VEGETATION AND FLORA OF THE SAVANNAS IN THE BRINCKHEUVEL NATURE RESERVE, NORTHERN SURINAME

P. A. TEUNISSEN and J. T. WILDSCHUT

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CHAPTER I

INTRODUCTION

Suriname is situated in the tropical part of South America, between 2° and 6° N. Lat., and has the Atlantic Ocean as northern, Brasil as southern, Guyana as western and French Guiana as eastern boundaries.

South of the ca. 100 km wide coastal area (Demerara series and Coropina series, fig. 4) we find a belt with a relatively large number of savannas (Coesewijne series). Its width varies from 15 to 40 km.

South of this belt we find the Precambrian Guiana Shield with hills and low mountains. In the northern part of this Shield area lies the Brinckheuvel Nature Reserve (Natuurreservaat Brinckheuvel) (fig. 1).

In the Nature Reserve of about 60 square km there are about thirty savannas belonging to the Sabanpasi savanna area with a total of about 22 square km, the object of this study. There are gentle slopes and three low hills. COHEN and VAN DER EYK (1953), who classified the savannas in northern Suriname from a geological and pedological point of view, and whose classification we shall follow, reckon the savannas of the Sabanpasi savanna area as belonging to the Sabanpasi type. On the three low hills there are savannas of the Cassipora type and the Zanderij type (see fig. 4). The characteristics of these savanna types are extensively discussed in chapter II.

The savanna concept

There are various opinions with regard to the concept "savanna". The most recent description accompanied by a detailed argumentation we find with VAN DONSELAAR (1965):

> "A savanna or a campo is an area with a xeromorphic vegetation comprising an ecologically dominant ground layer consisting mainly of grasses, sometimes together with sedges, and with or without trees and/or shrubs either forming a more or less continuous layer, or occurring in groups, or isolated."

Besides areas corresponding to this definition we also included in our investigation savanna bushes and scrub without a ground layer or without an ecologically dominant ground layer, as the component species of these bushes and of this scrub often occur only on savannas (*Psychotria cordifolia, Tetrapteris squarrosa, Davilla aspera, Roupala montana, Doliocarpus calinea*, etc.), while other species which are also found in wood [1]) vegetation, often have a quite different habit on the savannas (*Antonia ovata, Licania incana, Marlierea montana, Clusia nemorosa*, etc.).

[1]) The term "wood" was defined by LINDEMAN (1953) as: "a 10–15 m high vegetation without distinct stratification of the trees".

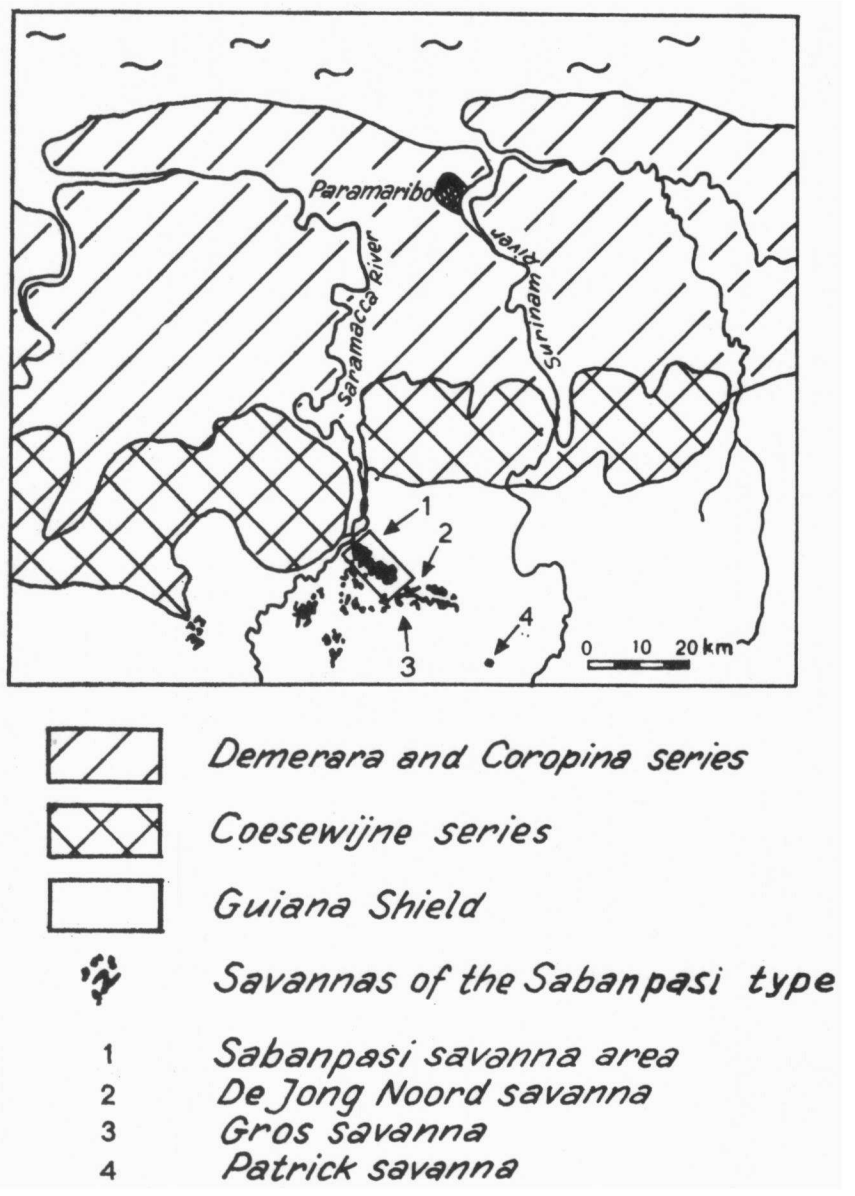

Fig. 1. Distribution of the savannas of the Sabanpasi type and situation of the Brinckheuvel Nature Reserve. (After SCHOLS and COHEN, 1953; COHEN and VAN DER EYK, 1953).

Wherever tall savanna scrub gradually merged into xerophytic wood, we drew the boundary line of the xerophytic wood there where straight stemmed tree growth became prevalent.

The study of the vegetation and flora of these savannas was carried out from August 1967 to February 1968.

CHAPTER II

ENVIRONMENTAL FACTORS

In analysing the factors influencing the origin, existence and maintenance of the savanna vegetations and determining their mutual differences, attention has been paid to precipitation and evaporation, to the soil condition (including hydrology) and to the influence of fires.

For general climatic data we refer to ALEWIJNSE (1963 and 1964), BRAAK (1935) and OSTENDORF (1953–1957).

§ 1: PRECIPITATION AND EVAPORATION

In Suriname dry and wet seasons are distinguished. The distinction is based only on the amount of rain.

a. a long rainy season — from middle March to mid August
b. a long dry season — from middle August to mid November
c. a short rainy season — from middle November to the end of January
d. a short dry season — from the end of January to mid March.

The length of these periods and the quantity of the rainfall in these periods differ from year to year. Figure 2 shows the average monthly rainfall in mm for the period 1931–1960; these figures were supplied by the Kwakoegron Observation Station (ALEWIJNSE, 1963). Kwakoegron is a bushnegro village situated on the Saramacca River, about 10 km

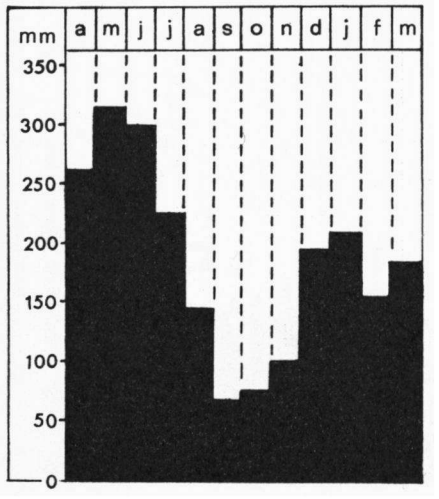

Fig. 2. Average monthly rainfall in mm (Kwakoegron). After figures of ALEWIJNSE (1963).

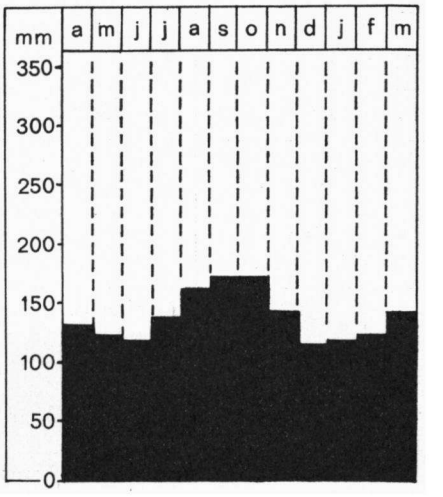

Fig. 3. Average monthly evaporation in mm (Paramaribo). After figures supplied by the Agricultural Experiment Station, Paramaribo.

north of the Brinckheuvel Nature Reserve. Rain figures from De Jong Noord (a small village of gold-miners, ca. 10 km south of the Brinckheuvel Nature Reserve), show the same picture (ALEWIJNSE, 1963).

Evaporation figures are available from Paramaribo only (Agricultural Experiment Station, Paramaribo, unpublished), calculated by the Penman formula and measured above an open water surface. Figure 3 shows the average monthly evaporation in mm for the period 1926–1940.

During the long dry season the evaporation will exceed the precipitation; during the rest of the year the precipitation will dominate.

§ 2: THE SOIL

For a better understanding of the edaphic factors it will be useful to start with a geological and geomorphological sketch of the Brinckheuvel Nature Reserve and its surroundings. A very simplified stratigraphic division of Suriname with its landscapes and savanna types, and a geological and geomorphological sketch were drafted from data supplied by COHEN and VAN DER EYK (1953), VAN DER EYK (1954), BRINCK (1956), MONTAGNE (1964) and O'HERNE (1966 and 1968).

Age	Stratigraphical unit	Landscape	Savanna type
Holocene	Demerara series		—
Eemian	Coropina series	Lelydorp	Watamaleo
Needian		Para	Welgelegen
Pliocene	Coesewijne series	Dek (=Cover-)	CASSIPORA ZANDERIJ Coesewijne
—			
Paleocene	Onverdacht series		—
U. Cretaceous	Nickerie series		
Precambrian 1700–1800 m.y.	Roraima formation	Plateau	Tafelberg
Precambrian 1800–2000 m.y.	Granite	Granite	Paroe
Precambrian > 2000 m.y.	Armina series	Schisthill	Bosland
	Rosebel series		
	Gros group	Sabanpasi- =Subgreywacke	SABANPASI
	Paramaka formation		
Archaic			

Fig. 4. Simplified stratigraphic division of Suriname. The savanna types which can be recognized in the Brinckheuvel Nature Reserve, are capitalised.

A. Geology

The Sabanpasi savanna area rests on rocks of the Precambrian Guiana Shield which extends over parts of the Guianas as far as the younger rock of the Brazilian Amazon basin in the south, and which in Venezuela dives below the young alluvial sediment of the Orinoco and extends further over a part of Colombia.

One of the three rock groups which can be distinguished in the Shield area consists of mainly metamorphous, sedimentary rocks (BRINCK, 1956). To this group belongs the Rosebel series, consisting of mostly coarse subgreywacke schists to subgreywacke conglomerates and, locally of phyllites and quartzites. A part of this series is called the Gros group (BRINCK, 1956).

The Gros group differs from the rest of the Rosebel series by its landscape type, the so-called Subgreywacke landscape or Sabanpasi landscape (BRINCK, 1956). With landscape here is meant an area which, owing to its geomorphological formation, forms a morphological unity characterized by a definite kind of rock and a definite range of soil condition and vegetation, typical of that area.

B. Geomorphology and soil

a. The Sabanpasi landscape

The Sabanpasi or Subgreywacke landscape is situated between the Saramacca River and the Surinam River and is bordered on the north by the line Kwakoegron – Berg en Dal and on the south by the line formed by the Brokolonko and Stonbroekoe hills, the Brownsberg and the northern edge of the Van Blommestein Lake.

The Sabanpasi landscape is characterized in its most typical part by a number of subgreywacke ridges with gentle slopes, running parallel to each other according to the strike of the rock (COHEN and VAN DER EYK, 1953 and VAN DER EYK, 1954).

In the centre of the ridges there is mostly one [1]) long fairly narrow rib (also on the strike of the rock) marked by a superficial layer of gravel.

[1]) COHEN and VAN DER EYK (1953), who described this area with the help of aerial photographs (see photo no. 1) mention a number of parallel ribs on every ridge, but this does not accord with our experiences in the field. On page 209 they give the following descriptions (translated):

> "Across the ridges just mentioned run low ribs, only a few meters wide, parallel to each other . . ."
>
> "Between these ribs and on either side of the large ridges soil profiles are found consisting of a colluvial topsoil . . ."
>
> "Both the residual ribs and the flat parts with a colluvial topsoil are covered with savannas, the former covered with a dense scrub and the latter quite open . . ."

It is true that the savanna bushes in large parts of the savannas as seen in the aerial photographs show parallel rows of dots in the strike of the rock (photo no. 1). However, it appeared to us in the field that there is only one rib per ridge (in one

These ribs are called gravel ribs or residual ribs. The gravel material, varying in diameter from 2 mm to 20 cm, is angular or rounded and is a remainder from the once overlying rock which contained quartz veins and/or pebbles, and which has disappeared through weathering and erosion.

There are mostly three kinds of soils found in the Sabanpasi landscape: residual soils (formed by the weathering of the parent rock in situ), colluvial soils (formed by material displaced over a short distance) and alluvial soils (formed by material transported over a great distance by creeks).

Residual soils are found in the Sabanpasi landscape on the above mentioned gravel ribs only. In these residual soils we find under the superficial layer of quartz material the subgreywacke. The latter is weathered in situ to loamy sand or sandy loam (containing kaolin), is often intersected by thick or thin quartz veins, and sometimes contains pebbles.

Colluvial soils. On either side of such a gravel rib, on the flanks of the ridges (VAN DER EYK, 1954: ridge feet) we find soil profiles consisting of a colluvial topsoil, mostly consisting of a more sandy material. The topsoil is in general softer to the touch (less structured), and is mostly separated by a layer of gravel from the residual subsoil.

Alluvial soils. Adjacent to the colluvial soil furthest away from such a rib is a strip of creek alluvium (VAN DER EYK, 1954: periodically submerged strip).

Both the residual soils (on gravel ribs) and the colluvial soils (on ridge flanks) are covered with savanna vegetation. Only the colluvial soil furthest away from the ribs is covered with xerophytic wood, whereas the adjacent strips of creek alluvium are covered with mesophytic forest (fig. 5).

Of the soils with savanna vegetation we examined five soil profiles more in detail.

b. The "Dek" (= cover) landscape

In the Sabanpasi savanna area we must mention as a geomorphological peculiarity the cover of white sand, about 6 m thick, on the flat tops of the Brinck Hill, the Klaiber Hill and the Lobles Hill (see vegetation map I). The sand is found in all these cases on unweathered subgreywacke rising above the level of the environment (see fig. 6).

case two). In many cases this rib is interrupted or is absent. On aerial photographs the most central and mostly much wider row of dots on a ridge represents the scrub on a residual rib, the remaining, often narrower, parallel rows of dots representing savanna bushes and scrubs on the ridge flanks with their colluvial topsoil. From borings it soon appeared that the gravel layer under the colluvial packet shows folds, running parallel to the rib. Where the colluvial packet is thickest there are savanna bushes whereas in the thinner parts we find an open vegetation. See fig. 5 and vegetation map II, strip C.

