fasciculatus; Euph.: Jatropha urens; Port.: Portulaca sedifolia; Solan.: Schwenckia americana.

II.7. Gallery forest and gallery woodland formation on riverbanks

II.7.1. Habitat

The natural levees which border some of the rivers and creeks are built up of material characterised by a great diversity of granular composition (from sandy clay to coarse sand). Generally the sediment is underlain by fresh rock or weathering clay at a depth of about 3 m.

The presence of the river nearby causes a relatively high groundwater table and a sufficient watersupply the year through.

II.7.2. Formation

This formation occurs as a small emergent zone along creeks and rivulets and is formed by shrubs and trees reaching a height of 6-8 m, having in their halfshade some characteristic species.

Characteristic species: Herb-layer: Comp.: Mikania amara; Schiz.: genus Lygodium; Shrub- and Tree-layer: Mel.: Macairea pachyphylla; Pap.: Cassia multijuga; Polyg.: Coccoloba mollis; Rub.: Genipa americana.

II.8. Tropical rain forest formation

Apart from the tropical rain forest belt bordering the savanna in the West, forest islands are present within the savanna area itself.

II.8.1. Habitat

The occurrence of forest islands within Sipaliwini-savanna seems to be determined by topographical factors.

Apart from the presence of gallery forest bordering rivers locally, the forest islands only occur on steep slopes such as Inselbergslopes and steep valley sides.

Furthermore they are found at a height of about 350 m. Under the

forest canopy a very different microclimate exists, different from the surrounding savanna.
Here soils are generally moister, having higher contents of organic matter and a more vivid biological activity, although the horizontation of the soil profile does not differ very much from that of adjacent savanna areas.
Frequently great blocks of fresh rock, scattered all over the surface, are present in the forest islands.

II.8.2. Formation

The tropical forest belt in the West has been classified provisionally as "semi-evergreen seasonal forest", although also patches of typical rain forest occur. The isolated forest islands are categorised as "evergreen rain forest". The formation is built up and characterised by a two-layered continuous tree-stratum, h. -35m, whereas incidentally emergent trees may rise up to a height of 50 m.
The forest formation felt beyond the scope of the authors' investigations and for this reason a specifically characteristic group among the plant species collected in this formation can not be indicated by us.
Species: see list.

II.9. Hydromorphic herb formation in creeks

Habitat & Formation

The species in this formation were collected in streaming water of creeks, on sandy banks and in riverbeds which were falling dry during the dry season.
Characteristic species: Herb-layer: Arac.: Montrichardia arborescens; Camp.: Lobelia aquatica; Podost.: Mourera fluviatilis.

II.10. Adventive herb formation on sites disturbed by man

Habitat & Formation

The adventives were mainly collected near the temporary settlement of "Meyers farm" in the West of the Sipaliwini savanna near the forest border, and along the cleared Sipaliwini-airstrip.
Characteristic species: see list.

Acknowledgements

We are indebted and grateful to WOTRO for the grants which made the successive expeditions and investigations possible. We wish to express our acknowledgements to the Institute of Systematic Botany in Utrecht (former Director Prof.Dr. J. Lanjouw) for the hospitality and facilities offered. Especially we want to thank the staff members (1968-1970) Dr. J.C. Lindeman and Dr. J. van Donselaar for their advice given before our departure to Surinam and for their assistance with the provisional identification of plant material after our return. We are most grateful to Mrs. P.B.A. Gradstein-Stuurman for correcting the English manuscript.
We are grateful for the hospitality offered to us by the Laboratory of Physical Geography, Utrecht (Director Prof.Dr. J.I.S. Zonneveld).
Without the cooperation, facilities and organisationtalent of our co-expeditionairs of the "Forest Service of Surinam" (Director Ir. F.C. Bubberman) and especially of Dr. J.P. Schulz (Head of the Conservation Department of the Forest Service) the expedition would have been impossible. In our thanks to several Government Services, (e.g. the Central Bureau for Aerial Survey, the Geological and Mining Service, the Service for Soil-Survey and the Meteorological Service) for facilities and information put at our disposal, we wish to express our gratitude to the people of Surinam for their hospitality, which enabled us to complete this first study about that wonderful region in their country, the Sipaliwini savanna.

SUMMARY

Chapter I. In the general introduction a survey is given of the maps and aerial photographs used; the history of discovery of the region; data concerning the meteorology and geology; and a general landscape description which is followed by a sub-divisioning of the landscape into the five landscape-types observed, I Sipaliwini-, II Morro Grande-, III Vier Gebroeders -, IV Paru-, and V Rivervalley- landscape.

The general impression of an open orchard savanna vegetation is illustrated into more detail by a description of the specific vegetation-types distinguished, from which are mentioned the classical Brazilian campo-types: campo coberto, campo limpo, campo sujo, campo cerrado & cerradão, besides: kawfutus, "Maurisie"-swamps and "Maurisie"-forests, mountain savanna forest, rock savanna, evergreen rain forest, muri-muri bush, savanna parkland, gallery woodland and gallery forest and semi-evergreen seasonal forest.

Seasonal aspects, fire and the influence of man in relation to the landscape and cultural history were indicated.

Chapter II The definition of Du Rietz: "A formation is an abstract type of association based upon physiognomy", was chosen and adopted as best fitted to our objective of provisional classification of the local vegetation on the basis of the formation principle.

Ten Habitat- and Formation-types are described:

I Tall bunch-grass formation on hill tops and slopes, II High-grass formation on colluvium, III Sedge and short-grass formation in valleys, IV Hygromorphic high-grass and shrub formation with palms in depressions, V Shrub-woodland formation on "Inselberg" slopes, VI Xeromorphic herb and shrub formation on granitic outcrops, VII Gallery forest and gallery woodland formation on riverbanks, VIII Tropical rain forest formation, IX Hydromorphic herb formation in creeks, X Adventive herb formation on sites disturbed by man.

In the addendum the conclusive species list arranged into formations according to habitat and physiognomy of vegetation is given.

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ADDENDUM

The formations in the following "list of species arranged according to habitat and physiognomy of vegetation types" were selected and taken from the "alphabetical list of plant species collected in the Sipaliwini savanna area till Febr. 1969", compiled by Oldenburger (1969), of the species lists from the collections of Hulk (1910-1911) coll. no. 35-80, Rombouts (1935-1936) coll.no. 193-554^{b}, Wessels Boer (1963) coll.no. 688-700 & 741-803, van Donselaar (1966) coll.no. 3523-3727, Oldenburger, Norde en Schulz (1968-1969) coll.no. 1-987, and the species occurring on "the list of spermatophytes and pteridophytes observed till 1967, on the Sipaliwini savanna and some smaller savannas in South Surinam" of van Dondelaar (1967). Until 1969 nearly 740 species were collected in the Sipaliwini savanna area and identified at least down to species level. The 1968-1969 Sipaliwini expedition brought back 400 new species for the Sipaliwini savanna region, among which approx. 80 new species for the Flora of Surinam and nearly 75 species which are still unidentified.

Most plant material was determined by Norde and Oldenburger with help of the taxonomic literature available at the library of the Institute of Systematic Botany of the Utrecht State University. As main works may be mentioned the "Flora of Suriname", edited since 1928 by Pulle and Lanjouw (Amsterdam, since 1964 Leiden) and the Flora Brasiliensis of Endlicher & Martius (1840-1906).

We wish to acknowledge the taxonomic specialists at the Institute of Systematic Botany (Utrecht), who took care of the identification of plant material of specific taxa: Drs. C.C. Berg (Moraceae), Dr. C.E.B. Bremekamp (Rubiaceae), Dr. J. van Donselaar (gen. Rhynchospora), Drs. A.R.A. Görts-van Rijn (Chrysobalanaceae), Drs. M.J. Jansen-Jacobs (Annonaceae), Dr. K.U. Kramer (Sapindaceae, Pteridophyta), Drs. P.J.M. Maas (Zingiberaceae), Drs. H. Maas-v.d. Kamer (Acanthaceae, Scrophulariaceae), Dr. A.M.W. Mennega (Sapotaceae, Celastraceae), Drs. A.C. de Roon (Meliaceae), Drs. H.J.H. Sipman (Liliaceae), Dr. G.J. Wessels Boer (Palmae), Drs. L.Y.Th. Westra (Malvaceae, Tiliaceae, Orchidaceae). We are indebted to Dr. G.J.H. Amshoff of the Laboratory for Plant Taxonomy and Plant Geography, Agricultural University (Wageningen) for the identification of some problematic Gramineae, Papilionaceae and Mimosaceae.

