

OBSERVATIONS ON SAVANNA VEGETATION-TYPES IN THE GUIANAS

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1. INTRODUCTION

COHEN & VAN DER EYK (1953) presented a survey of all Surinam savannas, based on the geological division of the country and the distinction of geomorphologic landscapes. This classification, in general moving from north (young) to south (old), may be summed up as follows:

- A. Savannas of the Coropina formation, i.e. the old coastal plain, probably deposited during the Quarternary period.
 - Old offshore-bar landscape: (1) *Watamalejo savanna-type*
 - Old sea-clay landscape: (2) *Welgelegen savanna-type*

- B. Savannas of the Zanderij formation, in particular the „dek” (= cover) landscape, from tertiary to quarternary age.
 Non-bleached soils: (3) *Coesewijne savanna-type*
 Bleached soils, poorly drained: (4) *Zanderij savanna-type*
 Bleached soils, well drained: (5) *Kasipora savanna-type*
- C. Savannas of the Roraima formation, i.c. the remnants of the sandstone cover that long ago made up a large portion of the land surface of the Guianas: (6) *Tafelberg savanna-type*
- D. Savannas of the basal complex, i.e. the exposed parts of the very old Guianan shield.
 Schist-hill landscape: (7) *Bosland savanna-type*
 Subgraywacke landscape: (8) *Sabanpasi savanna-type*
 Granite landscape: (9) *Paroe savanna-type*

Results of studies on savanna vegetations in northern Surinam were published by LANJOUW (1936, 1954), HEYLIGERS (1963), VAN DONSELAAR-TEN BOKKEL HUININK (1966), and VAN DONSELAAR (1965). The latter classified these vegetations according to the BRAUN-BLANQUET system in phytosociology, taking into account all available data, both published and unpublished. On the basis of the literature and some observations on the northern Rupununi Savanna in southern Guyana (the former British Guiana), it was supposed that the main lines of this classification might be applicable to the whole of the Guianas.

All types of open savanna and orchard-savanna vegetations were united in a single class, the *Leptocoryphio-Trachypogonetea*. The following summary gives the subdivision of this class down to the level of the alliances, with brief indications of the habitat of the constituent communities (the names of the soil types agree with the U.S.A. System):

- Order *Trachypogonetalia plumosi* — very dry to moist soils
 Alliance *Cassio (ramosae)-Trachypogonion* — white sand
 Alliance *Curatello-Trachypogonion* — red pure and loamy sand
 Alliance *Rhynchosporo (barbatae)-Trachypogonion* — sandy loam and sandy clay loam
- Order *Paspaletalia pulchelli* — wet (to very wet) soils
 Alliance *Syngonantho-Xyridion* — white sand
 Alliance *Bulbostylidion lanatae* — loamy sand and sandy loam
 Alliance *Imperato-Mesosetion cayennensis* — sandy loam and heavier soils

Order *Panicetalia stenodis* — very wet soils, watercourses and depressions

Alliance *Axonopodion chrysitidis* — very wet, sandy loam and heavier soils

Alliance *Mauritio-Hypogynion* — watercourses and depressions

During the years 1964—1966 the author made phytosociological observations on several not yet studied savannas in northern Surinam, as well as in southern Surinam and French Guiana. The results will be presented here against the background of the two summaries mentioned above. Some data from the northern Rupununi Savanna collected in 1959, though mentioned already before (VAN DONSELAAR 1965), will be included in the comparison.

2. SAVANNAS NEAR BROWNSWEG, NORTHERN SURINAM

The village Brownsweg is situated near the southern end of a complex of savannas belonging to the Sabanpasi type. These savannas are burnt now and then, but at least part of them probably owe their existence to edaphic factors preventing tree-growth.

The Gros Savanna and the De Jong Noord Savanna, both parts of this complex, were studied in 1959 (VAN DONSELAAR 1965), but at that time there was no opportunity to check the results in a larger area.

In the meantime some additional data were collected more to the south-east of the complex, in particular on a nameless savanna that will be called here De Jong Zuid Savanna.

The very attractive De Jong Zuid Savanna is situated east of the hamlet De Jong Zuid, on the watershed between two tributaries of the Saramaka River. It is a long stretch of savanna running ESE-WNW and covering an area of about 380 ha. The surface, 34 m above sea-level at a maximum, undulates slightly and slopes down gradually to the edges of the surrounding forest. In VAN KOOTEN (1954) details concerning the geology and soil conditions of this area and some good photographs can be found.

The vegetation agrees in principle with the one of the two above mentioned savannas. It consists for the greater part of communities belonging to the *Bulbostylidion lanatae*. See Table I (all records were made in December 1965).

Most slopes and flat ridges with sandy soil are covered by an open orchard-savanna vegetation in which the most common treelet is *Byrsonima crassifolia* in its characteristic gnarled orchard-tree form ("malosa"). Other frequent treelets are *Roupala montana*, *Antonia ovata*, and *Humiria balsamifera* var. *guianensis*. This vegetation type is

TABLE I

De Jong Zuid Savanna. Bulbostylidion lanatae.