VAN KOOTEN (1954) supposes that the sand caps are the remains of a sediment deposited at a higher level, and that the sand-cover in former times will have occupied a greater surface than at present.

On the ground of an analysis of the grains which form the sand cap of the Brinck Hill a parallel may be drawn between these sands and the white sands of the Coesewijne series (VAN KOOTEN, 1954). COHEN and VAN DER EYK (1953) regard these landscapes as small isolated representations of the Coesewijne series, which is found on the Precambrian Guiana Shield. Since superfluous precipitation on these sand caps is immediately carried off, the latter are considered to belong to the dry white sand soils, and therefore the savannas belong to the Cassipora type. Savannas of this type are generally scrub savannas called "moeri-moeri" (COHEN and VAN DER EYK, 1953).

The rainwater, that soon soaks through the white sand to the unweathered subgreywacke, is carried off sideways and reappears at the surface in various places at the foot of the white sand cap. During the greater part of the year the thin layer of white sand at the base of the cap is wet and this sand therefore produces savannas of the Zanderij type.

The hillsides of the three hills are still wooded in so far as they have

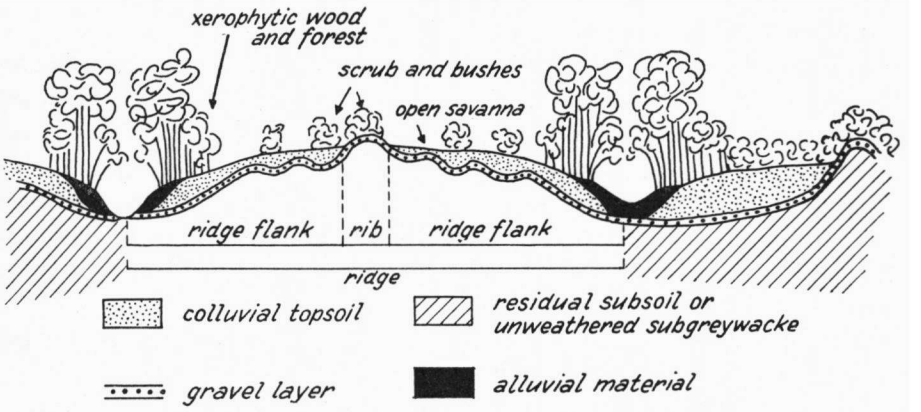

Fig. 5. Cross section of the Sabanpasi landscape (sketch).

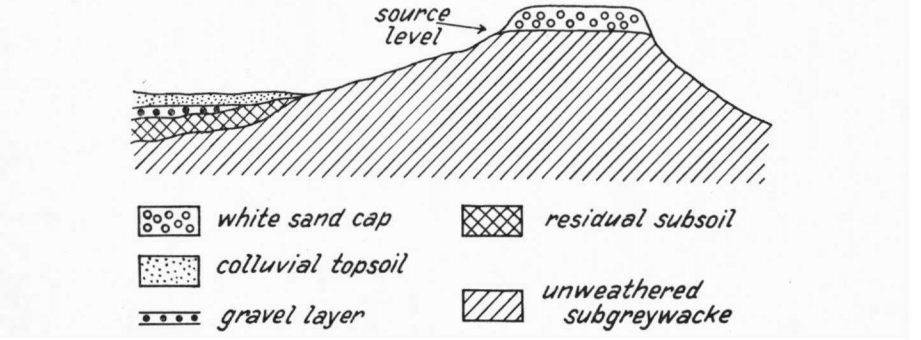

Fig. 6. Cross-section sketch of the Brinck Hill (VAN KOOTEN, 1954).

not been denuded down to the subgreywacke rock. The subgreywacke which appears here at the surface, is not strongly consolidated and easily crumbles apart. Therefore erosion is very rapid here (WIGGERS, 1956). As a result there are numerous eroded furrows in the strike of the rock, also erosion gullies, small oriçangas (circular basins) and table-shaped remains. We examined in detail two soil profiles of the white sand cap of the Brinck Hill.

c. Soil profiles

1) Methods

First a general pedological survey of the savanna area was carried out by means of a number of borings along lines. Later on, between 13th and 17th January 1968, J. A. Druiventak, cartographer of the Department of Soil Survey, Paramaribo, described and sampled the soil profiles of seven pits in plots bearing representative samples of recognized plant communities.

Besides the granular composition, the following soil factors were determined and described in the field, after methods mentioned by SLAGER (1966):

- location and vegetation of the profiles (see fig. 7)
- thickness of the horizons
- soil colours by means of Munsell Soil Color Charts (Munsell Color Company Inc., Baltimore, U.S.A.)
- moisture content (because the humidity of the soil is important for the soil colour)
- the texture was determined at the Pedological Laboratory of the Royal Institute for Research in the Tropics, Amsterdam, by boiling with peroxide, dispersing with Na-pyrophosphate and Na-bichromate, fractions 2000–200 μ and 200–50 μ by sifting (wet), fraction 50–20 μ by calculation, fractions 20–2 μ and $< 2\ \mu$ by precipitation, pipetting, drying and weighing (see fig. 8)
- the textural classes by means of the textural diagram in the Soil Survey Manual (1951)
- the content of organic matter by adding a drop of peroxide (30%) to a soil sample:
  smoking and frothing: much organic matter,
  frothing only: moderate quantity of organic matter
  neither smoking nor frothing: little organic matter or none
- the structure and consistence in terms of the Soil Survey Manual (1951) and SLAGER (1966)
- the mottling in terms of the Soil Survey Manual (1951) and SLAGER (1966)
- the acid value by means of the Truog Soil Reaction test with Hellige reagent (Hellige no. 697–27 Triplex Indicator, Hellige Inc., New York, U.S.A.)

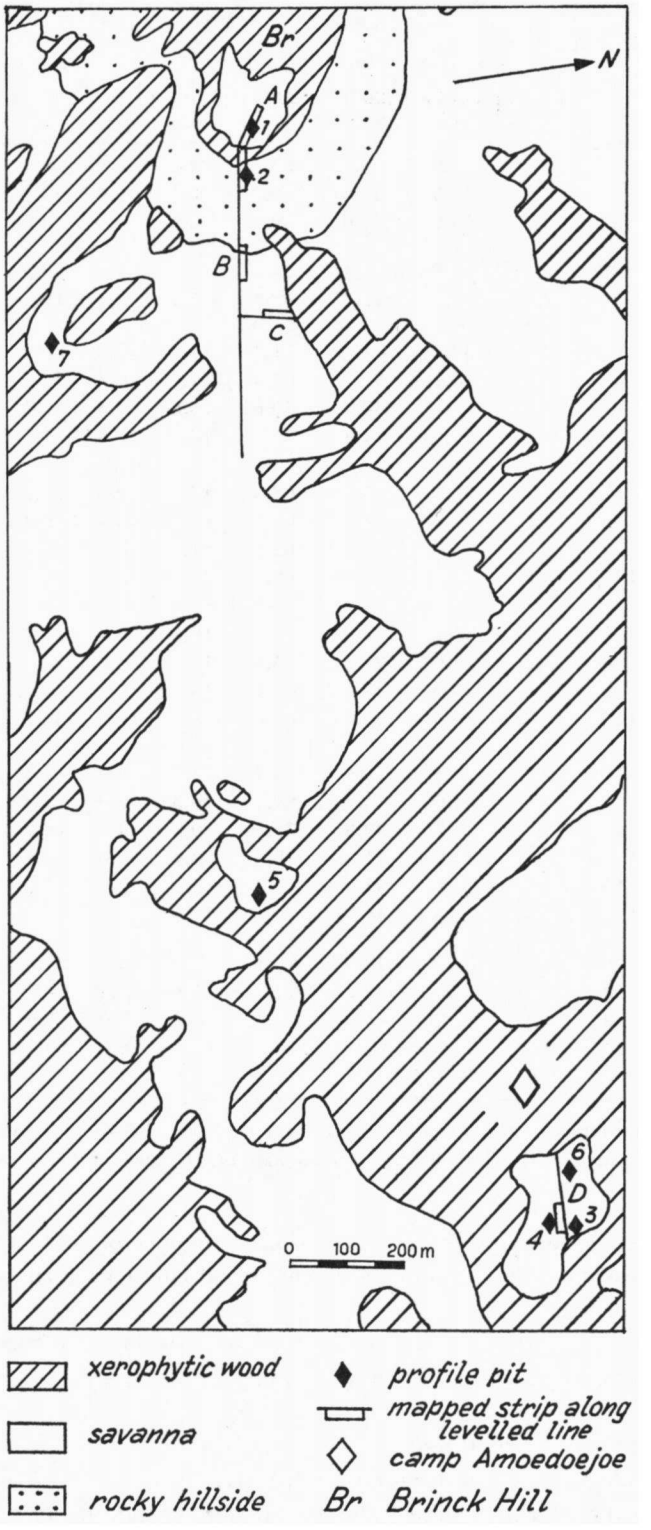

Fig. 7. Locality of profile pits, levelled lines and mapped strips.

Profile nr.	Depth in cm	Gravel > 2000 μ	Sand			Silt			Clay < 2 μ	Textural classes
			coarse	fine	total			total		
			2000–200 μ	200–50 μ	2000–50 μ	50–20 μ	20–2 μ	50–2 μ		
P1	0– 14	2,1	79,2	16,6	95,8	3,0	0,0	3,0	1,2	s
	14– 33	0,9	74,3	21,9	96,2	3,2	0,0	3,2	0,6	s
	33–200	4,7	75,2	21,0	96,2	3,0	0,0	3,0	0,8	s
P2	0– 8	8,4	46,0	28,1	74,1	15,8	7,7	23,5	2,4	ls
	8– 16	37,8	75,5	12,6	88,1	7,7	2,4	10,1	1,8	s
P3	0– 20	72,6	30,4	41,0	71,4	17,3	7,9	25,2	3,4	sl
	20– 55	5,8	33,7	35,7	69,4	14,0	8,4	22,4	8,2	sl
	55– 91	2,3	36,7	33,9	70,6	18,6	7,8	26,4	3,0	sl
	91–150	2,0	46,6	24,4	71,0	16,4	10,6	27,0	2,0	sl
P4	0– 15	69,1	32,9	35,4	68,3	14,3	9,8	24,1	7,6	sl
	15– 45	1,7	32,2	33,0	65,2	16,2	13,4	29,6	5,2	sl
	45– 75	0,9	33,6	28,6	62,2	21,2	13,2	34,4	3,4	sl
	75–135	25,2	35,0	27,7	62,7	21,5	13,0	34,5	2,8	sl
P5	0– 17	1,4	33,1	42,8	75,9	16,3	4,4	20,7	3,4	ls
	17– 25	25,7	48,6	27,2	75,8	14,4	3,6	18,0	6,2	sl
	25– 37	1,3	35,0	27,7	62,7	15,7	10,8	26,5	10,8	sl
	37–143	0.3	39,6	20,4	60,0	16,2	16,2	32,4	7,6	sl
P6	0– 10	0,8	36,3	45,4	81,7	11,1	2,2	13,3	5,0	ls
	10– 25	0,7	35,6	45,9	81,5	10,3	2,0	12,3	6,2	ls
	25– 47	0,9	39,7	39,8	79,5	10,3	2,6	12,9	7,6	ls
	47–102	0,5	37,0	41,8	78,8	9,4	2,6	12,0	9,2	sl
	102–116	27,2	34,1	41,3	75,4	12,2	3,6	15,8	8,8	sl
	116–150	4,8	32,5	44,9	77,4	12,2	1,6	13,8	8,8	sl
P7	0– 25	0,5	29,3	40,8	70,1	19,3	6,2	25,5	4,4	sl
	25– 50	0,3	37,6	33,6	71,2	15,8	8,4	24,2	4,6	sl
	50– 80	0,9	33,2	46,5	79,7	15,9	1,0	16,9	3,4	ls
	80–116	0,6	32,6	40,5	73,1	18,1	2,0	20,1	6,8	sl
	116–140	0,6	29,7	42,4	72,1	16,7	3,4	20,1	7,8	sl

Fig. 8. Granular composition in per cent over textural classes. (s = sand, sl = sandy loam, ls = loamy sand). The gravel percentage of the gravel layer is bold-faced.

- the biological activity by means of the occurrence of roots and biopores (= channels made by roots and soil organisms) in terms of SLAGER (1966)
- the kind of boundary between two horizons, in terms of SLAGER (1966)
- indirect data regarding the hydrology.

2) Description of soil profiles

The profile pits are numbered P1 to P7.

The locality of the profiles, the vegetation found in connection with

them and that in the immediate neighbourhood (in code) are mentioned below. Furthermore are mentioned the granular composition and textural classes of the profile horizons and the descriptions of the soil profiles.

Profile number	Locality of the profiles (see fig. 7)	Vegetation in code	Vegetation in the neighbourhood in code
P1	white sand cap Brinck Hill	I.1	I.2
P2	source level Brinck Hill	II.1a	—
P3	top high gravel rib	IV.2	IV.1a
P4	basis high gravel rib	IV.1b	IV.2
P5	gently sloping ridge flank with a thin packet of colluvial material	V.2c	V.3c and V.1
P6	gently sloping ridge flank with a thick packet of colluvial material	V.3b	—
P7	water course	V.2a	V.3a

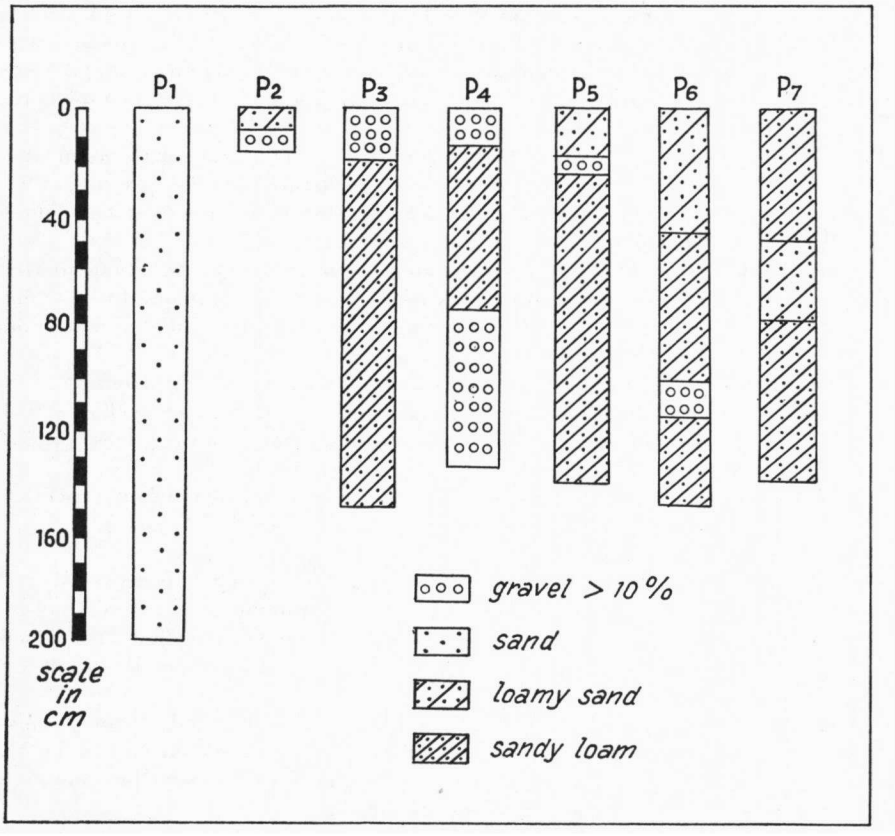

Fig. 9. Soil profiles based on textural classes.