LIST OF SPECIES ARRANGED ACCORDING TO HABITAT AND PHYSIOGNOMY OF VEGETATION TYPES

		occurrence in other groups
I TALL BUNCH-GRASS FORMATION ON HILL TOPS AND SLOPES		
Acanth.		
Ulleria angustifolia (Nees) Brem.		II
Apoc.		
Mandevilla tenuifolia (Mik.) Woods.		VI
Asclep.		
Barjonia racemosa Done.		
Comp.		
Baccharis varians Gardn.		
Calea solidaginea H.B.K.	along forest edge	or II?
Elephantopus tomentosus L.	,, ,, ,,	or II?
Eupatorium amygdalinum Lam.		
Ichthyothere terminalis (Spreng.) Malme		
Convolv.		
Evolvulus sericeus Sw.		
Merremia aturensis (H.B.K.) Hall.f.		
,, glabra (Aubl.) Hall.f.	along forest edge	or II?
Cyp.		
Bulbostylis capillaris (L.) Kunth var. capillaris		
,, ,, ,, ,, var. tenuifolia Clarke		
,, fasciculata Uitt.		
,, junciformis (H.B.K.) Kunth		
,, cf. ,, ,, ,,		
,, spadicea (H.B.K.) Kük.		
,, vestita Kunth		
Rhynchospora cephalotes (L.) Vahl		
Scleria cyperina Willd.		
,, scabra Willd.		
Erythrox.		
Erythroxylum sp. ON 915		
Flac.		
Casearea silvestris Sw. var. lingua (Camb.) Eichl.		
Gent.		
Coutoubea spicata Aubl.		
Lisianthus grandiflorus Aubl.		
,, uliginosus Griseb. var. guianensis Griseb.		
Gram.		
Andropogon leucostachyus H.B.K.		II
Aristida recurvata H.B.K.		
,, tincta Trin. et Rupr.		
Axonopus pulcher (Nees) Kuhlm.		
Ctenium cirrosum (Nees) Kuhlm.		
Digitaria aff. filiformis Koel.		
Elyonurus adustus (Trin.) Ekman		
Mesosetum tenuifolium Swallen		
Paspalum albidulum Henr.		
,, contractum Pilger		
,, gardnerianum Nees		
,, pectinatum Nees		
,, polychaetum Mez.		
,, ? albidulum ON 316		
,, sp. ON 791		
Schizachyrium riedeli (Trin.) A. Camus var. multirameum Henr.		

	occurrence in other groups
(Gram.)	
Setaria poiretiana Kunth	
Sporobolus cubensis Hitchc.	II
Thrasya petrosa (Trin.) Chase	II and VI
Irid.	
Sisyrhinchium marchio (Vell.) Steud.	
Loranth.	
Phoradendron racemosum (Aubl.) Krug. epiphyt on treelets	I and V
Psittacenthus collum-cygni Eich. ,, ,, ,,	I and V
Malp.	
Byrsonima coccolobaefolia Kunth	
,, crassifolia (L.) L.C. Rich.	
,, verbascifolia (L.) L. subsp. villosa Griseb. fo. spathula Ndz.	
Malv.	
Pavonia speciosa H.B.K. var. hostmannii Gürke	
Marant.	
Maranta orbiculata (Koern.) K. Schum.	
Melast.	
Clidemia rubra (Aubl.) Mart.	
Leandra sp. ON 40	
Miconia macrothyrsa Benth.	
,, pachyphylla Cogn.	
,, rubiginosa (Bonpl.) DC.	
,, rufescens (Aubl.) DC.	
,, stenostachya DC.	
Tibouchina aspera Aubl.	
Menisp.	
Cissampelos ovalifolia DC.	
Myrt.	
Eugenia punicifolia (H.B.K.) DC. var. punicifolia	
Orch.	
Cyrtopodium parviflorum Lindl.	
Habenaria sprucei Cogn.	
Spiranthes rupestris Barb. Rodr. non Lindl.	
Papil.	
Bowdichia virgiloides H.B.K.	
Cassia cultrifolia H.B.K.	
,, quinquangulata Rich.	
,, tetraphylla Desv. var. brevipes (Benth.) Irwin	
Clitoria guianensis (Aubl.) Benth.	
Dioclea glabra Benth.	
Eriosema crinitum (H.B.K.) G. Don.	
,, simplicifolium (H.B.K.) G. Don.	II
Polygal.	
Polygala mollis H.B.K. fo. mollis	
Rub.	
Borreria hispida Spruce ex K. Schum.	
Declieuxia fruticosa (Willd. ex R. et S.) Kuntze	or V
Palicourea rigida H.B.K.	
Scroph.	
Buchnera rosea H.B.K.	

		occurrence in other groups
Viol.		
	Hybanthus sp. WB 789	
Vochys.		
	Salvertia convallariodora St. Hil.	
II	HIGH-GRASS FORMATION ON COLLUVIUM	
Amaryll.		
	Curculigo scorzoneraefolia (Lam.) Baker	
	Hippeastrum puniceum (Lam.) Urb.	VI
Bign.		
	Tabebuia caraiba (Mart.) Bur.	
Borag.		
	Cordia schomburgkii DC.	
Commel.		
	Commelina erecta L. emend. Clarke	
Comp.		
	Chaptalia nutans L.Polakowski	along forest edge
	Conyza chilensis Spreng.	
	Elephantopus angustifolius Sw.	
	Erechtithes hieracifolia L. Raf. ex DC. var. cacaloides (Fisch. ex Spreng.) Griseb. em. Belcher	
	Eupatorium ivaefolium L.	
	,, sp. ON 369	
	Geissopappus caleoides Benth.	
	Riencourtia oblongifolia Gardn.	
	Vernonia apiculata Mart.	
	,, remotifolia L.C Rich.	
Convolv.		
	Merremia umbellata (L.) Hall.f.	VII
Cyp.		
	Bulbostylis stenocarpa Kük.	(III) and IV
	,, sp. ON 686	
	Cyperus flavus (Vahl) Nees	
	,, ligularis L.	
	Lipocarpha humboldtiana Nees	
	Rhynchospora glauca Vahl	
	,, nervosa (Vahl) Boeck. var. ciliata (Vahl) Kük.	
	,, rufa (Nees) Boeck.	IV
	,, sp. WB 741	
	,, sp. WB 758	
	Scleria bracteata Cav.	
	,, pterota Presl. var. pterota	
	,, ,, ,, var. melaleuca (Cham. et Schlecht.) Uitt.	
	,, sp. WB 756	III
Dill.		
	Curatella americana L.	I
Euph.		
	Croton glandulosus L.	IV
	Euphorbia brasiliensis Lam.	IV
	Manihot melanobasis Müll. Arg.	near rocks
	Sebastiana linearifolia Lanj.	

		occurrence in other groups
Gram.		
	Andropogon bracteatus Willd.	
	Arundinella hispida (Willd.) O.K.	IV
	Axonopus chrysites (Steud.) Kuhlm.	III and IV
	,, gentilis Henr.	
	,, pubivaginatus Henr.	
	,, purpusii (Mez.) Chase	III
	Echinolaena inflexa (Poir.) Chase	III and IV
	Ichnanthus calvescens Doell. along forest edge (as Homolepis isocalycia)	
	Imperata contracta (H.B.K.) Hitchc.	
	Leptocoryphium lanatum (H.B.K.) Nees	I
	Panicum cayennense Lam.	
	,, cyanescens Nees	IV
	,, olyroides H.B.K.	
	,, rudgei R. et S.	
	Paspalum coryphaeum Trin.	
	,, plicatulum Michx.	
	Schizachyrium condensatum (H.B.K.) Nees	
	Setaria geniculata (Lam.) Beauv.	IV
	,, tenax (Rich.) Desv. along forest edge	
	,, poiretiana Kunth ,, ,, ,,	
	Sorghastrum stipoides (H.B.K.) Nash	
	Trachypogon plumosus (H. et B.) Nees	I
	Tripsacum dactyloides (L.) L.	
Guat.		
	Vismia angusta Miq. in swamp-forest margin	
	,, japurensis Reich. transition to IV	
	,, aff. minutifolia Ewan ON 693	
Lab.		
	Hyptis atrorubens Poit.	IV
	,, hirsuta H.B.K.	
	,, lantanaefolia Poit. var. lantanaefolia	
Lil.		
	Smilax cumanensis Willd.	
Lythr.		
	Cuphea gracilis H.B.K.	III and IV
Malv.		
	Sida linifolia Cav.	
Marant.		
	Myrosma cannifolia L.f.	
Melast.		
	Aciotis ornata Gleason	
	Clidemia capitellata (Bonpl.) D.Don. var. dependens (D. Don.) Macbr. along rivulets	
	,, strigillosa (Sw.) DC. also along forest edge	
	Miconia albicans (Sw.) Triana	I and V
	,, ibaguensis (Bonpl.) Triana	
	Rhynchanthera cf. dichotoma (Desr.) DC. ON 821	
Mimos.		
	Calliandra surinamensis Benth.	
	Mimosa pudica L. ON 223	
	,, invisa Mart.	

		occurrence in other groups
Myrt.		
	Psidium guineense Sw.	
	,, quinquedentatum Amsh.	
Orch.		
	Cleistes rosea Lindl.	
	Cyrtopodium cristatum Lindl.	III
	Koellensteinia eburna (Barb. Rodr.) Schltr.	
Oxal.		
	Oxalis barrelieri L.	
Papil.		
	Aeschynomene brasiliana)Poir.) DC.	
	,, hystrix Poir.	VI
	,, paniculata Willd. ex Vog.	
	Bauhinia cumanensis H.B.K. forest edge	
	Calopogonium coeruleum (Benth.) Suav.	
	Cassia patellaria DC.	
	,, penelliana Amsh.	
	Centrosema pubescens Benth.	
	,, virginianum (L.) Benth.	IV
	,, sp. WB 777	
	Crotalaria pterocaula Desv.	IV
	Desmodium albiflorum Salzm.	
	,, axillare (Sw.) DC. var. acutifolia Kuntze forest edge	
	,, barbatum (L.) Benth.	
	,, cajanifolium (H.B.K.) DC.	
	,, sclerophyllum Benth.	
	Eriosema rufum (H.B.K.) G. Don.	
	,, violaceum (Aubl.) G. Don.	IV
	Phaseolus adenanthus G.F.W. Mey.	
	,, linearis H.B.K.	
	,, longipedunculatus H.B.K.	VI
	Stylosanthes guianensis (Aubl.) Sw. var. guianensis	
	Tephrosia adunca Benth.	
	,, purpurea (L.) Pers.	
	Zornia diphylla (L.) Pers.	VI and VII
Rub.		
	Gonzalagunia dicocca C. et S. along forest edge	
	Mitracarpus discolor Miq.	
	Nonatelia racemosa Aubl.	
	Sabicea romboutsii Brem. ,, ,, ,,	VI
	Sipanea glaberrima (Brem.) Steyerm.	
Solan.		
	Solanum jamaicense Mill.	
Sterc.		
	Helicteres pentandra L.	VII
Til.		
	Corchorus hirtus L.	
	Luehea paniculata Mart. et Zucc.	
Turn.		
	Piriqueta cistoides (L.) Griseb.	VI
Verb.		
	Lantana glutinosa Poepp. along forest edge	
	,, trifolia L.	

	occurrence in other groups
Vitac.	
Cissus erosa L.C. Rich.	
,, sicyoides L. var. sicyoides	
,, subrhomboidea (Baker) Planch.	
Gleich.	
Gleichenia flexuosa (Schrader) Mett.	also in recent gullies
Polyp.	
Adiantum serrato-dentatum Willd.	