P1 0– 14 cm black (2.5Y 2/0), moist to dry sand with much organic matter (carbonized wood); single grain, loose; pH 4.5; a few roots and rootlets; gradual and smooth on:

14– 33 cm grayish brown (2.5Y 5/2), dry sand with common to few organic matter; single grain, loose; pH 4.5; a few roots and rootlets; abrupt and wavy on:

33–200 cm white (2.5Y 8/0), dry sand; single grain, loose; pH 6.0; scarcely any roots and rootlets.

P2 0– 8 cm black (2.5Y 2/0), wet loamy sand with much organic matter; single grain, loose; many fine rootlets; gradual and smooth on:

8– 16 cm black (2.5Y 2/0) wet gravelly sand with much organic matter; single grain, loose; many fine rootlets; abrupt and wavy on rocky subgreywacke.

P3 0– 20 cm (see photo 9) pale brown (10YR 6/3), moist gravelly sandy loam with common to few organic matter; single grain, loose; pH 4.5; many roots and rootlets, many fine biopores; abrupt and smooth on:

20– 55 cm yellow (10YR 7/6), moist sandy loam; no macrostructure, very friable; pH 5.5; a few faint, fine, reddish yellow (7.5YR 6/8) mottles; scarcely any roots and rootlets, abundant fine biopores; gradual and wavy on:

55– 91 cm very pale brown (10YR 8/5), moist sandy loam; no macrostructure, very friable; pH 6.6; common, distinct, coarse, reddish yellow (5YR 6/8) and pinkish gray (5YR 7/2) mottles; scarcely any roots and rootlets, many fine biopores; diffuse on:

91–150 cm white (2.5Y 8/0), moist sandy loam; no macrostructure, very friable; abundant, prominent, coarse, light red (2.5YR 6/8) mottles; pH 6.0; scarcely any roots and rootlets, many fine biopores; 137–140 cm.: quartz vein.

P4 0– 15 cm brown (10YR 5/3), moist gravelly sandy loam with common to few organic matter; no macrostructure, friable; pH 4.5; a few faint, fine, yellow (10YR 7/8) mottles; many fine rootlets, common fine biopores; clear and wavy on:

15– 45 cm white (2.5 Y 8/0), moist sandy loam with very few organic matter; no macrostructure, very friable; pH 5.5; common, distinct, fine, yellow (10YR 7/8) mottles; scarcely any rootlets, many fine biopores; gradual and smooth on:

45– 75 cm white (2.5Y 8/0), moist sandy loam; no macrostructure, very friable; pH 5.5; common, distinct, fine to medium, yellow (10YR 7/8) mottles; scarcely any rootlets, many fine biopores; gradual and smooth on:

75–135 cm white (2.5Y 8/0), moist sandy loam; massive, friable; pH 5.5; scarcely any rootlets, many fine biopores;
130–132 cm.: quartz vein.

P5 0– 17 cm (see photo 14) pale brown (10YR 6/3), moist loamy sand with common organic matter; very weak granular to no macrostructure, friable; pH 6.0; a few, faint, fine, brownish yellow (10YR 6/8) mottles; a few roots and rootlets, a few fine biopores; abrupt and wavy on:

17– 25 cm very pale brown (10YR 8/3), moist gravelly sandy loam; massive and friable; pH 6.0; abundant, distinct, medium, yellow (10YR 7/8) mottles; scarcely any roots and rootlets, many fine and large biopores; clear and smooth on:

25– 37 cm very pale brown (10YR 7/3), moist sandy loam; massive and friable; pH 5.5; common, distinct, medium, brownish yellow

(10YR 6/8) and red (2.5YR 4/8) mottles; scarcely any roots and rootlets, many fine biopores; clear and smooth on:

37–143 cm white (10YR 8/2), moist to wet sandy loam; massive to weak medium prismatic, friable to slightly sticky non plastic; pH 5.5; common, distinct, medium, brownish yellow (10YR 6/8) and many prominent, coarse, red (10R 4/6) vertically elongated, sometimes hardened mottles; scarcely any roots and rootlets, common fine biopores.

P6 0– 10 cm (see photo 15) brown (10YR 5/3), moist loamy sand with common organic matter; weak (very) coarse granular to massive, friable; pH 4.5; many rootlets, common fine biopores; gradual and smooth on:

10– 25 cm pale brown (10YR 6/3), moist loamy sand with few organic matter; no macrostructure to weak medium sub-angular blocky, friable; pH 6.0; a few faint, fine, brownish yellow (10YR 6/8) mottles; a few roots and many rootlets, common fine and a few large biopores; gradual and smooth on:

25– 47 cm very pale brown (10YR 7/3), moist loamy sand; no macrostructure, very friable; pH 6.0; common, distinct, medium, yellow (10YR 6/8) mottles; a few roots and rootlets, many fine and a few large biopores; diffuse on:

47–102 cm very pale brown (10YR 7/4), moist sandy loam; no macrostructure, very friable; pH 6.0; a few roots and rootlets, common fine and common large biopores; abrupt and smooth on:

102–116 cm yellow (10YR 7/6), moist gravelly sandy loam; no macrostructure, very friable; pH 5.5; a few roots and rootlets, a few fine biopores; abrupt and smooth on:

116–150 cm yellow (10YR 7/8), moist sandy loam; no macrostructure, very friable; pH 5.5; common, distinct, medium, strong, brown (7.5YR 5/8) mottles; a few roots and rootlets, a few fine biopores.

P7 0– 25 cm pale brown (10YR 6/3), moist sandy loam with few organic matter; moderately medium to coarse prismatic, friable; pH 4.5; many roots and rootlets, a few fine and a few large biopores; clear and wavy on:

25– 50 cm very pale brown (10YR 8/3), moist sandy loam; single grain, very friable; pH 5.5; a few distinct, fine, brownish yellow (10YR 6/8) mottles; scarcely any roots and rootlets, a few fine and a few large biopores; clear and wavy on:

50– 80 cm very pale brown (10YR 8/3), moist loamy sand; single grain, very friable; pH 5.5–6.0; many coarse, prominent, brownish yellow (10YR 6/8) mottles; scarcely any roots and rootlets, many fine biopores; gradual and smooth on:

80–116 cm very pale brown (10YR 8/3), moist sandy loam, no macrostructure, very friable; pH 5.5–6.0; many coarse, prominent, brownish yellow (10YR 6/8) and a few, medium, distinct, yellowish red (5YR 5/6) mottles; scarcely any roots and rootlets, many fine biopores; gradual and smooth on:

116–140 cm white (2.5Y 8/0), moist sandy loam; massive and friable; pH 6.0; many coarse, prominent, strong, brown (7.5YR 5/6) mottles; scarcely any roots and rootlets; many fine biopores.

3) Hydrology

– Savanna-vegetation bearing soils of the "Dek" (= cover) landscape:

In general the white sand caps of the hills are well drained (VAN KOOTEN, 1954). Because the rainwater sinks down at once to the unweathered subgreywacke and is carried off sideways via the source level (a circle of springs), the white sand caps are never very wet. There is neither an extremely dry nor an extremely wet condition of the soil.

At the source level of the three hills we find a very thin wet layer of strongly to weakly humic sand, which may remain moist till late in the dry season but finally dries up. Therefore there is here an alternation of extremes, viz. of extremely dry and extremely wet.

– Soils of the Sabanpasi landscape, bearing a savanna vegetation:

COHEN and VAN DER EYK (1953) give characteristic soil profiles of the savanna-vegetation bearing parts of the subgreywacke ridges in which under the gravel layer the subgreywacke is found to be weathered to a kaolin-like clay.

When prospecting for diamond on the Sabanpasi savannas VAN KOOTEN (1954) observed that the bedrock is not infrequently weathered to an often white mass that feels like clay, of which he supposes that it partly consists of kaolin.

Prof. Dr. A. J. Wiggers, who, during the long rainy season of 1956, was engaged in geomorphological research in the Sabanpasi savanna area, reported that during heavy rains the water for the most part runs off the gently sloping ridge flanks along the surface down to the creek valleys carrying sand and loam down with it (sheet erosion) (personal information). As our investigation took place mainly during a long dry season and a short rainy season with hardly any precipitation, we were unable to ascertain this phenomenon. However, it did strike us that on the ridge flanks, especially in the immediate neighbourhood of the savanna bushes, the surface on the side furthest from the gravel ribs, was not infrequently covered with dried out *Algae*, whereas in places where the water would be able to flow unimpeded to the creek valleys this cover was mostly absent. On the latter places *Cyperaceae*, like *Rhynchospora rhizomatosa* and *Lagenocarpus tremulus*, were found with the rhizomes protruding above the soil surface, apparently because they were washed clean by running water. Near the borders of woods, on the other hand, partially buried vegetation was not infrequently observed.

After a few showers during the last weeks of the investigation the following facts were observed. When digging little pits in the gently sloping ridge flanks which were covered with a thin packet of colluvial material, this packet always appeared saturated with water while the residual subsoil had remained bone dry. The pits were subsequently seen to fill up with water from the colluvial topsoil. They then remained filled up to the height of the gravel layer even after days without preci-

pitation, whereas a few meters away from the pits at the same time no more ground water was found.

The above mentioned observations indicate that when the subgreywacke is weathered in situ it is hardly permeable and in any case unable to absorb quickly the large quantities of rainwater in the rainy seasons. The colluvial topsoil, which generally is sandier and shows less structure (WIGGERS, 1956) is better able to do so but as this packet usually is thin, it is soon saturated and soon dries up again.

Profile P5 (photo 14) can be attributed to such a hydrology as described above. The stains in the residual subsoil of this profile may, according to personal information by Prof. Wiggers, be fossil, dating from the time when this residual soil came into existence under other than the now prevailing circumstances.

It should be remarked that profiles like P5 may be expected throughout large parts of the Sabanpasi savanna area as the type of vegetation found on this soil type is very widely spread. COHEN and VAN DER EYK (1953) give a similar profile as an example of the savanna-bearing parts of the ridge flanks.

The descriptions of the profiles P3, P4 and P6 (see also photo 15) do not make it clear whether the residual soil material is permeable or not. These three profiles are found very close together on a small savanna. The whole area is covered with thick scrub accompanied by a few isolated trees.

Profile P7 is characterized by the occurrence of "kawfoetoes", i.e. configuration of up to 15 cm high hummocks of the topsoil, separated by more or less deep channels (hog-wallow structure). Kawfoetoes, literally meaning "cow feet", are formed on low lying, flat stretches where during the wet season stagnant or hardly moving water forms pools. They are said to be built up by worms in and around grass tufts (VAN DER VOORDE, 1957). Kawfoetoes occur in the Sabanpasi savanna area in watercourses and hollowed-out parts of the savannas, especially near wood borders.

C. Fires

In view of the primitive agricultural methods of the Indians and Bushnegroes (preparing fields for food-growing by chopping down and burning forest plots and of burning xeromorphic vegetation for hunting or purely for pleasure), it should be realized that wherever there is evidence of human habitation, this habitation was probably accompanied by the destruction of the original vegetation in the neighbourhood.

VAN KOOTEN (1954) reports that in various localities of the Sabanpasi savanna area, both in the gravel layer and in the colluvial and alluvial material, remains have been found such as potsherds, grindstones and partially carbonized wood, presumably originating from Indian settlements.

Through the Brinckheuvel Nature Reserve the Mindrineti River flows.

The name "Mindrineti" literally means "Midnight" and is said to be derived from the fact that in the 18th century numerous maroon settlements (villages built by runaway slaves) were attacked and burnt down here by a military patrol at midnight.

In the area along the State Railway between km 93 and km 133, near but not in the Nature Reserve, are numerous remains of gold explorations and gold exploitations in the shape of open quarries, tunnels, machine parts, boilers, narrow-gauge railroad tracks, dredgers, foundations, etc., dating from the beginning of this century. We ourselves found in the Nature Reserve a square bottle (= case bottle or Dutch gin bottle) dating from the end of the 19th century (KLEIN, 1966), i.e. from the initial period of the gold explorations.

The name "Sabanpasi" literally means "savanna path" and is said to indicate a path which, at the time of gold concessions, led from the then much larger village Sabanpasi on the Saramacca River to the area of the gold concessions.

WIGGERS (1956) reports traces of fires, partially due to the activity of the employees of the Geological and Mining Service, Paramaribo, who, during Van Kooten's prospecting for diamond in 1953, burned down large parts of the vegetation of the Brinck Hill and the Lobles Hill. Wiggers also came upon traces of fires dating from earlier periods.

The few gold-seekers who are still living by the railway do no longer set fire to the vegetation in the Sabanpasi savanna area since this has become a Nature Reserve in 1961.

During our investigation we found traces of fire mentioned above and, moreover, we found to the north of the Goboj-creek traces of a fire which must have raged in 1965 or 1966, and which probably was caused by the inhabitants of the Sabanpasi village as the latter have their food-growing fields close to the northern boundary of the Nature Reserve.

The presence of some small isolated circular xerophytic woods on the savannas and of rough, almost impenetrable scrub with a few isolated trees also indicates, in our opinion, the occurence of field fires in earlier periods.

It should be remarked that savanna fires will generally be restricted to only one savanna.

Although BRAAK (1935) gives 151 days of thunder-storm per annum for the Brinckheuvel area, no field fires caused by lightning have ever been reported.

CHAPTER III

THE FLORA

§ 1: LIST OF SPECIES FROM THE SABANPASI SAVANNA AREA (WITH REMARKS ON THE PHENOLOGICAL CONDITIONS PREVAILING DURING THE PERIOD AUGUST 1967 – JANUARY 1968)

Ca. 245 species were collected, among them 11 *Pteridophyta*, 8 *Bryophyta* and 6 *Lichenes*. Two complete sets were collected of which one has been deposited in the Botanical Museum and Herbarium of the State University of Utrecht and one in the Herbarium of the Surinam Forest Service at Paramaribo.

To denote the phenological conditions the following code was used:

v = only found in the vegetative state
fl = found at least once flowering
fr = found at least once bearing fruit
flr = found at least once flowering and at least once bearing fruit
sp = found at least once bearing spores
juv = only found in the juvenile state.

SPERMATOPHYTA

Anacardiaceae	
Anacardium occidentale L.	flr. shrub
Tapirira guianensis Aubl.	flr. tree
Annonaceae	
Guatteria schomburgkiana Mart.	fr. shrub
Xylopia frutescens Aubl.	v. tree
Apocynaceae	
Mandevilla subspicata (Vahl) Mgf.	fl. twiner
Odontadenia geminata (R. et S.) Müll. Arg.	fl. twiner
Aquifoliaceae	
Ilex jenmani Loesener	flr. tree
Araceae	
Philodendron scabrum K. Krause	v. epiphyte
Arecaceae	
Bactris campestris Mart.	flr. shrub
Mauritia flexuosa L. f.	flr. tree
Asclepiadaceae	
Gonolobus ligustrinus Dcne.	fl. twiner
Tassadia propinqua Dcne.	v. twiner

Asteraceae	
Melampodium camphoratum (L. f.) Baker	flr. herb
Bombacaceae	
Bombax flaviflorum Pulle	flr. tree
Bromeliaceae	
Aechmea bromeliifolia (Rudge) Baker	fl. epiphyte
Ananas comosus Merr.	v. terrestrial
Catopsis cf. *sessiliflora* (R. et P.) Mez	v. epiphyte
Tillandsia anceps Lodd.	fl. epiphyte
Tillandsia bulbosa Hook.	fr. epiphyte
Tillandsia flexuosa Sw.	fl. epiphyte
Tillandsia paraënsis Mez	fl. epiphyte
Tillandsia pulchella Hook. var. *surinamensis* Mez	fl. epiphyte
Burmanniaceae	
Burmannia bicolor Mart.	fl. herb
Burmannia capitata (J. F. Gmel.) Mart.	fl. herb
Burseraceae	
Protium heptaphyllum (Aubl.) March.	fl. tree
Trattinickia burserifolia Mart.	fr. tree
Celastraceae	
Goupia glabra Aubl.	v. tree
Maytenus oblongata Reiss.	fl. shrub
Clusiaceae	
Calophyllum brasiliense Camb.	fl. tree
Clusia fockeana Miq.	flr. shrub
Clusia grandiflora Splitg.	flr. epiphytic shrub
Clusia nemorosa G. F. W. Meyer	flr. shrub
Clusia cf. *palmicida* L. C. Rich. ap. Pl. et Tr.	v. shrub
Platonia insignis Mart.	fl. tree
Vismia cayennensis (Jacq.) Persoon	fl. tree
Connaraceae	
Rourea surinamensis Miq.	v. liane
Cyperaceae	
Bulbostylis circinata Kunth	flr.
Bulbostylis conifera Kunth	flr.
Bulbostylis fasciculata Uitt.	flr.
Bulbostylis junciformis (H.B.K.) Kunth	flr.
Bulbostylis lanata (H.B.K.) Clarke	flr.
Bulbostylis spadicea Kük.	flr.
Bulbostylis surinamensis Uitt.	flr.

Bulbostylis vestita Kunth	flr.
Cyperus chalaranthus Presl	flr.
Cyperus ligularis L.	flr.
Diplacrum guianense (Nees) T. Koyama	flr.
Hypolytrum pulchrum (Rudge) Pfeiff.	flr.
Lagenocarpus amazonicus (Clarke) Pfeiff.	flr.
Lagenocarpus tremulus Nees	flr.
Lagenocarpus weigeltii (Spreng.) Uitt.	flr.
Rhynchospora barbata (Vahl) Kunth var. *barbata*	flr.
Rhynchospora barbata (Vahl) Kunth var. *glabra* Maury	flr.
Rhynchospora caracasana (Kunth) Boeck.	flr.
Rhynchospora cephalotes (L.) Vahl	flr.
Rhynchospora curvula Griseb.	flr.
Rhynchospora globosa (H.B.K.) R. et S.	flr.
Rhynchospora graminea Uitt.	flr.
Rhynchospora rhizomatosa Lindeman ined.	flr.
Rhynchospora tenuis Link	flr.
Rhynchospora sp. nov. LBB 12185	flr.
Scleria bracteata Cav.	flr.
Scleria cyperina Willd. ex Kunth	flr.
Scleria martii (Nees) Steud.	flr.
Dilleniaceae	
Davilla aspera (Aubl.) R. Ben.	fl. shrub
Davilla LBB 11941	v. shrub
Doliocarpus calinea J. F. Gmel.	fl. shrub
Tetracera asperula Miq.	flr. shrub
Droseraceae	
Drosera capillaris Poir.	flr. herb
Drosera intermedia Hayne	flr. herb
Eriocaulaceae	
Paepalanthus bifidus (Schrad.) Kunth	fl. herb
Paepalanthus polytrichoides Kunth fma. *villosus* Moldenke	fl. herb
Paepalanthus subtilis Miq.	fl. herb
Syngonanthus glandulosus Gleason	fl. herb
Syngonanthus gracilis (Bong.) Ruhl.	fl. herb
Syngonanthus umbellatus (Lam.) Ruhl.	fl. herb
Erythroxylaceae	
Erythroxylum LBB 11847	v. shrub
Euphorbiaceae	
Croton hostmannii Miq.	fl. shrub
Maprounea guianensis Aubl.	flr. shrub

Pera bicolor (Klotzsch) Müll. Arg.	v. tree
Sebastiania corniculata (Vahl) Müll. Arg. var. *micrantha* (Benth.) Müll. Arg.	flr. herb
Gentianaceae	
Coutoubea densiflora Mart. (C. *spicata* Aubl. in Flora Sur.)	flr. herb
Curtia tenuifolia (Aubl.) Knobl.	fl. herb
Lisianthus coerulescens Aubl.	flr. herb
Lisianthus uliginosus Griseb.	flr. herb
Gesneriaceae	
Codonanthe crassifolia (Focke) Morton	flr. epiphyte
Gnetaceae	
Gnetum nodiflorum Brongn.	flr. liane
Gramineae	
Andropogon bicornis L.	flr.
Andropogon leucostachyus H.B.K.	flr.
Andropogon selloanus (Hack.) Hack.	fl.
Aristida tincta Trin. et Rupr.	flr.
Axonopus flabelliformis Swallen	flr.
Axonopus pulcher (Nees) Kuhlm.	flr.
Axonopus LBB 11919	flr.
Axonopus LBB 12183	flr.
Echinolaena inflexa (Poir.) Chase	flr.
Gymnopogon foliosus (Willd.) Nees	flr.
Leptocoryphium lanatum (H.B.K.) Nees	fl.
Mesosetum cayennense Steud.	flr.
Mesosetum tenuifolium Swallen	flr.
Panicum froesii Swallen	flr.
Panicum micranthum H.B.K.	fr.
Panicum nervosum Lam.	flr.
Panicum pilosum Sw.	flr.
Panicum stenodoides Hubbard	fl.
Paspalum arenarium Sw.	flr.
Paspalum contractum Pilger	flr.
Paspalum pulchellum Kunth	flr.
Paspalum LBB 11882	flr.
Raddiella nana (Doell) Swallen	flr.
Thrasya petrosa (Trin.) Chase	flr.
Trachypogon plumosus (H. et B.)Nees	flr.
Humiriaceae	
Humiria balsamifera (Aubl.) St. Hill. var. *balsamifera* fma. *attenuata* Cuatr.	flr. shrub
Humiria balsamifera (Aubl.) St. Hill. var. *balsamifera* fma. *balsamifera*	flr. shrub

var. *floribunda* (Mart.) Cuatr.	flr. shrub
var. *guianensis* (Benth.) Cuatr.	flr. shrub
Sacoglottis guianensis Benth.	
var. *guianensis* fma. *guianensis*	flr. shrub
var. *hispidula* Cuatr.	flr. shrub
Lamiaceae	
Hyptis atrorubens Poit.	fl. herb
Lauraceae	
Cassytha filiformis L.	flr. twiner
Ocotea schomburgkiana (Nees) Benth. et Hook. f.	juv. tree
Lentibulariaceae	
Genlisea repens Benj.	flr. herb
Utricularia amethystina St. Hil.	flr. herb
Utricularia hispida Lam.	flr. herb
Utricularia longeciliata A. DC.	flr. herb
Utricularia sandwithii P. Taylor	flr. herb
Liliaceae	
Smilax cf. *flavescens* Desv. ex Hamilt.	fr. liane
Smilax cf. *santaremensis* DC.	flr. liane
Loganiaceae	
Antonia ovata Pohl	flr. tree
Loranthaceae	
Oryctanthus botryostachys Eichl.	flr.
Oryctanthus florulentus (L.C. Rich.) Urb.	flr.
Phoradendron crassifolium (Pohl) Eichl.	v.
Phthirusa squamulosa Eichl.	fl.
Loranthacea LBB 11887	v.
Malpighiaceae	
Byrsonima crassifolia (L.) L.C. Rich. ex A. L. Juss. var. *crassifolia*	flr. shrub
Byrsonima densa (Poir.) DC.	v. shrub
Byrsonima verbascifolia (L.) L.C. Rich. var. *villosa* Griseb. fma. *spathulata* Ndz.	fl. herb
Heteropteris nervosa Juss.	fl. shrub
Tetrapteris squarrosa Griseb.	flr. liane
Marcgraviaceae	
Norantea guianensis Aubl.	fl. liane
Melastomataceae	
Aciotis purpurascens (Aubl.) Triana	fl. herb
Acisanthera recurva (L.C. Rich.) Griseb.	fl. shrub
Clidemia rubra (Aubl.) Mart.	v. shrub
Comolia lythrarioides Naud.	flr. shrub

Comolia vernicosa Benth.	fr. shrub
Miconia ciliata (L.C. Rich.) DC.	flr. shrub
Miconia myriantha Benth.	fr. shrub
Miconia phaeophylla Triana	fl. shrub
Siphanthera hostmannii Cogn.	fl. herb
Tibouchina aspera Aubl.	flr. shrub
Mimosaceae	
Pithecellobium corymbosum (L. C. Rich.) Benth.	v. tree
Moraceae	
Cecropia sciadophylla Mart.	v. tree
Cecropia surinamensis Miq.	v. tree
Myrsinaceae	
Conomorpha magnoliifolia Mez	fr. shrub
Myrtaceae	
Aulomyrcia hostmanniana Berg	fr. shrub
Aulomyrcia obtusa (Schauer) Berg var. *obtusa*	fr. shrub
Aulomyrcia obtusa (Schauer) Berg var. *surinamensis* (Miq.) Amsh.	fr. shrub
Calycolpus revolutus (Schauer) Berg	flr. shrub
Eugenia compta Berg	flr. shrub
Marlierea montana (Aubl.) Amsh.	flr. shrub
Myrcia sylvatica (G. F. W. Meyer) DC.	flr. shrub
Ochnaceae	
Ouratea decagyna Maguire	flr. shrub
Ouratea schomburgkii (Planch.) Engl.	fl. shrub
Sauvagesia rubiginosa St. Hil.	fl. herb
Sauvagesia sprengelii St. Hil.	flr. herb
Orchidaceae	
Aganisia pulchella Lindl.	fl. epiphyte
Catasetum discolor Lindl.	flr. epiphyte
Epidendrum oncidioides Lindl.	fl. epiphyte
Epidendrum vespa Vell.	fl. epiphyte
Habenaria amazonica Schltr.	fl. terrestrial
Rodriguezia secunda H.B.K.	fl. epiphyte
Spiranthes rupestris Barb. Rodr., non Lindl.	fl. terrestrial
Papilionaceae	
Aeschynomene hystrix Poir.	fr. herb
Andira coriacea Pulle	fr. tree
Cassia ramosa Vog. var. *ramosa*	flr. shrub
Ormosia coccinea Jacks.	v. tree
Sclerolobium guianense Benth.	fl. tree
Sclerolobium micropetalum Ducke	v. tree
Stylosanthes viscosa Sw.	fl. herb

Polygalaceae	
Bredemeyera densiflora Benn. var. *glabra* Benn.	fl. shrub
Polygala adenophora DC.	fl. herb
Polygala longicaulis H.B.K.	fl. herb
Polygala timoutou Aubl.	fl. herb
Polygala variabilis H.B.K.	fl. herb
Polygonaceae	
Coccoloba marginata Benth.	v. shrub
Proteaceae	
Roupala montana Aubl.	fl. shrub
Rhizophoraceae	
Cassipourea elliptica (Sw.) Poir. var. *psilogyna* Jonk.	fl. shrub
Rosaceae	
Chrysobalanus icaco L.	v. shrub
Hirtella paniculata Sw.	v. shrub
Licania incana Aubl.	flr. shrub
Parinari campestris Aubl.	flr. tree
Rubiaceae	
Alibertia myrciifolia K. Sch.	fl. shrub
Borreria suaveolens G. F. W. Meyer	flr. herb
Coccocypselum guianense (Aubl.) K. Sch.	flr. creeper
Malanea macrophylla Bartl. ex Griseb.	flr. shrub
Pagamea capitata Benth.	fl. shrub
Pagamea guianensis Aubl.	fl. shrub
Perama hirsuta Aubl.	flr. herb
Posoqueria latifolia (Rudge) R. et S.	flr. shrub
Psychotria cordifolia H.B.K.	flr. shrub
Retiniphyllum schomburgkii (Benth.) Müll. Arg.	flr. shrub
Sipanea pratensis Aubl.	fl. herb
Rubiacea LBB 11943	v.
Sapindaceae	
Matayba opaca Radlk.	flr. shrub
Scrophulariaceae	
Achetaria ocymoides (Cham. et Schl.) Wettst.	flr. herb
Buchnera palustris (Aubl.) Spreng.	fl. herb
Sterculiaceae	
Waltheria indica L. (*W. americana* L. in Flora Sur.)	flr. herb
Theaceae	
Ternstroemia dentata (Aubl.) Sw.	fr. shrub
Ternstroemia punctata (Aubl.) Sw.	fr. shrub

Verbenaceae	
Amasonia campestris (Aubl.) Moldenke	flr. herb
Vochysiaceae	
Vochysia densiflora Spruce ex Warm.	fl. tree
Vochysia surinamensis Stafl.	flr. tree
Xyridaceae	
Abolboda americana (Aubl.) Lanj.	fl. herb
Xyris fallax Malme	flr. herb
Xyris guianensis Steud.	fl. herb
Xyris malmeana L.B. Smith	fl. herb
Xyris paraënsis Poepp.	fl. herb
Xyris subuniflora Malme	fl. herb
Xyris surinamensis Spreng.	fl. herb

PTERIDOPHYTA

Gleicheniaceae	
Gleichenia flexuosa (Schrad.) Mett.	sp.
Hymenophyllaceae	
Trichomanes pinnatum Hedw.	sp.
Polypodiaceae	
Blechnum indicum Burm. f.	sp.
Lindsaea stricta (Sw.) Dryander var. *parvula* (Fée) Kramer	v.
Polypodium ciliatum L.	sp.
Polypodium lycopodioides L. var. *salicifolium* (Willd.) Bonap.	sp.
Pteridium aquilinum (L.) Kuhn ssp. *caudatum* (L.) Bonap. var. *arachnoideum* (Klf.) Herter	sp.
Schizaeaceae	
Schizaea incurvata Schkuhr	sp.
Schizaea pennula Sw.	sp.
Lycopodiaceae	
Lycopodium cernuum L.	sp.
Lycopodium meridionale Underw. et Lloyd	sp.