III SEDGE AND SHORT-GRASS FORMATION IN VALLEYS

Burm.	
Burmannia bicolor Mart.	
,, capitata (J.F. Gmel.) Mart.	
,, flava Mart.	II
Convolv.	
Ipomoea schomburgkii Choisy	
Cyp.	
Bulbostylis lanata (H.B.H.) Clarke	
Cyperus unioloides R. Br.	IV
Lagenocarpus tremulus Nees	
Lipocarpha sellowiana Kunth.	(II and) IV
Rhynchospora armerioides Presl.	
,, barbata (Vahl) Kunth	I
,, curvula Griseb.	
,, cyperoides (Sw.) Mart.	(X)
,, globosa (H.B.K.) R. et S.	II and IV
,, graminea Uitt.	II
,, junciformis (Kunth) Boeck.	
,, podosperma C. Wright	
,, tenerrima Nees ex Sprengel	
,, sublanata J.C.Lindeman et J.v.Donselaar	
Scleria hirtella Willd.	II
,, micrococca (Liebm.) Steud.	I

	occurrence in other groups
Dros.	
Drosera capillaris Poir.	
,, cayennensis Sagot	
,, esmeralda (Steyerm.) Mag. et Wurdack	
,, sessiflora St. Hil.	
Erioc.	
Paepalanthus lamarckii Kunth	
Philodice hoffmanseggii Mart.	
Syngonanthus biformis (N.E.Br.) Gleason	VI
,, fertilis (Koern.) Ruhl.	
,, glandulosus Gleason	VI
,, gracilis (Bong.) Ruhl.	
,, ,, ,, ,, var. koernickeanus Ruhl.	
,, ,, ,, ,, cf. var. koernickeanus Ruhl.	
,, umbellatus (Poir.) Ruhl.	
Gent.	
Curtia tenuifolia (Aubl.) Knobl.	I (colorvariation)
Lisianthus coerulescens Aubl.	
Schultesia brachyptera Cham.	
,, pohliana Progel.	
Gram.	
Andropogon angustatus (Presl.) Steud.	
,, selloanus (Hack.) Hack.	II
Eriochrysis cayennensis P. Beauv.	II and IV
Manisurus guianensis Hitchc.	IV
Mesosetum cayennense Steud.	I
,, loliiforme (Hoechst.) Chase	
Panicum nervosum Lam.	
,, parviflorum Lam.	
,, siccanum Trin.	
,, stenodes Griseb.	
,, stenodoides Hubbard	
Paspalum maculosum Trin.	II
,, pulchellum Kunth	
,, serpentinum Hochst. et Steud.	
,, aff. pulchellum H.B.K. ON 646	
,, cf. millegranum Schrdd. et Schult ON 653	
Graminae ON 918 (Mesosetum?)	
Gutt.	
Clusia nemorosa G.F.W. Meyer — Forest edge	
Laur.	
Cassytha filiformis L.	IV
Lent.	
Utricularia adpressa St. Hil.	IV
granite spec. unknown ,, amethystina St. Hil.	
,, fimbriata Kunth	
,, hispida Lam.	(VI vD)
,, lloydii Merl.	
,, pusilla Vahl	
,, subulata L.	
,, triloba Benj.	
,, sp. WB 779	
(Malp. Byrsonima eugeniifolia Sandw. — white sand savanna Paru-plain)	
Melast.	
Acisanthera bivalvis (Aubl.) Cogn.	(VII vD)
,, crassipes (Naud.) Wurdack	
,, limnobios (DC) Triana	
,, sp. ON 596=ON 67	

	occurrence in other groups
(Melast.)	
Comolia lythrarioides Naud.	
,, veronicaefolia Benth.	
Rhynchanthera serratula (Rich.) DC.	
(Myrsin.	
Rapanea sp. ON 560	white sand savanna Paru-plain)
Myrt.	
Aulomyrcia citrifolia (Aubl.) Amsh.	forest edge
Myrcia deflexa (Poir.) DC.	,, ,,
,, sp. ON 956	
Ochn.	
Sauvagesia erecta L.	
,, rubiginosa St. Hil.	IV
,, sprengelii St. Hil.	II and IV
,, tenella Lam.	
Orch.	
Galeandra juncea Lindl.	
Habenaria amazonica Schltr.	
,, leprieurii Reichb.f.)	
,, sp. ON 970	
Otostylis brachystalix (Reichb.f.)	
Papil.	
Clitoria laurifolia Poir.	
Polygal.	
Polygala adenophora DC.	
,, angustifolia H.B.K. var. latifolia St. Hil. ex Chordat	
,, hygrophila H.B.K.	
,, paludosa St. Hil.	
,, subtilis H.B.K.	
,, timoutou Aubl.	
Rapat.	
Cephalostemon affinis Koernicke	
,, gracilis (Poepp. et Endl.) Rob. Schomb.	
Ros.	
Hirtella paniculata Sw.	forest edge Little Sand Savanna
Licania albiflora Fanshawe & Maguire	forest edge Little Sand Savanna
Rub.	
Mapouria chionantha (DC.) Müll.Arg.	,, ,, ,, ,, ,,
Perama hirsuta Aubl.	
Scroph.	
Buchnera palustris (Aubl.) Spreng	I
Gerardia hispidula Mart.	
Melasma melampyroides (L.C. Rich.) Pennell	
Xyr.	
Albolboda pulchella H. et B.	
Xyris fallax Malme	
,, macrocephala Vahl	IV
,, malmeana L.B. Smith	
,, paraënsis Poepp. et Kunth	
,, savanensis Miq.	
,, ,, ,, var. glabrata Seubert	
-.	
Lycopod.	
Lycopodium alopecuroides L. var. integerrimum Spring.	
,, cernuum L.	
Polyp.	
Pteridium aquilinum?	VII

IV HYGROMORPHIC HIGH-GRASS AND SHRUB FORMATION WITH PALMS IN DEPRESSIONS	occurrence in other groups
Acanth.	
Ulleria geminiflora(H.B.K.) Brem.	
Staurogyne linearifolia Brem.	
Alism.	
Echinodorus latifolius (Seub.) Rataj	
,, longipetalus Micheli	Maurisie-forest
,, scaber Rataj	
,, muricatus ON 739	
Amaryll.	
Crinum erubescens Solandr.	
Apoc.	
Odontadenia nitida (Vahl) Müll. Arg. var. oblongifolia Müll. Arg.	
Aroid.	
Montrichardia linifera (Arr.) Schott ?	(and IX)
Asclep.	
Marsdenia sp. ON 619 near rock	
Bign.	
Tabebuia insignis (Miq.) Sandw. Maurisie-forest	
Campan.	
Centropogon cornutus (L.) Druce ,, ,,	
Comp.	
Clibadium armani (Balbis) Schultz-Bip.	II
Eleutheranthera ruderalis (Sw.) Schultz-Bip.	
Ichthyothere aff. terminalis (Spreng.) Malme ON 447	
Mikania micrantha H.B.K.	
Convolv.	
Aniseia cernua Moricand	
Ipomoea sqamosa Choisy	
Cucurb.	
Melothria fluminensis Gardn.	
Indet. ON 651	
Cyp.	
Calyptrocarya cf. poeppi giana Kunth (= ex C.palmetto Nees)	
Cyperus haspan L. subsp. juncoides (Lam.) Kük. var. juncoides	
,, kyllinga Endl.	
,, megapotamicus Kunth	
,, pseudodistans Uitt.	
,, virens Mich.	
,, sp. ON 551	
Diplacrum africanum (Benth.) Clarke	transition to III
Eleocharis amazonica C.B. Clarke	
,, fistulosa (Poir.) Link.	
,, interstincta (Vahl) R. et S.	
,, mitrata (Griseb.) C.B. Clarke	
,, cf. nodulosa (Roth) Schultes	
,, ochreata Nees	
,, pachystyla (C. Wright) C.B. Clarke	
,, nana Kunth	
,, retroflexa (Poir.) Urb.	
,, sulcata (Roth) Nees	
Fimbristylis complanata (Retz.) Link	
Fuirena umbellata Rottb.	
Rhynchospora guianensis Lindeman & v. Donselaar	
,, brevirostris Griseb. var. truncata Kük.	
,, candida Boeck.	
,, corymbosa (L.) Britton	
,, viridi-lutea Clarke	

	occurrence in other groups
(Cyp.)	
Scleria macrophylla Presl.	
,, microcarpa Nees	
,, setacea Poir.	
Diosc.	
Dioscorea polygonoides H. et B.	Maurisie-forest
Erioc.	
Eriocaulon humboldtii Kunth	
Syngonanthus caulescens (Poir.) Ruhl	
,, sp. ON 446 (nov. sp.)	
Euph.	
Caperonia corchoroides Müll. Arg.	
,, palustris (L.) St. Hil.	
,, stenophylla Muell.	
Croton sipaliwinensis Lanj.	
Phyllanthus stipulatus (Raf.) Webster	III
Sebastiana linearifolia Lanj. fo. pilosa Lanj.	
Gent.	
Coutoubea ramosa Aubl. fo. vulgaris	
Gram.	
Acroceras zizanioides (H.B.K.) Dandy	
Andropogon bicornis L.	II
Coelorachis aurita (Steud.) Henr.	II and III
,, sp. ON 227	
Erianthus trinii Hackel	
Hackelochloa granularis (L.) O. Ktze.	
Homolepis isocalycia (Meyer) Chase	also along forest edge in II
Hymenachne amplexicaulis (Rudge) Nees	
Hypogynium virgatum (Desv.) Dandy	
Ischaemum guianense Kunth	
Lasiacis sorghoidea (Desv.) Hitchc. et Chase	edge Maurisie-forest
Leersia hexandra Sw.	
Luziola bahiensis (Steud.) Hitchc.	IX
Oryza grandiglumis Prodoehl	
Panicum cf. cyanescens Nees ON 91	
,, laxum Sw.	
,, pilosum Swartz	IX
,, succisum Swallen	III
Isachne polygonoides Doell	
Paspalum densum Poir.	
Sacciolepis myuros (Lam.) Nees	III
Thrasya reticulata Swallen	
Hydroph.	
Hydrolaea spinosa L.	VI
Lab.	
Hyptis microphylla Pohl	
,, recurvata Poit.	
Lythr.	
Rotala mexicana Cham. et Schl.	
Malv.	
Hibiscus furcellatus Desr.	
Pavonia julianae Uitt.	
,, sessiliflora H.B.K.	
Marant.	
Myrosma cannifolia L.f.?	
Mayac.	
Mayaca fluviatilis Aubl.	
Melast.	
Aciotis purpurascens Tr.	
Acisanthera recurva (L.C. Rich.) Griseb.	
Clidemia hirta (L.) D.Don. var. elegans (Aubl.) Griseb.	

	occurrence in other groups
(Melast.)	
Desmocelis villosa (Aubl.) Naud	
Miconia sp. ON 938	
Rhynchanthera grandiflora (Aubl.) DC.	
,, div. sp. ON 286, 391, 755?	
Mus.	
Heliconia hirsuta L.f.	
,, psittacorum L.f.	II
Onagr.	
Ludwigia nervosa (Poir.) Hara	
,, rigida (Miq.) Sandw.	
,, sp. WB 787	
Palmae	
Mauritia flexuosa L.f.	
Papil.	
Aeschynomene sensitiva Sw.	
,, fluminensis Vell.	
Calopogonium mucunoides Desv.	
Canavalia dictyota Piper	
Cassia tetraphylla Desv. var. tetraphylla	
Crotalaria anagyroides H.B.K.	II
Dioclea guianensis Benth.	II
,, virgata (Rich.) Amsh.	
Phaseolus peduncularis H.B.K. var. clitorioides (Benth.) Hassl.	
Pip.	
Piper amplectans (Miq.) DC.	
Polygal.	
Polygala cf. galioides Poir. ON 186	
,, subtilis H.B.K.	
Polygon.	
Polygonum hydropiperoides Michx .	
Primul.	
Centunculus pentander R.Br.	transition to III
Rub.	
Borreria ocimoides (Burm.f.) DC.	
,, verticillata (L.) G.F.W. Meyer	
Coccypselum guianense (Aubl.) K. Schum.	
Diodia pulchristipula Brem.	
,, sarmentosa Sw.	
Oldenlandia lancifolia (Schuhm.) DC.	
Scroph.	
Bacopa angulata Edwall	
,, monnierioides Robinson	
,, reflexa (Benth.) Edwall	
Conobea scoparioides Benth.	
Sterc.	
Buettneria scabra Loefl.	
Melochia villosa (Mill.) Fawc. et Rendle	
Zing.	
Costus arabicus L. Maurisie-forest	
Renealmia exaltata L.f. ,, ,,	
.-.	
Polypod.	
Blechnum indicum Burm.f.?	
Polypodium triseriale Swartz	
Thelipteris hostmannii (Kl.) Marton	

V SHRUB-WOODLAND FORMATION ON "INSELBERG" SLOPES

occurrence in other groups

Anacard.
Astron ium lecointei Ducke
Tapirira guianensis Aubl. var. cuneata Engl.
Annon.
Annona sericea Dun.
Xylopia frutescens Aubl.
Apoc.
Himatanthus articulatus (Vahl) Woods VI
,, bracteatus (A.D.C.) R.E. Woodson
Mandevilla scabra (R. et S.) K. Schum.
var. intermedia Müll. Arg.
Asclep.
Blepharodon nitidus (Vell.) Mcbr.
Bign.
Jacaranda obtusifolia H. et B.
var. rhombifolia (G.F.W. Mey.) Sandw.
Dill.
Davilla aspera (Aubl.) R. Ben.
,, rugosa Poir.
Doliocarpus calinea J.F. Gmel.
,, guianensis (Aubl.) Gilg.
Erythrox.
Erythroxylum sp. ON 314
Euph.
Pera nitida (benth.) Jabl.
Gram.
Raddiella nana (Doell.) Swallen
Gutt.
Vismia latifolia (Aubl.) Choisy
Hum.
Humiria balsamifera (Aubl.) St. Hil. var. balsamifera
,, ,, ,, ,, ,, var. floribunda (Mart.) Cuatr.
Sacoglottis guianensis Benth.
,, ,, ,, var. guianensis
Malp.
Byrsonima coriacea (Schwartz) Kunth
var. spicata (Cav.) Ndz.
Camarea affinis St. Hil.
Melast.
Miconia ciliata DC.
,, sp. ON 296
Mimos.
Anadenanthera peregrina (L.) Speg. var. peregrina
Piptadenis sp. ON 330=454
Myrsin.
Rapanea guianensis Aubl.
Myrt.
Myrcia bracteata (Rich.) DC.
sp. ind. ON 818
Papil.
Andira surinamensis (Bondt) Splitg. ex Palle
Cassia faginoides Vog.
,, hispidula Vahl
Crotalaria maypurensis H.B.K.
Lonchocarpus floribundus Benth.
Stylosanthes guianensis (Aubl.) Sw. var. gracilis (H.B.K.) Vog.
Prot.
Roupala montana Aubl. II

occurrence in other groups

Ros.

Hirtella racemosa Lam. var. hexandra (Willd. ex R. et S.) Prance
,, glandulosa Sprengel

Rub.

Alibertia edulis (L.C. Rich.) A. Rich. ex DC.
,, myrcifolia (Spruce ex K. Sch.) K. Sch. var. myrcifolia
Genipa caruto H.B.K.
Guettarda viburnoides Cham. et Schl. cf. fo. pannosa Müll. Arg.
Malanea sarmentosa Aubl. cf. fo. tomentosa Steyerm.
Mapouria borjensis (H.B.K.) Müll. Arg.
Psychotria bracteata DC.
Thieleodoxa nitidula Brem.
Tocoyena surinamensis Brem.
Uncaria guianensis (Aubl.) Gmel.

Rut.

Fagara rhoifolia (Lam.) Engl.

Simar.

Simarouba amara Aubl.

Symploc.

Symplocos guianensis (Aubl.) Gürke var. guianensis
,, aff. guianensis (Aubl.) Gürke ON 937
,, sp. ON 220

Theac.

Ternstroemia dentata (Aubl.) Sw.

Verb.

Aegiphyla lhotzkiana Cham.
Amazonia campestris (Aubl.) Moldenke
Vitex cf. polygama Cham. var. bakeri Moldenke ON 313, 323, 360

.-.

Hymenoph.

Trichomanes primatum Hedw.

Polypod.

Polypodium percussum Cav.

Schiz.

Anemia pallida Gardn.

VI XEROMORPHIC HERB AND SHRUB FORMATION ON GRANITIC OUTCROPS

Amaryll.

Furcraea foetida (L.) Haw.

Apoc.

Peschiera sp. ON 406 — forest edge

Arac.

Caladium bicolor (Ait.) Vent.
Philodendron acutatum Schott.

Asclep.

Gonolobus ligustrinus Dcne

Bign.

Tabebuia sp. ON 544 — forest edge — or V?

Brom.