BRYOPHYTA

Musci

Calymperes donnellii Aust.
Campylopus surinamensis C.M.
Isopterygium LBB 11931
Octoblepharum albidum Hedw.

Octoblepharum cylindricum Mont.
Sphagnum palustre L.

Hepaticae
Frullania nodulosa (Reinw., Blume et Nees) Nees
Odontoschisma cf. *denudatum* (Mart.) Lindb.

LICHENES

Cladonia cf. *furcata* (Huds.) Schrad.
Cladonia LBB 11403 (subgenus *Cladonia*)
Cladonia LBB 11933 (*Cocciferae*)
Cladonia LBB 11934 (*Cocciferae*)
Parmelia LBB 11413

§ 2: FLORISTIC AND AUTECOLOGICAL NOTES

Araceae

Philodendron scabrum: found on the top of the Brinck Hill as an epiphyte in savanna scrub (community of *Myrcia sylvatica* and *Matayba opaca*). The specimens have much larger leaves than the material hitherto collected. *Philodendron scabrum* has been collected only three times before: Rio Branco – Amazonas – Brazil (type specimen), Lobin savanna (Suriname) and Waneweg (Suriname).

Cyperaceae

Rhynchospora caracasana: collected on high gravel ribs. First record from Suriname.

Rhynchospora rhizomatosa: Very common in the Sabanpasi savanna area. Only known from savannas of the Sabanpasi type and from the Coesewijne savanna – Suriname – (VAN DONSELAAR, 1963).

Rhynchospora LBB 12185: undescribed species. Collected in moist depressions on open savannas. Second record from Suriname, known only from the Kaiser savanna.

Gramineae

Mesosetum tenuifolium: very common in open savanna vegetations. In Suriname only known from savannas of the Sabanpasi type and from the Sipaliwini savanna (VAN DONSELAAR, 1965, 1968).

Paspalum contractum: found only once in the Sabanpasi savanna area. First record from northern Suriname, already known from the Sipaliwini savanna (VAN DONSELAAR, 1968).

Among the grasses collected there may be more species that are rare or even new for Suriname. They await identification by T. R. Soderstrom (Washington) to whom the material has been handed over.

Humiriaceae

Humiria balsamifera: during the field work CUATRECASAS' (1961) monograph on the Humiriaceae was not available. Therefore a large number of collections were made of the common and very variable *Humiria balsamifera* in different habitats. After identification in Utrecht it appeared that the winged form: *Humiria balsamifera* var. *balsamifera* fma. *balsamifera* has not been found in the scrub vegetations belonging to the community of *Myrcia sylvatica* and *Matayba opaca*. It may be assumed that this form is absent in dry places. For other varieties and forms, no conclusions could be drawn with regard to their habitat (LINDEMAN, 1953).

Lentibulariaceae

Our collection of *Lentibulariaceae* is not complete because the dry season started soon after the beginning of the investigation, with the result that the *Lentibulariaceae* completely disappeared. Nothing definite can therefore be said as to their habitats. All species grow on relatively moist places. The following species were collected:

at the source level: *Genlisea repens*
Utricularia amethystina
Utricularia sandwithii,
at moist parts of ridges: *Utricularia amethystina*
Utricularia longeciliata
Utricularia sandwithii.

Melastomataceae

Miconia phaeophylla: second record from Suriname, known only from the Kappel savanna (KRAMER & VAN DONSELAAR, 1969).

Orchidaceae

Spiranthes rupestris: found once in a cluster of several specimens in an open savanna. Second record from Suriname, only known from Zanderij.

Lichenes

On the white sand of the hill tops two *Lichenes* were found, both with red apothecia. As very little attention had been paid to this plant group in South America it can only be said that they belong to the genus *Cladonia* and to the group of *Cocciferae* in particular. The one species (LBB 11933) is mealy soredial, the other (LBB 11934) is granular soredial.

§ 3: INTRUDING PLANTS AND PLANTS OF DISTURBED HABITATS

On the most northerly hill, the Lobles Hill (about 3 hours walking from the bushnegro village Sabanpasi), traces of human influence were found in the vegetation: *Ananas comosus* and *Anacardium occidentale*. OSTENDORF (1963) reports that *Ananas comosus* is cultivated while *Anacardium occidentale* is sometimes cultivated and sometimes wild.

On the Brinck Hill slope, just below the flat top but still on the white sand, a spot with an aberrant vegetation was found, consisting exclusively of *Andropogon bicornis*, *Andropogon selloanus*, *Cyperus chalaranthus* and *Cyperus ligularis*. These are all species known from disturbed places, especially from road-sides.

Spread everywhere in the savannas we found profile and prospection pits dug by previous prospectors. Only in these pits, which during a great part of the year are filled with water, *Panicum pilosum* and *Diplacrum guianense* were found. *Rhynchospora tenuis* occurs especially in these pits but was also found in other habitats. The walls of dry pits are sometimes covered with *Gleichenia flexuosa*.

On a small savanna in the neighbourhood of camp Amoedoejoe we found at one place the remains of old bottles and of charred wood. Here a rather rough vegetation was found with *Andropogon selloanus* in particular, but also with *Achetaria ocymoides*, which was found nowhere else in the Reserve.

CHAPTER IV

THE VEGETATION AND ITS RELATION TO THE HABITAT FACTORS

§ 1: METHODS

The vegetation was studied after methods and concepts of the French-Swiss school of phytosociology (BRAUN-BLANQUET, 1964).

Dependent on the minimum area of the (with regard to the floristic composition) homogeneous vegetations, the sample plots varied in extent from 4–10 m^2 (in open savanna vegetations) to 30–100 m^2 (in savanna bushes and scrubs).

From each plot data were collected concerning:

- height in cm and degree of cover in per cent of the shrub, herb and moss layer and the total degree of cover as a percentage,
- the combined estimate of abundance and degree of cover of each species,
- the sociability,
- the phenological condition of each species (see chapter III, § 1),
- the habitat factors,
- the locality.

The tabulating and classification was done following a fixed procedure, as described in detail by ELLENBERG (1956). The delimination and classification of the plant communities is primarily based on characteristic (in the sence of faithful) species and differential species (see table I and II). The communities in this chapter are arranged according to the habitat from a practical point of view.

The results of the investigations could be compared with four publications concerning savannas of the Sabanpasi, Cassipora and Zanderij types:

- VAN DONSELAAR 1965:	Gros savanna, De Jong Noord savanna and Lobin savanna,
- VAN DONSELAAR 1969:	De Jong Zuid savanna,
- HEYLIGERS, 1963:	Savanna area between Jodensavanna and Cassipora,
- LANJOUW, 1936:	Patrick savanna.

§ 2: SURVEY OF THE PLANT COMMUNITIES

I. *Vegetation types found on the white sand caps*

I.1.1	Community of	*Gymnopogon foliosus*
I.1.2	Community of	*Paspalum arenarium*
I.1.3	Community of	*Cassia ramosa* var. *ramosa*
I.1.4	Community of	*Borreria suaveolens*

I.1.5	Community of	*Bulbostylis junciformis*
I.1.6	Community of	*Axonopus flabelliformis*
I.1.7	Community of	*Acisanthera recurva*
I.1.8	Community of	*Bulbostylis surinamensis*
I.1.9	Community of	*Paepalanthus subtilis*
I.1.10	Community of	*Trachypogon plumosus*
I.1.11	Community of	*Andropogon leucostachyus*
I.1.12	Community of	*Andropogon selloanus*
I.1.13	Community of	*Bulbostylis conifera*
I.2	Community of	*Myrcia sylvatica* and *Matayba opaca*

II. *Vegetation types found at the source level*

II.1	Community of	*Panicum froesii* and *Syngonanthus umbellatus*
II.1a	Variant with	*Blechnum indicum*
II.1b	Variant with	*Abolboda americana*
II.2	Community of	*Clusia fockeana* and *Scleria martii*

III. *Vegetation types found on the rocky hillsides*

III.1	Community of	*Paspalum pulchellum*
III.2	Community of	*Gleichenia flexuosa*

IV. *Vegetation types found on the gravel ribs*

IV.1	Community of	*Mesosetum tenuifolium*, *Mesosetum cayennense* and *Bulbostylis circinata*
IV.1a	Variant with	*Rhynchospora caracasana*
IV.1b	Typical variant	
IV.2	Community of	*Marlierea montana* and *Scleria cyperina* variant with *Antonia ovata* and *Roupala montana*

V. *Vegetation types found on the ridge flanks*

V.1	Community of	*Bulbostylis lanata* and *Drosera capillaris*
V.2	Community of	*Panicum nervosum* *Hypolytrum pulchrum*
V.2a	Variant with	*Lindsaea stricta* var. *parvula* and *Echinolaena inflexa*
V.2b	Variant with	*Rhynchospora globosa*
V.2c	Typical variant	
V.3	Community of	*Marlierea montana* and *Scleria cyperina*
V.3a	Variant with	*Lindsaea stricta* var. *parvula*, *Echinolaena inflexa* and *Mauritia flexuosa*
V.3b	Variant with	*Coccoloba marginata* and *Rhynchospora cephalotes*
V.3c	Typical variant	

§ 3: DESCRIPTION OF THE PLANT COMMUNITIES AND THEIR HABITAT

I. *Vegetation types found on the white sand caps*

The white sand caps (see fig. 6 and photo 2) possess a very well drained soil consisting of bleached coarse white sand. There is little soil-biological activity: this appears from the fact, among others, that there is a thick layer of undecayed leaves under the shrubs. Since the rainwater is drained off fairly quickly, the white sand caps are never very wet but usually dry. See description of soil profile P1 (chapter II, § 2B).

There is open savanna vegetation as well as savanna scrub on the white sand caps.

I.1 Pioneer communities I.1.1-I.1.13

Degree of cover 5–90 per cent, height up to 100 cm.

On the tops of the three hills there is no optimal development of open savanna vegetation. Owing to the fairly recent field fires (the last one was presumably in 1953) these open patches originated from savanna scrub and xerophytic wood. The total cover can be very scanty and we find a patchwork of pioneer communities in which one or two species dominate.

These communities do not correspond individually with communities already described from other dry white sand savannas, but as a whole they contain so many components of the alliance *Cassio* (*ramosae*) – *Trachypogonion* (VAN DONSELAAR, 1965) that they must certainly be very closely related to it. The species found on the open patches of the white sand caps which are characteristic of the above mentioned alliance, are i.a. *Cassia ramosa* var. *ramosa*, *Waltheria indica* [1]), *Borreria suaveolens*, *Paepalanthus subtilis*, *Schizaea incurvata*, *Axonopus flabelliformis* [2]), *Lagenocarpus weigeltii* and *Schizaea pennula* [3]). The near-absence of *Bulbostylis conifera* is very striking. This species was found in only one place on the white sand caps, i.e. on the Lobles Hill. The following record was made:

Surface: 2 × 2 metres
Degree of cover of the herb layer: 30 per cent
Height of the herb layer: 40 cm

Bulbostylis conifera	2.1
Trachypogon plumosus	1.2
Lagenocarpus weigeltii	+.1
Axonopus flabelliformis	+.1

[1]) HEYLIGERS (1963) and VAN DONSELAAR (1965) use for this species the synonym *Waltheria americana L.*

[2]) HEYLIGERS (1963) and VAN DONSELAAR (1965) call this species erroneously *Axonopus attenuatus* (Presl) Hitchc.

[3]) HEYLIGERS (1963) and VAN DONSELAAR (1965) use for this species the synonym *Actinostachys pennula* (Sw.) Presl.

Borreria suaveolens	r.1
Cladonia spec.	present

The community of *Gymnopogon foliosus* (I.1.1) is the most peculiar of the thirteen dominant communities in which we have divided the open vegetation types of the white sand caps. It is probably identical with the community that LANJOUW (1936) found in the proximity of Sectie O. This would confirm VAN DONSELAAR's hypothesis (1965) that the vegetation type with *Gymnopogon foliosus* as dominant species belongs to the group of associations on dry white sand (alliance *Cassio* (*ramosae*) – *Trachypogonion*). This community was found by us on the Lobles Hill only.

For other communities see table I.

I.2 Community of *Myrcia sylvatica* and *Matayba opaca*

Degree of cover 70–100 per cent, height 4–8 m.

In this community the shrubs *Myrcia sylvatica* and *Matayba opaca* are the most common and characteristic species. The community is comparable with the *Ternstroemia – Matayba* bushes (VAN DONSELAAR, 1965) and the *Ternstroemia – Matayba* scrub (HEYLIGERS, 1963) of the dry white sand savannas. *Ternstroemia punctata* is very common here, but was also fairly frequently found by us in scrub vegetations of another type.

HEYLIGERS (1963) divides his *Ternstroemia – Matayba* scrub into three variants. In our opinion this subdivision was not possible here.

We could find no difference in habitat for the open savanna vegetations and the scrub vegetations on the white sand caps. Therefore it is highly probable that the community of *Myrcia sylvatica* and *Matayba opaca* is here either the climax vegetation or an intermediary stage to xerophytic wood. This hypothesis is strengthened by the fact that the Klaiber Hill, which has had no fires in recent years, is almost entirely covered with savanna scrub of the community of *Myrcia sylvatica* and *Matayba opaca* and with xerophytic wood. The aerial photographs of the Nature Reserve made before the fires took place (1947, scale 1 : 40.000), show that the Brinck Hill and the Lobles Hill were at that time entirely covered with scrub and xerophytic wood. A third argument for this supposition is that especially *Matayba opaca* was often found in a juvenile state on open patches of the white sand caps.

II. *Vegetation types found at the source level*

The white sand caps on the tops of the three hills are very well drained. The rainwater sinks away quickly down to the unweathered subgreywacke rock and is then drained off sideways (see fig. 6). In various places at the bottom of the white sand caps the water reappears at the surface and these places remain wet until late in the dry season. Then they dry up completely. At source level the unweathered subgreywacke is

covered by a thin layer of white sand varying in thickness from a few centimetres to some decimetres.

II.1 Community of *Panicum froesii* and *Syngonanthus umbellatus*

The open vegetations found at source level belong to the alliance *Syngonantho – Xyridion* (VAN DONSELAAR, 1965) of the wet white sand savannas. We found as characteristic species of this community: *Panicum froesii* [1]), *Syngonanthus umbellatus*, *Xyris fallax* [2]) and the moss *Campylopus surinamensis*. This community was subdivided by us in two variants.

II.1a Variant with *Blechnum indicum*

Degree of cover 100 per cent, height 15–100 cm

This variant can be found where the thin soil layer is strongly humic. See profile P2. Besides *Blechnum indicum* we found as characteristic species *Scleria martii* [3]), *Syngonanthus gracilis*, *Lagenocarpus amazonicus* and the moss *Octoblepharum cylindricum*. We also noticed *Panicum nervosum* and *Hypolytrum pulchrum*: these two species reach their optimum in community V.1, and are scarcely found anywhere else.

This vegetation type was found neither by Heyligers nor by Van Donselaar. It can be considered as a sub-association of the *Xyrido – Paspaletum pulchelli* or perhaps even as a new association belonging to the alliance *Syngonantho – Xyridion* described by VAN DONSELAAR (1965).

II.1b Variant with *Abolboda americana*

Degree of cover 50–100 per cent, height 30–50 cm.

This type of vegetation is found in those parts of the source level where the soil is not humic.

Characteristic species are: *Abolboda americana*, *Drosera intermedia*, *Burmannia capitata* and *Xyris surinamensis*.

The records we made were compared with the record made by van Donselaar on a small stretch of white sand found in the centre of the north-western part of the Gros savanna (VAN DONSELAAR, 1965, p. 60). In that place, however, instead of *Abolboda americana*, *Abolboda killipii* was found. Since these two species have a fairly similar ecological amplitude in Suriname and are even often found together, we may conclude that these vegetations are closely related. With van Donselaar we are of the opinion that this vegetation type shows a great resemblance to the sub-association *panicetosum polycomi* of the association *Xyrido – Paspaletum*

[1]) *Panicum froesii* (see photo 3) is a grass described by SWALLEN (1966); it was misidentified by HEYLIGERS (1963) and VAN DONSELAAR (1965) as *Panicum polycomum* Trin.

[2]) HEYLIGERS (1963) and VAN DONSELAAR (1965) use for this species the synonym *Xyris dolichosperma* Lanj.

[3]) HEYLIGERS (1963) and VAN DONSELAAR (1965) use for this species the synonym *Scleria pyramidalis* Hochst.

pulchelli. However the name of this sub-association will have to be changed into *panicetosum froesii*.

Whether this sub-association is identical with the *Lagenocarpus tremulus* vegetation, *Panicum polycomum* variant of HEYLIGERS (1963) could not be ascertained, because the specimen of *Panicum polycomum* collected by Heyligers between Jodensavanna and Cassipora, is not present in the collection of the Utrecht herbarium. It is nevertheless quite possible that Heyligers did give the correct name to the *Panicum* found by him, and therefore to the vegetation type in question.

II.2 Community of *Clusia fockeana* and *Scleria martii*

Degree of cover ± 90 per cent, height up to 5 m.

In the lowest part of the white sand caps, a narrow strip just above the source level, the scrub resembled the vegetation type with *Myrcia sylvatica* and *Matayba opaca* but proved to contain a few remarkable species: here and there we encountered *Bactris campestris* and in various places *Scleria martii* penetrated from the source level into the scrub. The palm *Bactris campestris* and the sedge *Scleria martii* are both moisture-loving species and both appear to be characteristic of the *Clusia – Scleria* scrub and bushes of the wet white-sand savannas described by HEYLIGERS (1963) and VAN DONSELAAR (1965). The strip with this vegetation if present, was as a rule not wider than 50 cm.

The layer of white sand is thicker here than at the source level. At a depth of about 1.5 m we struck the unweathered subgreywacke rock. The soil here is considerably moister than at the top of the hills.

Sphagnum palustre [1]) was found by us at the source level and is noted by the authors mentioned above as undergrowth of *Clusia – Scleria* bushes and *Clusia – Scleria* scrub.

III. *Vegetation types found on the rocky hillsides*

By rocky hillsides we mean those slopes in which unweathered subgreywacke rock comes to the surface. This is the case on the slopes of the three hills (see fig. 6), and in two other places on the flanks of a few rather steep ridges (see vegetation map I).

Except *Algae* no plants are growing on the bare subgreywacke rock. But in the crevices, furrows and oriçangas which are filled with erosion material and which vary greatly in depth, we found vegetations of several types which, with the exception of two, were identical with or very closely related to vegetation types we came across on the ridges. These will be extensively discussed in the following pages. They are:

[1]) HEYLIGERS (1963) and VAN DONSELAAR (1965) use for this species the synonyms *S. antillarum* and *S. kegelianum* respectively.

IV.1b The community of *Mesosetum tenuifolium, Mesosetum cayennense* and *Bulbostylis circinata*, typical variant. A vegetation of this type was found in very shallow furrows and oriçangas filled up with erosion material containing a high percentage of gravel, and also in narrow rock crevices (see photo 5).

IV.2 The community of *Marlierea montana* and *Scleria cyperina*, variant with *Antonia ovata* and *Roupala montana*. A vegetation of this type was found in a few places at the foot of the three hills. Juvenile specimens of *Antonia ovata* and *Roupala montana* often grow in deep and narrow rock crevices.

V.1 The community of *Bulbostylis lanata* and *Drosera capillaris*. A vegetation of this type occurs in about 25 cm deep furrows filled up with a layer of fine erosion material.

V.2c The community of *Panicum nervosum* and *Hypolytrum pulchrum*, typical variant. A vegetation of this type always forms a fringe with a width varying from a few decimetres to a few metres round the bushes of the community of *Marlierea montana* and *Scleria cyperina*, typical variant, both on the ridges and here also on the hillsides.

V.3c The community of *Marlierea montana* and *Scleria cyperina*, typical variant. Bushes of this type were found in the places where the layer of colluvial material is up to one metre deep.

The two vegetation types not occurring on the ridges, but only on the hillsides are:

III.1 Community of *Paspalum pulchellum*

Degree of cover 100 per cent, height 30–50 cm.

This community is characterized by the very high degree of cover reached by *Paspalum pulchellum*. Other species which regularly occur in it are: *Rhynchospora barbata, Lagenocarpus tremulus, Rhynchospora curvula* and *Panicum micranthum*.

This community is related to the association *Syngonantho-Lagenocarpetum tremuli*, described by VAN DONSELAAR (1965).

The community of *Paspalum pulchellum* occurs especially in small hollows filled with an almost permanently moist, only a few centimetres thick, strongly humic soil, and in narrow rock crevices, in particular immediately below the source level of the three hills (see photo 4).

III.2 Community of *Gleichenia flexuosa*

This too is a community characterized by a very high degree of cover reached by a single species: viz. *Gleichenia flexuosa*.

Here is a record:

Shrub layer
Degree of cover: 25 per cent
Height : 4 m
Alibertia myrciifolia 1.2
Matayba opaca 1.1
Myrcia sylvatica 1.1
Roupala montana 1.1

Herb layer
Degree of cover: 100 per cent
Height : 1.20 m
Gleichenia flexuosa 5.5
Scleria cyperina 1.1
Lisianthus uliginosus 1.1
Tibouchina aspera 1.1

This community occurs on very steep slopes (60–90°), not only on the hillsides but also often on the sides of dry prospection and profile pits.

Outside the Reserve we repeatedly saw *Gleichenia flexuosa* in fresh incisions caused by road-construction.

IV. *Vegetation types found on the gravel ribs*

The in most cases long ribs running centrally across the ridges are characterized by the presence of a great deal of gravel on the surface, mostly bedded in sandy loam. In most cases the gravel ribs barely rise above the ground, but sometimes they rise steeply to a height of 8 m above the ridges. The residual soil is relatively dry, owing to the fact that the rainwater mostly runs off along the surface to lower-lying savanna parts. The vegetation forms a patchwork of fairly high scrub and spots with nothing but herbs (see photo 8).

IV.1 Community of *Mesosetum tenuifolium*, *Mesosetum cayennense* and *Bulbostylis circinata*

This community occurs on those parts of the ribs that are covered with a thick layer of gravel. It resembles the association *Bulbostylidetum coniferae minoris* described by VAN DONSELAAR (1965). However, there are some differences as will appear from the descriptions of the variants.

Our community has as its characteristic species *Bulbostylis circinata*, *Mesosetum cayennense* and to a lesser degree *Mesosetum tenuifolium*.

Bulbostylis conifera, *Rhynchospora rhizomatosa* and *Perama hirsuta* are species which were found both in this vegetation type and in the community of *Bulbostylis lanata* and *Drosera capillaris* (V.1), but nowhere else. On the gravel ribs we found a small form of *Bulbostylis conifera* such as van Donselaar found on the pebble-knolls in the Gros savanna and in the De Jong Noord savanna; on the ridge flanks a somewhat larger form was found.

IV.1a Variant with *Rhynchospora caracasana*

Degree of cover 60–80 per cent; height 40–50 cm.

Vegetation belonging to this variant is only found on the tops of the really steep gravel ribs. See description of profile P3 and photo 9.

Characteristic species of this community variant are *Rhynchospora caracasana* and *Axonopus pulcher*. Very striking is the absence of a few species which otherwise occur in all the open vegetation types found on gravel ribs and ridges: *Rhynchospora curvula*, *Comolia lythrarioides*, *Rhynchospora graminea* and *Lagenocarpus tremulus*. It must further be remarked that *Trachypogon plumosus* is sometimes found in this vegetation type, a species which elsewhere occurs only on the white sand caps of the three hills.

This variant is very closely related to the association *Bulbostylidetum coniferae minoris* of the alliance *Bulbostylidion lanatae* described by VAN DONSELAAR (1965). However, the characteristic species of our variant were not found by van Donselaar.

IV.1b Typical variant

Degree of cover 10–90 per cent, height 20–40 cm.

This variant is found on the low gravel ribs and at the foot of the slopes of high gravel ribs. See profile P4 and photo 7. The characteristic species of the above mentioned variant are absent. This typical variant too is related to the association *Bulbostylidetum coniferae monoris* (VAN DONSELAAR, 1965), but with this difference that *Rhynchospora curvula*, *Comolia lythrarioides*, *Lagenocarpus tremulus* and *Rhynchospora graminea* do occur here. *Rhynchospora graminea*, however does not reach its optimum here.

IV.2 Community of *Marlierea montana* and *Scleria cyperina*, variant with *Antonia ovata* and *Roupala montana*

General remarks regarding the community of *Marlierea montana* and *Scleria cyperina* see V.3.

Degree of cover 90–100 per cent, height 3–7 m.

The variant with *Antonia ovata* and *Roupala montana* is only distinguishable from the other variants of the community by the presence of the two species after which the variant has been named. *Roupala montana* and *Antonia ovata* were only rarely found outside the gravel ribs, viz. in the variant with *Coccoloba marginata* and *Rhynchospora cephalotes* (V.3b). *Antonia ovata* has an unusual habit there: the leaves are much larger and are yellowish green instead of dark green. We never found this form in bloom.

In this vegetation type *Marlierea montana*, *Bactris campestris* and *Miconia ciliata* occur less frequently than in the other variants of this scrub community.

This vegetation type is identical with the *Roupala – Antonia* bushes described by VAN DONSELAAR (1965).

V. *Vegetation types found on the ridge flanks*

The growth on the ridge flanks consists either of a more or less uninterrupted savanna scrub (see photo 13) or of an open vegetation with clearly isolated savanna bushes surrounded by a fringe of herbs (see photo 10).

The unweathered subgreywacke or residual soil is always covered by a layer of colluvial material varying in depth from more than one meter (photo 15) to a few cm (see photo 14).

V.1 Community of *Bulbostylis lanata* and *Drosera capillaris*

Degree of cover 50–95 per cent, height 20–40 cm.

On flat savanna parts with a thin layer of colluvial material. See description of profile P5 and photos 10, 11 and 14. The degree of moisture of the colluvial layer varies from very wet in the rainy season to very dry in the dry season. In those places where the layer of colluvial material is a little deeper we find savanna bushes belonging to the community of *Marlierea montana* and *Scleria cyperina*, typical variant (V.3c).

Besides the presence of *Bulbostylis lanata* and *Drosera capillaris*, that of a great number of *Lentibulariaceae* (see chapter III) is characteristic for this community. *Rhynchospora curvula* is less characteristic because this sedge also occurs in great number in the community of *Mesosetum tenuifolium, Mesosetum cayennense* and *Bulbostylis circinata*, typical variant (IV.1b).

This vegetation type corresponds with the association *Rhynchosporetum curvulae* described by VAN DONSELAAR (1965). Van Donselaar found this type in the Gros savanna only in places where there is much gravel in the top soil, but it already appeared in his investigations on the De Jong Zuid savanna that this is no rule (VAN DONSELAAR, 1969). Like the community IV.1, this community belongs to the alliance *Bulbostylidion lanatae* (VAN DONSELAAR, 1965). This certainly appears from the occurrence of *Bulbostylis conifera, Rhynchospora rhizomatosa* and *Perama hirsuta*, three species which hardly occur outside these vegetation types.

V.2 Community of *Panicum nervosum* and *Hypolytrum pulchrum*

This community comprises variants which are all characterized by a fairly high, rather rugged growth with a high degree of cover. Characteristic species for this community are, besides *Panicum nervosum* and *Hypolytrum pulchrum*, i.a. *Scleria cyperina, Aristida tincta* and *Raddiella nana*. The community is related to the alliance *Axonopodion chrysitis* [1]) described by VAN DONSELAAR (1965).

[1]) The name of this alliance ought to be changed into *Axonopodion chrysitidis*.

V.2a Variant with *Lindsaea stricta* var. *parvula* and *Echinolaena inflexa*

Degree of cover 90–100 per cent, height 40–100 cm.

This variant was found on kawfoetoes (see chapter II). Besides the species after which the variant was named, the moistloving *Sauvagesia rubiginosa* and *Lycopodium meridionale* also frequently occur. On the kawfoetoes, but nowhere else *Rhynchospora sp. nov.* (LBB 12185) was found.

See soil profile P7.

V.2b Variant with *Rhynchospora globosa*

Degree of cover ± 80 per cent, height ± 40 cm.

The peculiarity of this variant is that *Rhynchospora globosa* is strongly dominant. This is also the only characteristic species of this variant. On a visit to the Gros savanna in January 1968 it appeared to us that this variant shows a great similarity to the association *Rhynchosporetum globosae* described by VAN DONSELAAR (1965), but also that this vegetation type is much better developed on the Gros savanna than in the Sabanpasi savanna area. On the Gros savanna this type of vegetation occupies several metres wide strips along watercourses, while in the Sabanpasi savanna area only one spot large enough to be mapped was discovered. Here too this variant was always found in the proximity of watercourses or at least immediately below the ridges on very moist places.

V.2c Typical variant

Degree of cover 90–100 per cent, height 20–90 cm.

This variant includes the fringe vegetations round the savanna bushes belonging to the community of *Marlierea montana* and *Scleria cyperina*, typical variant (V.3c). VAN DONSELAAR did not acknowledge this vegetation type because it was not distinctly developed on the Gros savanna and the De Jong Noord savanna (probably owing to the frequent fires). The fragments if any he reckoned to the savanna bushes (see photo 11).

V.3 Community of *Marlierea montana* and *Scleria cyperina*

Very common species of this community are: *Marlierea montana*, *Bactris campestris*, *Psychotria cordifolia*, *Ouratea schomburgkii*, *Conomorpha magnoliifolia* and the herbs *Scleria cyperina* and *Hypolytrum pulchrum*.

HEYLIGERS (1963) did not include the xerophytic wood in his study of the white sand savannas but restricted his attention to the floristically closely related scrub vegetations. VAN DONSELAAR (1965) also did not collect data on the vegetation of the xerophytic wood and did not attempt a classification of the various types of scrubs and bushes, but restricted himself to a description of the latter. In spite of the fact that we have not studied the xerophytic wood either, we may yet conclude from the presence of the great number of species they have in common, that all scrub vegetations found by us on gravel ribs, ridge flanks and

near the watercourses are closely related to each other. Therefore we have placed the discerned types in one community, consisting of four variants.

The variant with *Antonia ovata* and *Roupala montana* (IV.2) was already dealt with and described under the vegetation types of the gravel ribs.