Aechmea sprucei Mez.
,, tocantina Baker
Pitcairnia geyskesii L.B. Smith
Tillandsia fasciculata Sw.

occurrence in other groups

Cact.
Cereus sp. ON 871
Melocactus sp.
Comp.
Melampodium camphoratum (L.f.) Baker
,, sp. ON 512
Convolv.
Evolvulus alsinoides L.
,, filipes Mart.
Jacquemontia guianensis (Aubl.) Meissn.
Cucurb.
Ceratosanthes sp. ON 857
Cyp.
Bulbostylis capillaris (L.) Kunth var. maior Uitt.
,, surinamensis Kunth
Cyperus capillifolius A. Richard
Rhynchospora fallax Uitt.
,, tenella (Nees) Boeck.
,, ,, ,, ,, var. haplostylis Uitt.
Erioc.
Paepalanthus fasciculatus (Rottb.) Koern.
,, subtilis Miq.
Syngonanthus cf. caulescens (Poir.) Rühl.
Euph.
Jatropha urens L.
Gent.
Neurotheca loeselioides (Spruce ex Progel) Baillon
Gesn.
Rechsteineria incarnata (Aubl.) Lubg.
Gram.
Aristida capillacea Lam.
,, riparia Trin.
,, setifolia H.B.K. var. genuina Henr.
Axonopus ramosus Swallen
Eragrostis maypurensis Steud.
Gymnopogon foliosus (Willd.) Nees also white sand savanna Paru
Panicum pyrularium Hitchc. et Clarke
Paspalum cf. melanospermum Desv. ex Poir. ON 839
,, multicaule Poir.
,, parviflorum Rhodé ex Flügge
Schizachyrium domingense Nash
* Gutt.
Clusia leprantha Mart. forest edge
,, pana-panari (Aubl.) Choisy forest edge
Malv.
Sida viarum St. Hil.
Marant.
Calathea mansonis Koern.
Melast.
Miconia alata (Aubl.) DC.
Ernestia nov. sp. aff. rubra ON 114, 165, vD 3705
Mimos.
Mimosa plumaeifolia Kleinh.
Myrt.
Eugenia punicifolia (H.B.K.) DC.
var. brachypoda (DC.) Kr. et Urb.
Psidium sp. ON 459
Ochnac.
Sauvagesia pulchella Planchon

* Sporobolus sp. ON 517

occurrence in other groups

Orch.
Cyrtopodium andersonii (Lambert ex Andrews) R. Brown — rocks near forest edge
Schomburgkia crispa Lind. — ,, ,, ,, ,,

Papil.
Stylosanthes cf. guianensis (Aubl.) Sw. — dwarf form ON 449

Portul.
Portulaca sedifolia N.E. Brown

Rub.
Borreria splitgerberi Brem. — edge with trickling spring
Faramea crassifolia Benth.
Guettarda spruceana Müll. Arg.
?Richardia scabra L.

Solan.
Schwenckia americana L.
? ,, guianensis Benth.

Sterc.
Waltheria indica L. — II

Turn.
Turnera ulmifolia L. var. surinamensis (Miq.) Urb. — II

Velloz.
sp. indet. ON 562

Xyr.
Xyris jupicai L.C. Richard

.-.

Schiz.
Anemia ferruginea H.B.K. var. ahenobarba (Christ.) Mickel — V
,, oblongifolia (Car.) Swartz
,, tripinnata Copeland
,, villosa H. et B. ex Willd.

Selaginell.
Selaginella densifolia Spruce

VII GALLERY FOREST AND GALLERY WOODLAND FORMATION ON RIVERBANKS

Acanth.
Stethoma pectoralis (Jacq.) Ragin.

Apoc.
Mandevilla scabra (R. et S.) K. Schum. var. pubiflora Müll. Arg. — Maurisie forest IV

Arac.
Monstera pertusa (L.) de Vriese

Bign.
Adenocalymma inundatum Mart. ex DC. var. surinamensis Bur. et K. Schum.

Bomb.
Bombax spectabile Ulbrich

Comp.
Eupatorium laevigatum Lam.
Mikania amara (Vahl) Willd.
Piptocarpha sp. ON 675

Cyp.
Scleria cf. macrogyne Clarke

Euph.
Phyllanthus diffusus Klotzsch
,, juglandifolius Willd.

Flac.
Homalium guianense (Aubl.) Warburg

occurrence in other groups

Malp.
Heteropteris macrostachya Juss. fo. oblonga Ndz.
Hiraea chrysophylla Juss.
Malv.
Sida quinquenervia Duchass. ex Pl. et Tr.) or II?
,, urens L.)
Wissadula patens (St. Hil.) Garcke)
Melast.
Macairea pachyphylla Benth.
Meliac.
Guarea guidonia (L.) Sleumer
Myrt.
Marliera montana (Aubl.) Amsh.
Papil.
Cassia multijuga L.C. Rich.
Dioclea cf. virgata ON 378
Passifl.
Passiflora sp. R 450
Polygon.
Coccoloba mollis Casar.
Rub.
Alibertia latifolia (Bth.) K. Sch.
cf. var. paraguieniana Steyerm.
Diodia spicata Miq.
Genipa americana L.
Palicourea crocea (Sw.) DC.
P osoqueria latifolia (Rudge) R. et S.
Rudgea crassifolia (Benth.) Rob. nov.var? VIII
Sipanea pratensis Aubl. var. pratensis VI
Til.
Triumfetta althaeoides Lam.
Turn.
Turnera odorata Rich. VI
Verben.
Stachytarpheta jamaicensis (L.) Vahl

.-.

Polyp.
Adianthum petiolatum Desv.
Schiz.
Lygodium venustum Swartz
,, venustum x volubile
,, volubile Swartz

VIII TROPICAL RAIN FOREST FORMATION

Anacard.
Anacardium giganteum Hancock
Annon.
Annona montana Macfad
Cymbopetalum brasiliense (Vell.) Benth.
Duguetia surinemensis R.E.Fr.
,, cf. tessmannii R.E.Fr.
Guatteria schomburgkiana Mart.
Oxandra aff. asbecki (Pulle) R.E. Fries
,, krukoffii R.E. Fries
Trigynaea guianensis R.E. Fries
Apoc.
Aspidosperma aff. album (Vahl) R. Ben.
,, cf. excelsum Benth.
Bign.
Tabebuia sp. ON 387

occurrence in other groups

Bomb.
Bombax globosum Aubl.
Borag.
Cordia bicolor A. de Candolle
Burs.
Protium heptaphyllum (Aubl.) March near forest edge
,, neglectum Swart
Cappar.
Capparis frondosa Jacq.
Celastr.
Maytenus sp. ON 427
Commel.
Dichorisandra hexandra (Aubl.) Standley
Comp.
Wulffia baccata (L.f.) Kuntze
Connar.
Connarus pachyneurus Radlk.
Elaeoc.
Sloanea sp. ON 475
,, ,, ON 477
,, ,, ON 502
Erythrox.
Erythroxylum roraimae Klotzsch
,, sp. ON 494
Flac.
Casearea guianensis (Aubl.) Urb.
Xylosma sp. ON 912
Gent.
Leiphaimos auriantica (Splitg.) Miq.
Gram.
Oplismenus hirtellus (L.) Beauv.
Pharus latifolius L.
Gutt.
Vismia sprucei Sprague
Laur.
Nectandra sp. ON 588
Ocotea glomerata (Nees) Mez.
,, aff. pretiosa Benth. et Hook ON 353
,, cf. schomburgkiana (Nees) Mez. ON 589
sp. indet. 536
Lecyth.
Eschweilera cf. longipes (Poit.) Miers ON 420
,, subglandulosus (Steud.) Miers
Marant.
Ichnosiphon obliquus (Rudge) Koern.
Monotagma laxum (Poepp. et Endl.) K. Schum.
Melast.
Miconia holosericea (L.) DC.
,, racemosa (Aubl.) DC.
,, sp. ON 584
,, sp. ON 585
Meliac.
Guarea cf. davisii Sandw. ON 436
Trichilia trinitensis A. Juss.
Mimos.
Inga aff. cayennensis Sagot var. sessiliflora Ducke ON 345
,, sp. ON 586

occurrence in other groups

Morac.
Brosimum guianense (Aubl.) Huber
Helicostylis tomentosa (P.E.) Rosby

Mus.
Heliconia densiflora Hort. ex Verlot.

Myrsin.
Cybianthus brownii Gleason

Myrt.
Aulomyrcia obtusa (Schauer) Berg
,, pyrifolia (Desv. ex Ham.) Berg forest edge V
Calyptranthes fasciculata Berg
Campomanesia cf. aromatica (Aubl.) Griseb ON 533
Eugenia coffeifolia DC.
,, florida DC.
,, cf. praetermissa McVaugh ON 444
,, riparia DC.
,, sp. ON 582
Myrcia schomburgkiana Berg
Myrciaria floribunda (Willd.) Berg
sp. indet. ON 441
,, ,, ON 532
,, ,, ON 576
,, ,, ON 535

Ochn.
Ouratea castaneifolia (DC.) Engl.

Olac.
Heisteria caulifolia Smith

Opil.
Agonandra silvatica Ducke

Palmae
Acrocomia lasiospatha Mart.
Attalea speciosa Mart.

Papil.
Cassia quinquangulata Rich.
Copaifera guianensis Desf.
Cynometra marginata Benth.
Elisabetha princeps Benth.
Eperua rubiginosa Miq.
Hymenolobium sp. ON 547
Machaerium cf. ferox (Benth.) Ducke ON 428
? ,, sp. ON 545
Swartzia panacoco (Aubl.) Cowan CN 482, ON 476
,, sp. ON 491
sp. indet. ON 506

Pip.
Peperomia quadrangularis (Thomps.) A. Dietz rock

Quiin.
Quiina integrifolia Pulle
,, aff. parvifolia Lanj. et V.Heerdt ON 509

Rhizoph.
Cassipourea guianensis Aubl.

Ros.
Hirtella bicornis Mart. et Zucc. forest edge
Licania discolor Pilger
,, majuscula Sagot
sp. indet. ON 418

Rub.
Alibertia myrcifolia (Spruce ex K. Sch.) K. Sch.
var. tepuiensis Steyerm. forest edge
vs.Alseis longifolia Ducke var. pentamera Brem.ON 495

occurrence in other groups

(Rub.)
Cephaëlis pubescens Hoffmans ex Willd
Palicourea longiflora (Aubl.) A. Rich. forest edge (near Pal.)
Psychotria romboutsii Brem.
Retinophyllum sp. vD 3692
Ronabea latifolia Aubl.