V.3a Variant with *Lindsaea stricta* var. *parvula*, *Echinolaena inflexa* and *Mauritia flexuosa*

Degree of cover 100 per cent, height 2,5–8 m.

This variant is characterized by the presence of the highly moisture-loving palm *Mauritia flexuosa* in the shrub layer and by that of *Echinolaena inflexa*, *Lindsaea stricta* var. *parvula* and *Raddiella nana* in the herb layer. This vegetation was found only in very moist places, where it forms a patchwork with the herb vegetation of the community V.2a.

V.3b Variant with *Coccoloba marginata* and *Rhynchospora cephalotes*

Degree of cover 90–100 per cent, height 2.5–6 m (see photo 13).

This variant includes the uninterrupted, dense and hardly penetrable scrub, often interspersed with solitary trees such as *Parinari campestris*, *Platonia insignis*, *Calophyllum brasiliense* and *Andira coriacea*. Perhaps most of this scrub forms an intermediary stage to xerophytic wood. See soil profile P6.

VAN DONSELAAR (1965) did not find this vegetation type on the Gros savanna and the De Jong Noord savanna, but he does speak of a kind of scrub occurring on the De Jong Zuid savanna (VAN DONSELAAR, 1969) which does not differ much in composition from the *Marlierea* bush and which he therefore calls *Marlierea* scrub. It is striking that *Rhynchospora cephalotes* does not occur in his records, whereas in the Sabanpasi savanna area it is the most characteristic species (photo 12). Besides *Rhynchospora cephalotes* we mention *Coccoloba marginata*, which has its optimum in this vegetation type.

V.3c Typical variant

Degree of cover 100 per cent, height 2–4 m.

This variant comprises the small rounded bushes scattered throughout the open parts of the ridge flanks. Profile pits showed that the gravel layer lies under the bush-covered surface at a somewhat greater depth than it does under the surface covered by a herb vegetation of community V.1 (photos 10, 11 and 14).

This typical variant is identical with the *Marlierea* bushes described by VAN DONSELAAR (1965).

§ 4: COMPARISON OF THE VEGETATION TYPES WITH THOSE RECOGNIZED BY VAN DONSELAAR

VAN DONSELAAR (1965): Survey of the hierarchic system (simplified).	TEUNISSEN and WILDSCHUT: Code of the vegetation types.
1. Order Trachypogonetalia plumosi	
1.1. Alliance Cassio–Trachypogonion	I.1.1.–I.1.13
1.1.1. Ass. Mesoseto–Trachypogonetum	
1.1.2. Ass. Lagenocarpo–Axonopodetum attenuati [1])	
1.1.3. Ass. Bulbostylidetum coniferae	
1.2. Alliance Curatello–Trachypogonion	
1.3. Alliance Rhynchosporo–Trachypogonion	
2. Order Paspaletalia pulchelli	
2.1. Alliance Syngonantho–Xyridion	II.1a
2.1.1. Ass. Bulbostylidetum circinatae	
2.1.2. Ass. Xyrido–Paspaletum pulchelli	
2.1.2.a. Subass. typicum	
2.1.2.b. Subass. panicetosum polycomi [2])	II.1b
2.1.3. Ass. Syngonantho–Lagenocarpetum tremuli	III.1
2.2. Alliance Bulbostylidion lanatae	
2.1.1. Ass. Rhynchosporetum podospermae	
2.2.2. Ass. Byrsonimetum crassifoliae malosae	
2.2.3. Ass. Rhynchosporetum curvulae	
2.2.3.a. Subass. typicum	V.1
2.2.3.b. Subass. bulbostylidetosum minoris	
2.2.4. Ass. Bulbostylidetum spadiceae boreosurinamense	
2.2.5. Ass. Bulbostylidetum coniferae minoris	IV.1a, IV.1b
2.3. Alliance Imperato–Mesosetion cayennensis	
3. Order Panicetalia stenodis	
3.1. Alliance Axonopodion chrysitis [3])	V.2a, V.2c
3.1.1. Ass. Arundinello–Panicetum stenodis	
3.1.2. Ass. Rhynchosporetum globosae	V.2b
3.1.3. Ass. Ischnosiphono–Panicetum nervosi	
3.2. Alliance Mauritio–Hypogynion virgati	
B 1 Ternstoemia punctata – Matayba opaca bushes	I.2
B 4 Clusia fockeana – Scleria pyramidalis bushes [4])	II.2
B 5 Marlierea montana bushes	V.3a, V.3b, V.3c
B 6 Roupala montana – Antonia ovata bushes	IV.2

[1]) Ought to be changed into Lagenocarpo–Axonopodetum flabelliformis.
[2]) Ought to be changed into panicetosum froesii.
[3]) Ought to be changed into Axonopodion chrysitidis.
[4]) Ought to be changed into Clusia fockeana–Scleria martii bushes.

CHAPTER V

VEGETATION MAPPING

§ 1: METHODS

First the savanna area was thoroughly surveyed by means of CBL map 21d (4th ed. 1966, 1 : 40.000) and aerial photographs. Next vegetation units were distinguished based on more than one hundred vegetation records. Vegetation mapping was started after four months of field work.

We had two series of aerial photographs at our disposal, one series on a scale 1 : 40.000 (1947) and one series on a scale 1 : 20.000 (1956). For the vegetation mapping mostly the latter was used.

Vegetation map I

First of all we made a photo-analysis map of the savanna area. With the aid of a stereoscope we drew on the aerial photographs (scale 1 : 20.000) the boundaries of the savannas, and indicated parts of the savannas that looked homogeneous. These savanna parts as seen on the aerial photographs appeared in the field to coincide with landscape elements such as white sand caps, grounds at source level, rocky hillsides, gravel ribs, ridge flanks and watercourses. By the study in the field the vegetation of these elements appeared in all cases to consist of a number of the plant communities distinguished by us, which together form a more or less regular pattern. The landscape elements with their combination of plant communities were chosen by us as mapping units. With the aid of a sketchmaster the savanna parts distinguished on the aerial photographs were transposed and fitted into the CBL map 21d which had been enlarged to a scale of 1 : 10.000, thus providing a more or less photogrammetrically corrected photo-analysis map. This map, where necessary, was corrected in the field, and was afterwards reduced to the present scale.

Vegetation map II

Most of the distinguished communities were found in our four strips which were chosen by us in the field. These strips give a good picture of the patterns formed by the different combinations of plant communities which are represented within the mapping units of vegetation map I. (For the location of the strips see fig. 7)

Vegetation and soil along levelled lines

The above mentioned strips were levelled along lines, and cross-sections were constructed. (For the location of the lines see fig. 7)

§ 2: THE LANDSCAPE ELEMENTS ON THE AERIAL PHOTOGRAPHS (see photo 1)

1. On the unburnt parts of the white sand caps of the three hills, a more or less uninterrupted about 6 m high scrub of the community of *Myrcia sylvatica* and *Matayba opaca* (I.2) is found; the parts burnt in 1953 have vegetations consisting of low herbs (communities I.1.1–I.1.13) with scattered bushes belonging to the community of *Myrcia sylvatica* and *Matayba opaca* (I.2). These bushes vary considerably in shape and size. (For the vegetation pattern see vegetation map II, strip A)

On the white sand caps also grows xerophytic wood. On the aerial photographs it can be distinguished from the uninterrupted scrub by its height and moreover by a definite canopy. The burnt parts can be recognized by the presence of dark bush formations on a clear white ground; the white sand bears here but a scanty herb vegetation.

2. The source level has a herb vegetation belonging to the community of *Panicum froesii* and *Syngonanthus umbellatus* (II.1) and here and there scrub belonging to the community of *Clusia fockeana* and *Scleria martii* (II.2).

The source level of the three hills is visible on the aerial photographs as a narrow white to grey band on the edge of the white sand caps. The white bands show the vegetation belonging to the variant with *Abolboda americana* (II.1b), the grey bands that belonging to the *Blechnum indicum* variant of the community II.1. The scrub vegetation belonging to the community of *Clusia fockeana* and *Scleria martii* generally forms a narrow zone (not distinguishable on the aerial photographs) between the herb vegetation of the just mentioned variants and the scrub vegetation belonging to the community of *Myrcia sylvatica* and *Matayba opaca*. (For the vegetation patterns see vegetation map II, strip A)

3. Rocky hillsides are usually found round the white sand caps of the three hills. They can be recognized by very fine, almost black stripes in the strike of the rock on a dark grey ground. The almost black stripes are caused by the presence of deep furrows in the unweathered subgreywacke rock, the dark grey ground is caused by a cover of purple-coloured *Algae*. In so far as the deep furrows are filled with erosion material they are hidden by vegetations of various kinds of communities which are frequently found in other places in the Sabanpasi savanna area, but not on the white sand caps of the hills. The community of *Paspalum pulchellum* (III.1) and the community of *Gleichenia flexuosa* (III.2) occur only on the rocky hillsides.

None of the communities occurring on the rocky hillsides are distinguishable separately on the aerial photographs. (For the vegetation pattern see vegetation map II, strip A and strip B)

4. The herb community of *Mesosetum tenuifolium*, *Mesosetum cayennense* and *Bulbostylis circinata* (IV.1) and the scrub community of *Marlierea*

montana and *Scleria cyperina*, variant with *Antonia ovata* and *Roupala montana* (IV.2), are found on gravel ribs. The high gravel ribs are for the most part occupied by the scrub vegetation, which shows up on the aerial photographs as broad, darkly shaded strips running centrally across the ridges. Often they are half as wide as the ridges themselves. The herb vegetation on the tops of high ribs (community IV.1a) and that at their feet (community IV.1b) are not visible on the aerial photographs on account of their small size. Scrub of the community IV.2 is less frequently found on low gravel ribs that hardly rise above the surrounding landscape and in which we sometimes found uneroded rock immediately below the layer of gravel. The variant with *Rhynchospora caracasana* of community IV.1 is here always absent, the typical variant of that community is always found here. On the aerial photographs these open vegetations are difficult to distinguish from vegetations of community V.1.

5. On the ridge flanks two combinations of plant communities can be distinguisted.

The first is a combination dominated by the herb community of *Bulbostylis lanata* and *Drosera capillaris* (V.1) and includes small savanna bushes belonging to the community of *Marlierea montana* and *Scleria cyperina*, typical variant (V.3c); the latter are mostly surrounded by a fringe belonging to the herb community of *Panicum nervosum* and *Hypolytrum pulchrum*, typical variant (V.2c).

On the ridge flanks with such a vegetation we also find watercourses running from the gravel ribs to the border of the xerophytic wood (thus mostly not in the strike of the rock!) covered with a scrub vegetation belonging to the community of *Marlierea montana* and *Scleria cyperina*, variant with *Lindsaea stricta* var. *parvula*, *Echinolaena inflexa* and *Mauritia flexuosa* (V.3a), which is sometimes surrounded by a fringe belonging to the community of *Panicum nervosum* and *Hypolytrum pulchrum*, variant with *Rhynchospora globosa* (V.2b). In these watercourses and in their immediate vicinity we sometimes found a kawfoetoe vegetation belonging to the community of *Panicum nervosum* and *Hypolytrum pulchrum*, variant with *Lindsaea stricta* var. *parvula* and *Echinolaena inflexa* (V.2a).

The parts of the ridge flanks as described above can easily be recognized on the aerial photographs. The small savanna bushes of the community V.3c can be recognized as tiny dark dots on a light or dark grey ground caused by a vegetation of community V.1 together with a vegetation of community V.2c and a layer of *Algae* that can cover the soil. Walking from the centre of a ridge to the border of the xerophytic wood, the degree of cover of community V.1 increases, the fringe vegetations of community V.2c around the savanna bushes increase in width to such a degree that they finally unite and form one uninterrupted whole, and the cover of *Algae* increases too. This is shown on the aerial photographs by the fact that the dots caused by the savanna bushes often show up

against the wood borders on a darker ground than on the more central parts of the ridges [1]).

It should further be noticed that the bushes of the community V.3c often occur in rows in the strike of the rock (see vegetation map II, strip C and footnote to chapter II, § 2 B). The vegetation of the watercourses can easily be recognized on the aerial photographs as more or less narrow, lengthy, dark scrub formations on a mostly dark grey ground, pointing in the direction of a wood border. Only in the broader and higher scrub formation, especially in the proximity of a wood, we frequently find on the aerial photographs the characteristic palm *Mauritia flexuosa*. Fringe vegetation and kawfoetoe vegetation cannot be recognized on the aerial photographs.

Other parts of the ridge flanks show the second combination of plant communities: more or less uninterrupted scrub belonging to the community of *Marlierea montana* and *Scleria cyperina*, variant with *Coccoloba marginata* and *Rhynchospora cephalotes* (V.3b) in which there are a few small patches with a herb vegetation of the community V.1 (see photo 13 and vegetation map II, strip D). On the aerial photographs the scrub vegetation is difficult to distinguish from the scrub formation of community IV.2, which often occur together. However, the former scrub vegetations are, as a rule, on a lower level and often contain isolated trees. On account of their small size open patches can rarely be found on the aerial photographs.

[1]) The floristic composition of the fringes of the savanna bushes is similar to that of the wood borders. It would be interesting to find out whether the mantle of the wood and the savanna bushes have the same floristic composition. This might indicate that the savanna bushes of community V.3c are remains of a retiring, or pioneer vegetations of an extending wood.

CHAPTER VI

ORIGIN, EXISTENCE AND MAINTENANCE OF THE SABANPASI SAVANNA AREA

The presence of the white sand caps on the three hills and the present-day soil profiles in other places of the savanna area indicate that this area probably had a different appearance in the past.

§ 1: ORIGIN

Nothing is known with certainty about the age of the Sabanpasi savanna area. The data that hitherto have been gathered are inadequate for a complete explanation of its origin. After the greater part of the white sand cover had disappeared and a part of the subgreywacke rock had weathered away, the Sabanpasi landscape must have been completely covered for some time with a layer of quartz material. The quartz material must have had its origin in rock containing quartz veins and pebbles. Since this whole area must have been covered evenly with this quartz material, this must have been transported by forces that are no longer active. Professor A. J. Wiggers informs us that, nowaday, even with very heavy rains the quartz material on the residual ribs is not washed away by water flowing over the surface.

For some reason or other the transport of coarse quartz material suddenly stopped. Since then only finer sandy material was washed away. VAN KOOTEN (1954) described how the lower-lying parts of the area were filled up by this material so that now the earlier relief of the area is less pronounced and has sometimes almost vanished.

In the colluvial and alluvial material deposited on the gravel layer and in the gravel layer itself van Kooten discovered remains of Indian cultures down to a depth of 2 m (see chapter II, § 2 C). From this he concludes that the filling up of the lower-lying parts of the area must have taken place at a rapid rate. Unfortunately van Kooten does not mention the age of the remains. However, this find does suggest that Indians may already have been in this area when the enormous erosion processes set in and may perhaps have started them by cutting down and burning the vegetation.

The fact that the place was inhabited at a later period by maroons and gold-diggers (see chapter II, § 2 C) will undoubtedly have contributed to the development of the Sabanpasi savanna area as we find it to-day.