Rut.
Esenbeckia coriacea A.C. Smith

Sapind.
Cupania scrobiculata L.C. Rich.
Talisia megaphylla Sagot
Talisia r. tuse Cowan
sp. indet. ON 438

Sapot.
Chrysophyllum cf. cuneifolium (Rudge) A.DC. ON 481
,, sp. ON 417
Ecclinusa ramiflora Mart. var. tomentosa (Miq.) Monach
Pouteria caimito Radlk.
,, cladantha Sandw.
,, hispida Eyma
,, venosa (Mart.) Baehni
,, sp. ON 388
,, sp. ON 474
,, sp. ON 493
,, sp. ON 591 a

Simar.
Simaba cuspidata Spruce et Engl.

Sterc.
Sterculia excelsa Mart.
,, pruriens (Aubl.) Schum.
,, cf. pruriens (Aubl.) Schum. ON 473, ON 492 *

Til.
Luehea speciosa Willd.

Viol.
Amphirrhox longifolia (St. Hil.) Spreng.
Rinorea pubiflora (Benth.) Sprague et Sandw.

Zing.
Costus scaber R. et P.

.-.-.-.-.-.-.-.-.-.-.-.-.-.-.

Polyp.
Adiantum cayennense Willd. ex Kl.
,, glaucescens Klotzsch
,, obliquus Willd.
Pteris lithobrochioides Kl.
Thelipteris abrupta (Desv.) Proctor

Selaginell.
Selaginella pedata Klotzsch
,, seemannii Baker

IX HYDROMORPHIC HERB FORMATION IN CREEKS

Acanth.
Hygrophila cf. guianensis N. ab E.
Staurogyne lepidoglottoides Leonard

Arac.
Montrichardia arborescens (L.) Schott ?

* ON 415

occurrence in ot er groups

Campan.
Lobelia aquatica Cham.

Cyp.
Cyperus miliifolius Poepp. et Kunth
Diplacrum capitatum (Willd.) Boeck.
Fimbristylis dichotoma (L.) Vahl X
,, cf. var. annua (All.) T. Koyoma
Rhynchospora pubera (Vahl) Boeck.

Papil.
Desmodium adscendens (Sw.) DC. same place as Staurogyne lepidoglottoides

Podost.
Mourera fluviatilis Aubl.

Xyr.
Xyris cf. tenella Kunth fo. subtenella Malme ON 188

X ADVENTIVE HERB FORMATION ON SITES DISTURBED BY MAN

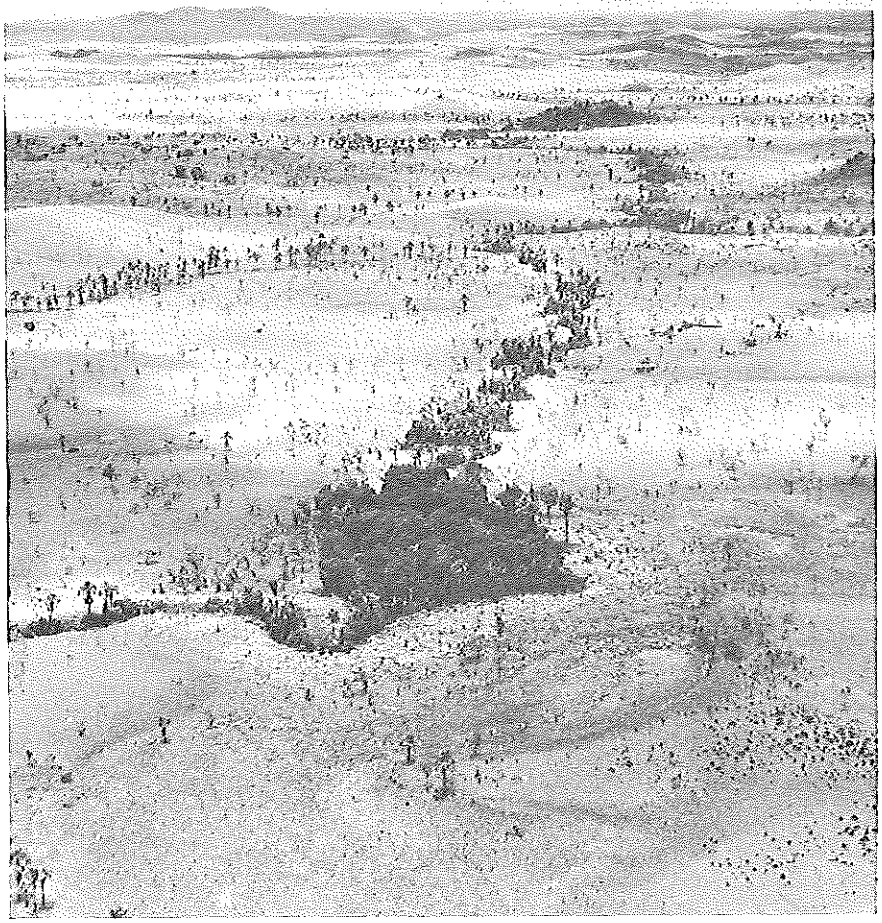
Cyp.
Cyperus densicaespitosus Mattf. et Kük.
,, luzulae L. Retz.
,, sp. WB 693
Fimbristylis dichotoma (L.) Vahl
Scirpus micranthus Vahl

Euph.
Euphorbia thymifolia L.

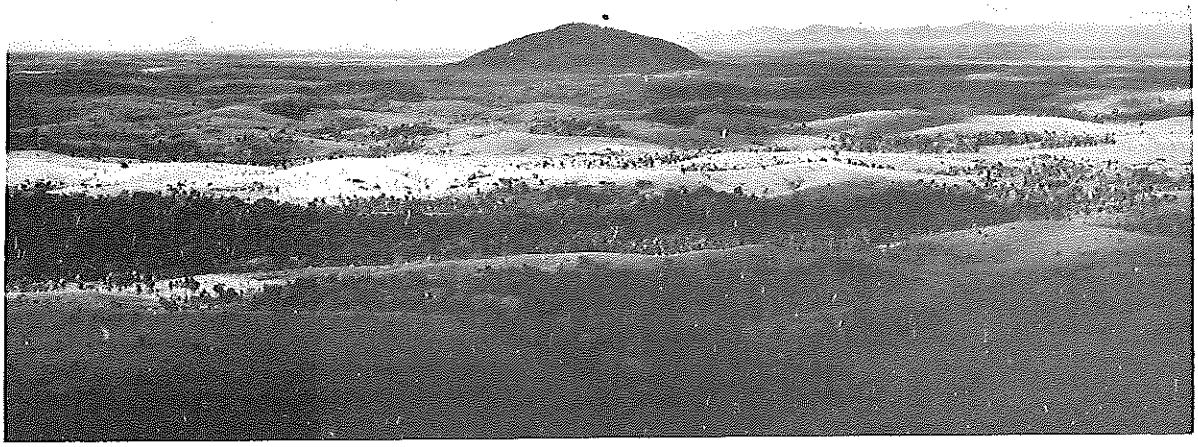
Gram.
Digitaria horizontalis Willd.
,, violascens Link
Eleusine indica (L.) Gaertn.
Eragrostis pilosa (L.) Beauv.
Oryza sativa L.
Paspalum conjugatum Berg.
,, melanospermum Desv. ex Poir.

Scroph.
Scoparia dulcis L.

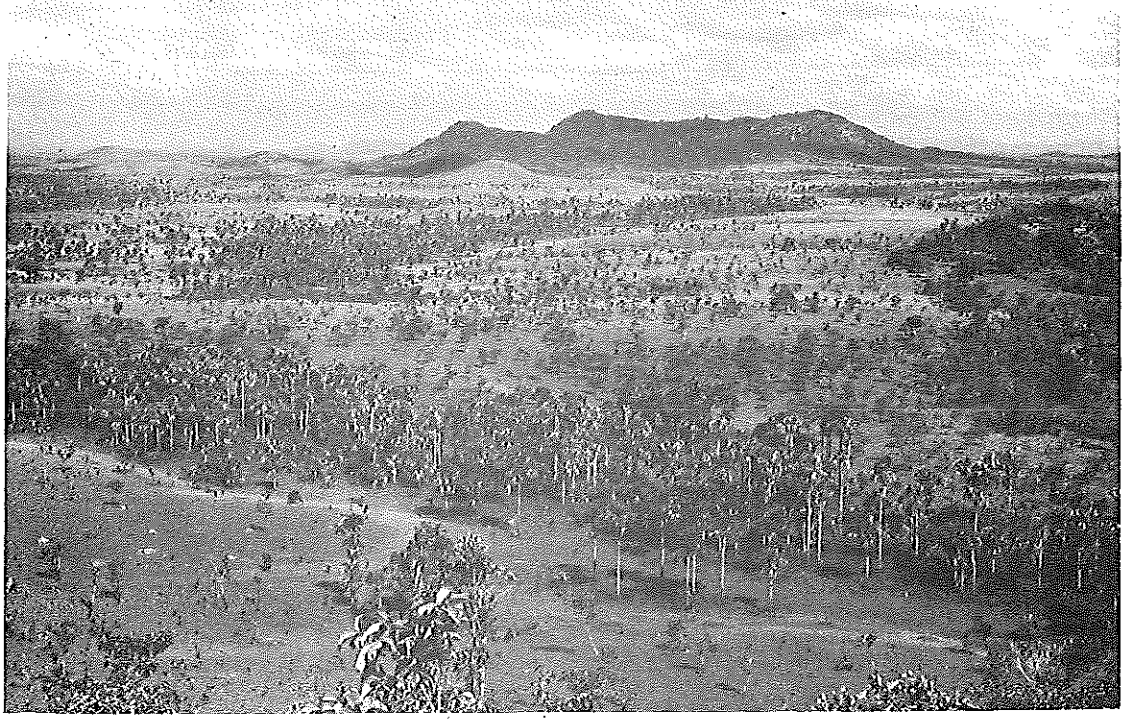
Solan.
Capsicum frutescens L.
Solanum stramoniifolium WB 689 II?



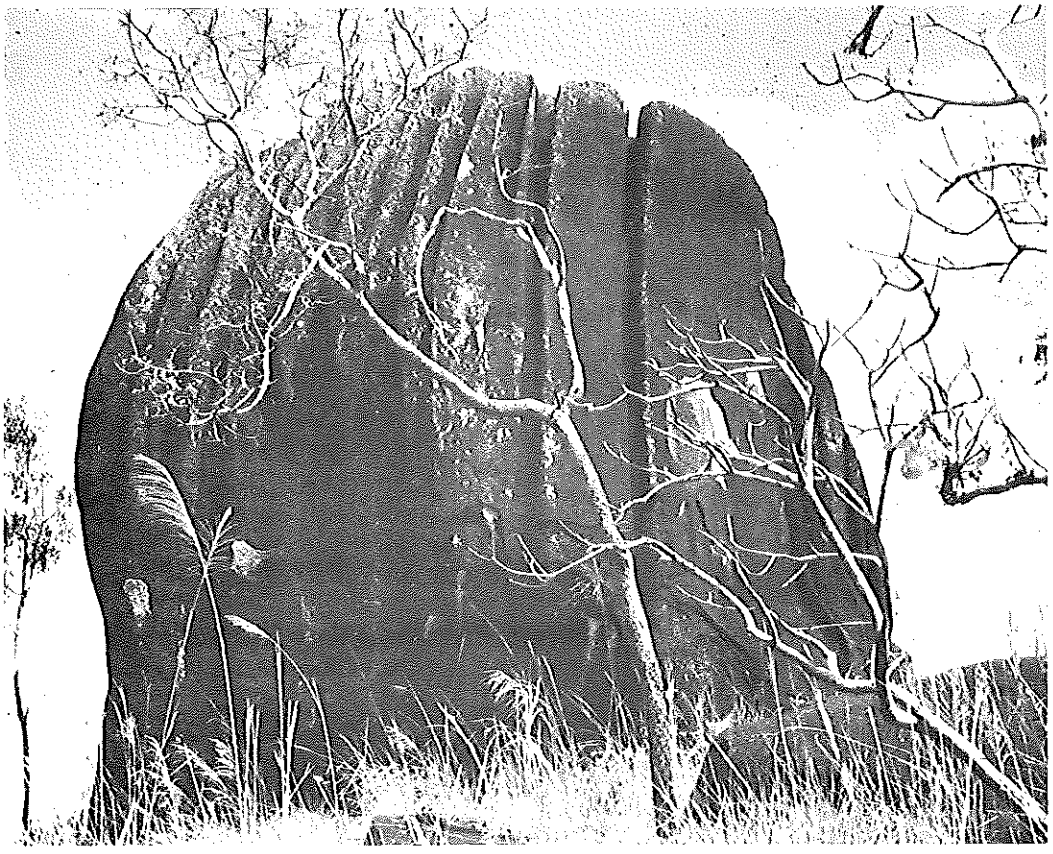
1.- Typical Sipaliwini-savanna landscape with scattered gnarled trees on the hills and "Maurisie"-palms in the depressions, while "gallery forest" accompanies the "Vier Gebroeders" creek which crosses the savanna. (Photo by F.C. Bubberman)



2.- The dome of the Morro Grande Inselberg rising above the regularly undulating, hilly peneplaned Morro Grande landscape. In the foreground and on more distant hill slopes: "forest islands". In the background to the North: the Frontier Mountain massif, an extension of the more eastern Tumuc Humac mountain range. (Photo by J.P. Schulz)

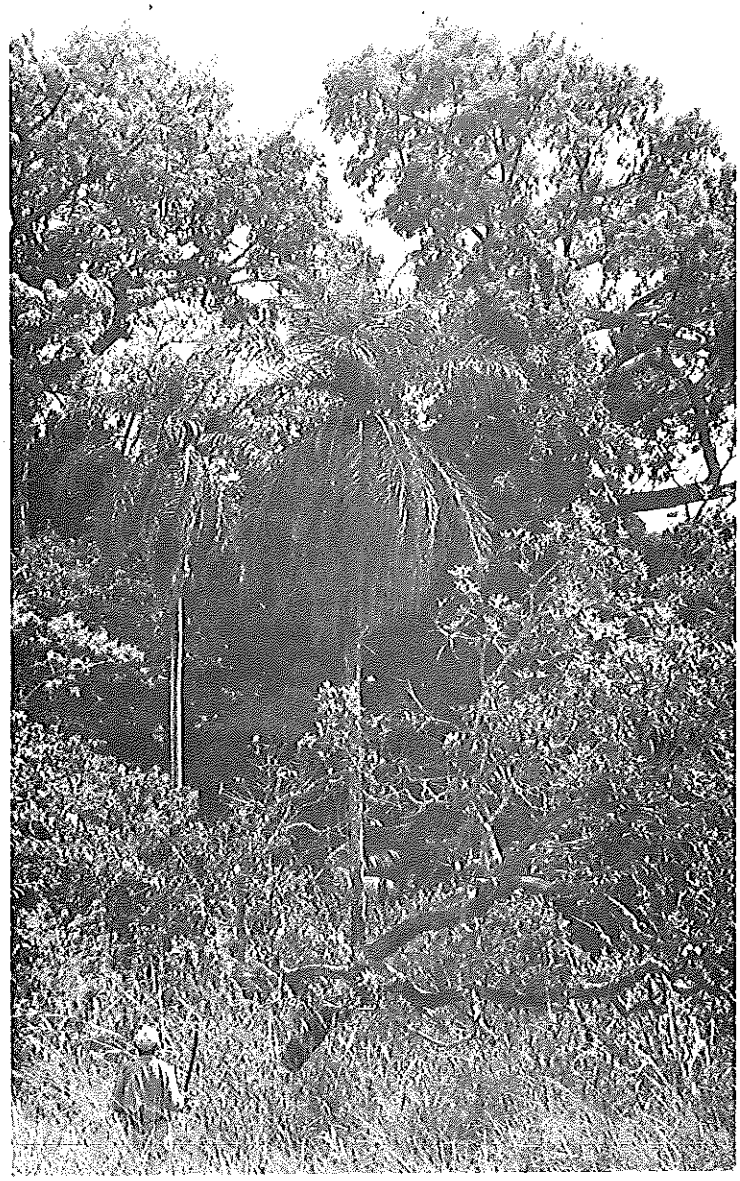


3.- The "Vier Gebroeders Inselberg" complex from the East.
In the depressions in the foreground and more distantly in the center: "Maurisie"-swamps and -forests. On the interfluvia typical open orchard savanna or "campo coberto" vegetation of scattered gnarled trees. (Photo by J.P. Schulz)



4.- An enormous, typically weathered "dragontooth".
The culms of the grass to the left are from Axonopus gentilis.
(Photo by J.P. Schulz)

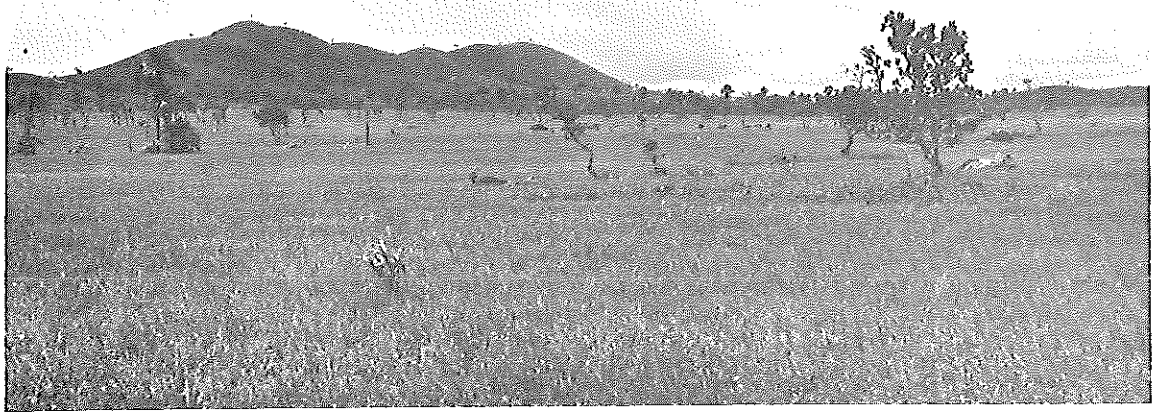
5.- A "lavaka" marks a collapsing steep hillslope illustrating the heavy physical and mechanical erosion processes to which the denudated landscape is subjected. (Photo by J.P. Schulz)



6.- The "forest border". The palms are of the species Acrocomia lasiospatha. The emergent crowns of the "kakantri": Ceiba pentandra. (Photo by J.P. Schulz)

7.- Small creek streaming openly through the savanna bordered by "Maurisie"-palms.
(Photo by J.P. Schulz)