Although it is agreed that in Northern Suriname the climate does not play a primary role in the existence of the savanna, as under the same climatological circumstances both savanna and forest occur (LANJOUW, 1936), the alternation of dry and wet seasons, in combination with

other – non climatological – factors may well have been the cause of the existence of the savanna vegetation.

§ 2: PRESENT EXISTENCE

The Sabanpasi savanna area is situated between the valley of the Mindrineti River and that of the Saramacca River, more or less on the water-shed between them. Small creeks in the forest-covered periodically submerged strips drain the area. The whole soil complex lies on uneroded subgreywacke rock, and when once dried up it is no longer fed either by creeks or from subterranean sources.

That over great portions of the area a more or less impermeable soil layer is present at no great depth, makes it possible that the overlying permeable mass is alternately wet and dry, according to the time of the year. The degree to which this happens depends not only on the thickness of this permeable topsoil but also on the slope of the terrain.

BEARD (1953) presumes there are two groups of trees: one adapted to a periodical drying up of the soil but unable to endure very wet soils, and another adapted to wet soils but unable to stand drought. The plants best adjusted to the alternation of extreme wetness and extreme drought are especially grasses and sedges. The greater the contrast between wet and dry, the more difficult it becomes for trees to maintain themselves. This will be illustrated by a few examples (see also figure 10):

Xerophytic wood is found on white sand caps and on the slopes of the three hills and also on very high residual ribs north of the Goboj Creek. In these places the rainwater disappears rapidly, either because the soil is well drained (white sand caps), or because, owing to the sloping ground, most of the water runs off along the surface. The soil is never extremely wet.

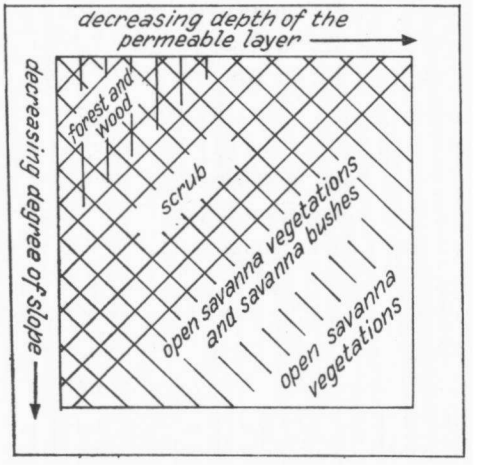

Fig. 10. Vegetation units in relation to the depth of the permeable top layer and the degree of slope.

Savanna scrub is found on less high residual ribs (community IV.2) and on gently sloping land with a thick permeable topsoil (community V.3b). In both cases the soil is able to soak up more water and to hold it longer. The contrast between wet and dry is greater.

Savanna bushes (community V.3c) and *open vegetations* (communities V.1 and V.2) are found on the parts with a more level surface and a thin topsoil consisting of permeable material. The topsoil is soon saturated with rainwater that can not or hardly be drained off, but dries up relatively soon. The contrast between wet and dry is therefore even greater.

Exclusively open vegetations, finally, are found on flat savanna parts with a few cm deep soil situated on uneroded rock, e.g. at the source level of the three hills (community II.1), beside or near great rock flats (community V.1), and on level residual ground covered with gravel (community IV.1b). Here we find the greatest contrast between wet and dry.

All this illustrates the fact that in the Sabanpasi savanna area the hydrology of the soil is one of the principal habitat factors. For a more detailed study of the relation between vegetation and habitat in the Brinckheuvel Nature Reserve more attention should be paid to this factor than was possible within the scope of our investigations.

§ 3: MAINTENANCE

A problem worthy of attention is whether the savannas in the Reserve are in stable condition, i.e. whether they will remain in existence without the assistance of man. Except in those places where there is an unbroken scrub of the community V.3b accompanied by isolated trees, there is no indication that they are only a temporary phenomenon. Also the comparison of the aerial photographs of 1947 with those of 1956 shows no clear change in the vegetation. It is recommended to check by means of permanent plots whether any changes in the vegetation are taking place or not, and, at fixed places, to burn some savannas and xerophytic wood, in order to be able to follow the succesion in the vegetation.

SUMMARY

The Brinckheuvel Nature Reserve includes the most characteristic part of the geomorphological Sabanpasi (or Subgreywacke) landscape (see fig. 4), formed by low, elongate, parallel, gently sloping ridges. The centre of each ridge is crowned by a narrow rib (gravel rib) (see fig. 5).

The gravel ribs are in general formed by residual soils of sandy loam covered with a thin layer of quartzite material. The flanks of the ridges are occupied by sandy colluvial soils separated by a layer of gravel from the residual subsoil. At the bases of these flanks there is alluvial soil (see fig. 5 and 9).

Generally the residual and colluvial soils bear savanna vegetation, the alluvial soils bear xerophytic wood and mesophytic forest. In the savanna vegetation on the ribs and the flanks of the ridges twelve plant communities can be distinguished (see table I and II).

The residual soils are hardly permeable; the colluvial soils, on the other hand, absorb rainwater quickly and soon dry up again.

In the Nature Reserve there are three hills: Brinck Hill, Klaiber Hill and Lobles Hill. They rise about 30 m above the level of the vicinity and consist of unweathered subgreywacke rock; their tops are flat and have a cover of 6 m of very permeable, white sand (see fig. 6). In the places where the vegetation was burned in the last few years there is now a savanna vegetation in which fourteen plant communities can be distinguished (see table I and II). The rest of the tops of the hills is covered with xerophytic wood. The rainwater quickly seeps through the white sand cap to the unweathered subgreywacke, runs off sideways, and reappears at the foot of the cap (the so-called source level). On the greater part of the slopes of the hills the subgreywacke crops out, with little gullies and furrows that are filled with erosion material.

Ca. 245 species of plants were collected on the savannas of the Brinckheuvel Nature Reserve.

Except in places where the influence of fire was noticeable, the presence of a more or less impermeable soil layer at shallow depth is doubtless responsible for the existence of the savannas of the Nature Reserve. This layer makes it possible that the overlying permeable mass is alternately wet and dry, depending on the season. The degree to which this happens depends not only on the thickness of this permeable topsoil but also on the inclination of the surface.

This may be illustrated by the following (see fig. 10):

1. *Xerophytic forest* is found on white sand caps and slopes of the three hills and on very high gravel ribs. In such places the rainwater disappears rapidly, either the soil is well drained (white sand caps), or because most of the water runs off on the surface owing to the sloping of the ground. The soil is never extremely wet.

2. *Savanna scrub* is found on less high residual ribs and on gently sloping land with a thick permeable topsoil. In both cases the soil can take up more water and hold it longer. The contrast between wet and dry is greater.

3. *Savanna bushes* and *open vegetations* are found on the parts with a more level and thin topsoil of permeable material. The topsoil is soon saturated with rainwater that can not or hardly drain off, but dries up relatively soon. The contrast between wet and dry is therefore even greater.

4. *Exclusively open vegetations*, finally, are found on flat savanna parts with a few cm deep soil situated on uneroded rock, e.g. at the source level of the three hills, beside or near great rock flats and on level residual ground covered with gravel. Here we find the greatest contrast between wet and dry.

All this illustrates the fact that in the Sabanpasi savanna area the hydrology of the soil is one of the principal habitat factors. Therefore, more attention should be paid to this factor by a next investigation in the Brinckheuvel Nature Reserve.

RESUMEN

La Reserva Nacional de Brinckheuvel comprende la porción más característica del paisaje geomorfológico Sabanpasi (o Subgrauwacke) (consulte fig. 4), formado por colinas prolongadas bajas que corren paralelemente y que tienen pendientes suaves. Cada colina tiene un lomo plano de cuya parte central se desprende una prominencia en forma de costilla (las „costillas") (consulte fig. 5).

Las costillas de modo general están formadas por suelos residuales de textura areno-limosa, cubiertos con una capa delgada de cuarzo. En los flancos de estas colinas se encuentran suelos coluviales de textura franco-arenosa que descansan sobre un subsuelo residual y están separados de aquello por una capa de grava. En la base de estos flancos se encuentran suelos aluviales (consulte fig. 5 y 9).

Los suelos residuales y coluviales soportan principalmente vegetaciones sabaneras, y los aluviales bosques xerofíticos y mesofíticos. Se clasificaron 12 comunidades vegetales en la sabana de las costillas y de los flancos de las colinas paralelas (consulte quadro I y II).

Los suelos residuales son difícilmente infiltrables para agua de lluvia; en los suelos coluviales, contrariamente, el agua se infiltra con rapidez, asimismo la desecación se produce inmediatamente.

En la Reserva hay tres colinas aisladas, la de Brinck, de Klaiber y de Lobles. Aquellas se elevan aproximadamente 30 metros sobre la superficie del terreno y están compuestas de roca subgrauwacke inalterada; los topes son llanos y cubiertos de una capa de arena blanca, excesivamente permeable, de 6 metros de espesor (consulte fig. 6). En las partes subjetas a incendios durante los últimos años, se encuentra una vegetación sabanera en la cual se distinguieron 14 comunidades. En la parte restante de la cima de las colinas se desarolla un bosque xerofítico (consulte quadro I y II).

El agua de la lluvia se infiltra rápidamente en la capa de arena blanca, luego fluye lateralmente por encima de la superficie del subgrauwacke para aparecer en la base de la capa de arena (el llamado „nivel de manantiales"). A lo largo de las laderas de las tres colinas aflorece el subgrauwacke, con pequeñas depresiones y grietas donde se acumula material produzido por erosión.

En total se encontraron 245 especies de plantas en la sabana de Sabanpasi.

Sin duda alguna, aparte de los incendios, la presencia de una capa más o menos impermeable cercana a la superficie es responsable para la existencia de las sabanas de Sabanpasi. En consecuencia, el suelo se mantiene alternativamente de seco a mojado, dependiente de la estación del año. La intensidad de estos cambios depende del espesor del suelo y de la pendiente del terreno.

Para ilustrar lo expuesto anteriormente se describen algunos ejemplos (consulte fig. 10):

1. En los sitios sin extrema humedad se desarrolla frecuentemente el *bosque xerofítico*: p. ej. en las capas de arenas blancas y en las laderas de las tres colinas, en lomitas residuales aisladas y en las costillas residuales más altas en las colinas elongadas. En estas condiciones el agua se pierde rápidamente, y a sea el suelo es bien drenado, o porque el agua se escurre por la pendiente impermeable.

2. *Matorrales sabaneros.* Este tipo de vegetación se encuentra en las partes menos escarpadas de las prominencias residuales (las costillas) y sobre las laderas con ligera pendiente, donde se acumula una capa gruesa de material coluvial. En ambas situaciones el suelo es capaz de absorber más agua y conservarla por más largo tiempo. Los contrastes de períodos húmedos/secos son más amplios.

3. *Vegetaciones abiertas con bosquetes* ("matas") se encuentran en las partes más llanas, con un suelo delgado de material coluvial, que se satura rápidamente con agua de lluvia, pero también se seca fácilmente. En estos sitios los contrastes de seco a húmedo son aún más pronunciados.

4. *Comunidades herbáceas puras* se encuentran en las partes llanas del subgrauwacke, con suelos que descansan a los pocos centímetros sobre una capa impermeable de roca inalterada (p. ej. el nivel de manantiales en las tres colinas y los suelos residuales cubiertos con una capa de grava). En aquellos lugares los contrastes de humedad son los más pronunciados.

Lo expuesto anteriormente es una clara ilustración de que en el complejo de sabanas de Sabanpasi las condiciones de humedad en el suelo juegan un papel primordial en el complejo de factores ambientales. Por consecuenia se recomienda una investigación más detallada de este factor en el estudio de la relación vegetación – suelo en la Reserva.

ADDITIONS TO TABLES I AND II

TABLE I

record nr.	species	degree of cover/sociability
62	Aeschynomene hystrix	1.2
	Sebastiania corniculata	+.1
50	Paspalum LBB 11882	1.2
60	Waltheria indica	+.2
51	Cyperus ligularis	1.1
58	Catasetum discolor	r.1
114	Cyperus chalaranthus	+.2
82	Tetracera asperula	+.2
	Tibouchina aspera	+.1
81	Tibouchina aspera	+.1
80	Xyris malmeana	1.1
76	Xyris paraënsis	+.1
77	Xyris guianensis	+.1
16	Lisianthus coerulescens	2.1
15	Conomorpha magnoliifolia	1.1
	Xyris subuniflora	1.2
	Algae	25 %
47	Curtia tenuifolia	+.1
45	Leptocoryphium lanatum	+.3
49	Humiria balsamifera	+.1
71	Doliocarpus calinea	+.1
	Ouratea polygyna	+.1
	Marlierea montana	2.2
4	Lisianthus coerulescens	+.1
	Xyris paraënsis	+.1
8	Maytenus oblongata	+.1
37	Byrsonima crassifolia var. crassifolia	+.1
	Cassytha filiformis	+.1
41	Xyris subuniflora	1.1
109	Tetracera asperula	+.1
	Byrsonima verbascifolia	1.1
40	Bactris campestris	1.1
	Ouratea polygyna	1.1
	Mauritia flexuosa	+.1
110	Paspalum contractum	2.2
	Davilla aspera	1.1
13	Polygala adenophora	r.1
7	Tibouchina aspera	r.1
	Odontoschisma denudatum	r.1
102	Polygala adenophora	r.1

TABLE II

record nr.	species	degree of cover/sociability
83	Bulbostylis junciformis	1.1
	Cassia ramosa var. ramosa	r.1
	Octoblepharum cylindricum	+.3
	Campylopus surinamensis	+.3
57	Cyperus chalaranthus	r.1
	Pteridium aquilinum ssp. caudatum	+.1
96	Axonopus flabelliformis	3.2
86	Ormosia coccinea	2.2
	Tapirira guianensis	2.1
	Octoblepharum cylindricum	+.3
85	Andropogon leucostachyus	+.1
	Clusia grandiflora	+.1
	Philodendron scabrum	+.1
56	Paspalum arenarium	r.1
84	Norantea guianensis	1.1
	Ocotea schomburgkiana	1.1
52	Coccocypselum guianense	2.2
	Melampodium camphoratum	1.1
75	Aulomyrcia hostmanniana	3.1
	Lagenocarpus tremulus	+.1
	Smilax spec.	+.1
65	Miconia phaeophylla	+.1
	Perama hirsuta	+.1
	Rhynchospora graminea	1.2
	Rhynchospora rhizomatosa	1.1
	Sclerolobium guianense	+.1
66	Bulbostylis conifera	+.2
	Perama hirsuta	+.1
	Rhynchospora graminea	1.2
	Rhynchospora rhizomatosa	1.1
93	Posoqueria latifolia	+.1
94	Lagenocarpus tremulus	1.1
46	Mesosetum cayennense	+.1
	Rhynchospora curvula	2.1
	Sauvagesia sprengelii	+.1
63	Comolia lythrarioides	+.1
	Polypodium ciliatum	+.1
	Polypodium lycopodioides	+.1
	Posoqueria latifolia	+.1
	Rodriguezia secunda	+.1
48	Sauvagesia sprengelii	+.1
90	Paepalanthus polytrichoides	2.1
	Xyris guianensis	+.1
72	Bulbostylis lanata	+.2
14	Maytenus oblongata	+.1
	Malanea macrophylla	+.1

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