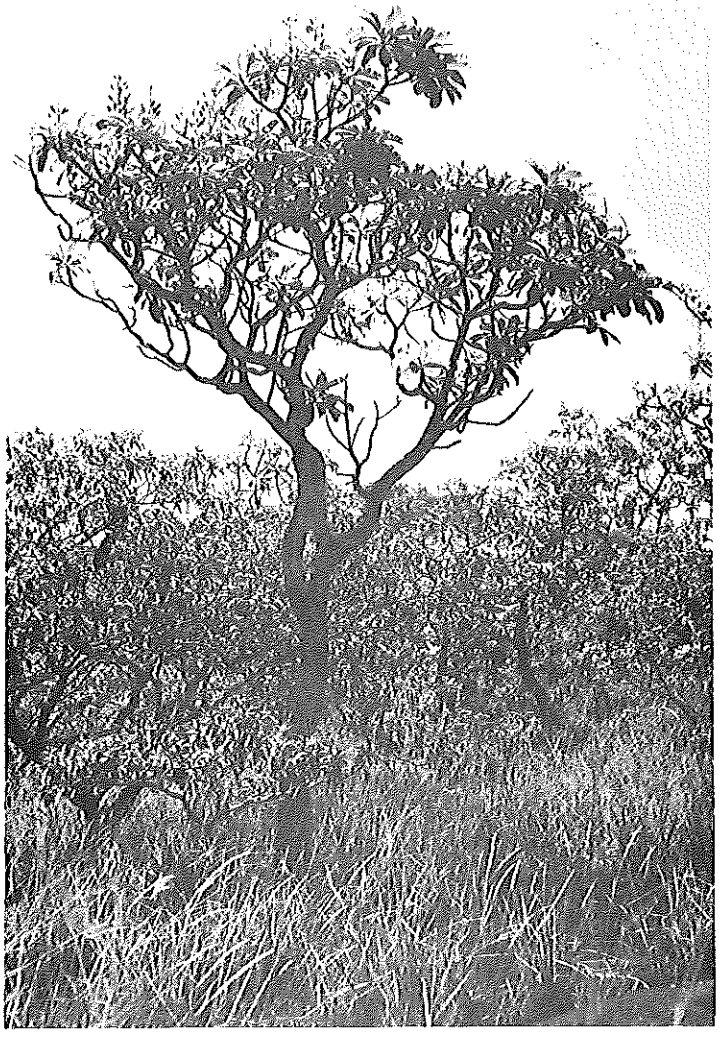
8.- "Campo coberto" or "covered plain" with regularly interspaced gnarled trees amongst which Salvertia convallariodora is dominant. The soil is denudated by recent fire. The black dots on the hillside are Bulbostylis spadicea, a Cyperacae and a typical pyrophyt.
(Photo by J.P. Schulz)



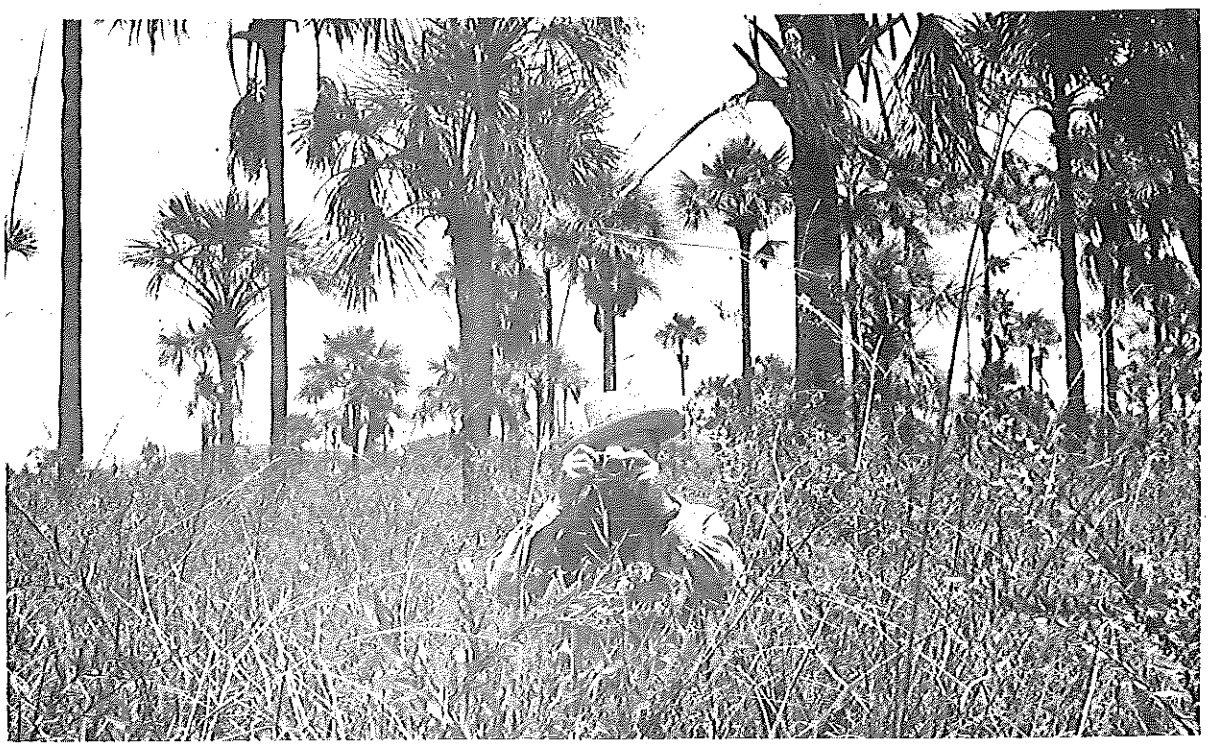
9.- "Campo limpo" or "pure open grassland" in a valley. The gnarled tree in the foreground on the right is Curatella americana. (Photo by F.H.F. Oldenburger)

10.- In the foreground a "Byrsonima orchard", an example of "campo sujo" or "shrub and small tree savanna". On the hill slope in the rear: "campo coberto". (Photo by J.P. Schulz)

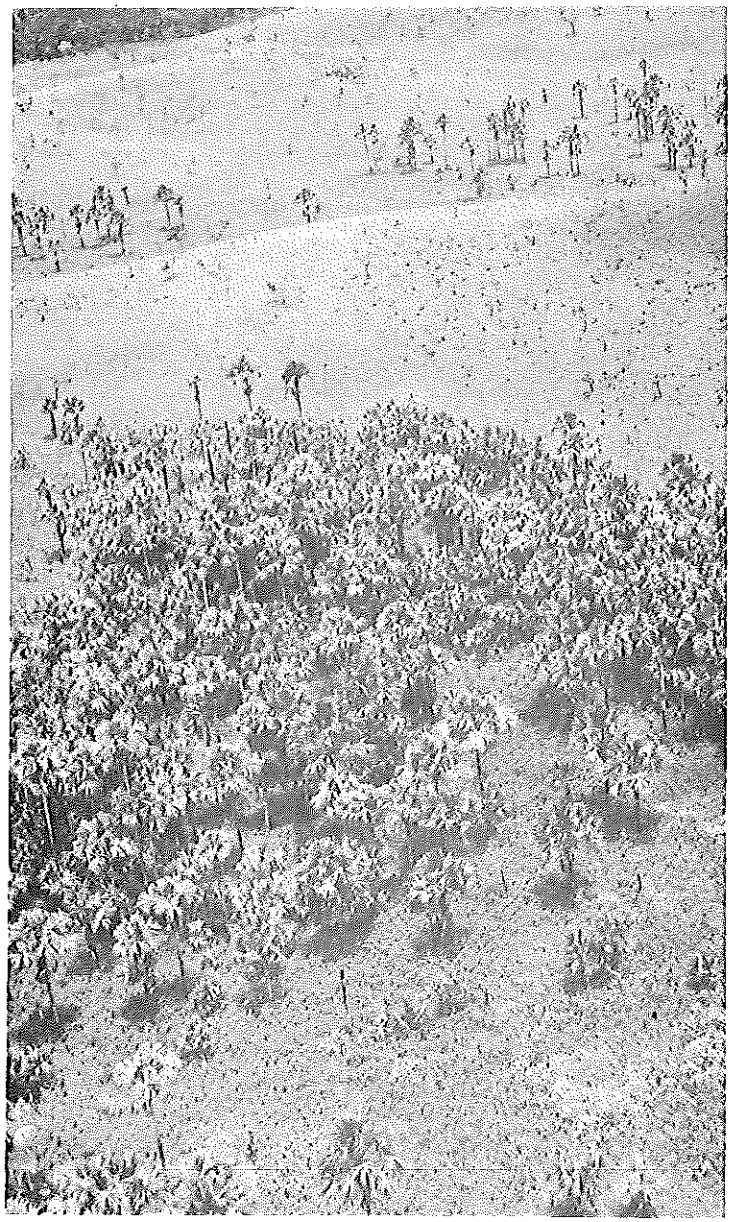
11.- "Campo sujo" or "dirty plain" with Dioclea guianensis shrubs in the foreground. The scorched stem of the gnarled tree to the right is of Curatella americana. (Photo by J.P. Schulz)



12.- "Campo cerrado" or "closed orchard savanna" with Salvertia convallariodora as dominant gnarled tree in the foreground. In the grass layer tall bunch-grass Trachypogon plumosus is dominant. (Photo by J.P. Schulz)



13.- Location between "kawfutu" and "Maurisie"-swamp. The flowering herby shrubs in front of the photographer are Ludwigia nervosa an Onagracae and a typical "Maurisie"-swamp species. (Photo by R. Norde)



14.- "Maurisie"-swamp grading to "Maurisie"-forest. On the other side of the hill in the background "kawfutu" grading to "Maurisie"-swamp shown by the interspacing of the "Maurisie"-palms. (Photo by F.C. Bubberman)

15.- Striking stone block with Amerindian engravings or petroglyphs on low hill overlooking the valley and transit area through which assumedly Amerindians migrated from the Amazon-West Paru basin to the Corantyne riversystem and vice-versa. (Photo by J.J. Janssen)