Nr. of record	1	2	3	4
Area (m ²)	1000	100	100	20
Cover (%), total	85	90	85	60
tree layer	25	5	-	-
herb layer	75	90	85	60
Layer of algae	x	x	x	-
Height, tree layer (m)	8	3	-	-
herb layer (cm)		55	40	35
<u>1 a Ch. Bulbostylidion lanatae and associations</u>				
<i>Rhynchospora rhizomatosa</i> Lindeman ined.	1	2	3	.
<i>Bulbostylis spadicosa</i> (H.B.K.) Kth. (local)	1	+	.	.
<i>Bulbostylis lanata</i> (H.B.K.) Clarke	.	2	2	.
<i>Mesosetum tenuifolium</i> Swallen (local)	2	.	.	1
<i>Byrsonima crassifolia</i> (L.) L.C.Rich.				
orchard tree ad.	2	1	+	+
juv.	3	1	+	+
<i>Rhynchospora curvula</i> Griseb.	.	.	1	.
<i>Bulbostylis conifera</i> Kunth, small form	.	.	2	2
<u>Ch. Paspalotelia pulchelli</u>				
<i>Panicum micranthum</i> H.B.K.	1	1	.	1
<i>Sauvagesia sprengelii</i> St.Hil.	+	+	.	+
<i>Perama hirsuta</i> Aubl.	+	+	.	.
<i>Legenocarpus tremulus</i> Nees	+	.	1	.
<i>Cosolia lythraroides</i> Naud.	.	+	+	.
<i>Paspalus pulchellus</i> Kunth	.	.	2	+
<i>Rhynchospora graminea</i> Uitt.	.	.	+	.
<i>Bulbostylis carolinata</i> (Nees) Kunth	.	.	.	3
<u>Ch. class</u>				
<i>Rhynchospora barbata</i> (Vahl) Kunth var. barb.	1	1	2	+
<i>Leptocoryphium lanatum</i> (H.B.K.) Nees	2	1	1	.
<i>Hypolytrus pulchrus</i> (Rudge) Pfeiff.	1	2	+	.
<i>Trachypogon plumosus</i> (H. & B.) Nees	3	3	.	1
<i>Coutoubea spicata</i> Aubl.	+	.	+	+
<i>Aristida tinota</i> Trin. & Rupr.	1	1	.	.
<i>Sipanea pratensis</i> Aubl.	+	+	.	.
<i>Rhynchospora globosa</i> (H.B.K.) R. & S.	.	1	+	.
<i>Mesosetum cayennense</i> Steud.	+	.	.	1
1/2 <i>Scleria cyperina</i> Willd.	1	1	.	.
Number of species omitted from the table	3	5	1	1

- Rec. 1 2: *Humiria balsamifera* (AUBL.) ST. HIL. var. *guianensis* (BENTH.) CUATR. 1, *Roupala montana* AUBL. 1, *Antonia ovata* POHL +.
- Rec. 2 ch. cl.: *Panicum nervosum* 1, *Buchnera palustris* +, *Axonopus purpusii* +; 1/2: *Eugenia punicifolia* var. *punicifolia* +; 2: *Tetracera asperula* +.
- Rec. 3 *Cassytha filiformis* +.
- Rec. 4 ch. cl.: *Axonopus pulcher* +.

the *Byrsonimetum crassifoliae malosae* (rec. 1 and 2).

On the higher parts of the savanna this community may be bordered on its upper side by a vegetation of the *Bulbostylidion spadicosa boreo-surinamense* (photo 1), but a mosaic of both may occur also here and there. The latter association is characterized mainly by the preponderance of the interesting though annoying sedge *Bulbostylis spadicosa*, whose short woody stems, whenever close-set, make walking a torment.

In the highest part of the savanna the vegetation tends towards the *Axonopodetum purpusii*, an association of the Imperato-Mesosetion. Here *Axonopus purpusii* and *Mesosetum cayennense* are the most common species.

Another milieu is formed by some small mounds consisting



Photo 1. De Jong Zuid Savanna, northern Surinam. *Bulbostylidetum spadiceae boreo-surinamense*. Recognizable are *Byrsonima crassifolia* (treelet), *Trachypogon plumosus* (high grass), *Bulbostylis spadicea* (shaving-brush shaped sedge).
 Photo 2. Savanna 7 km west of Kourou, French Guiana. Hygrophilous community of *Byrsonima verbascifolia*. The globular inflorescences belong to *Rhynchospora barbata*.

mainly of pebbles. Here open bushes are developed, characterized by *Roupala montana* and *Antonia ovata* (*Roupala-Antonia* bushes, VAN

DONSELAAR 1965). On the small open patches between them the scanty vegetation is primarily made up of *Bulbostylis circinata* and very small specimens of *Bulbostylis conifera* (*Bulbostylidetum coniferae minoris*, rec. 4).

Stretches of the savanna with moister soil conditions support another association, viz. the *Rhynchosporietum curvulae* (rec. 3). On the Gros Savanna this vegetation seemed to be associated with the occurrence of many pebbles in the soil. This is not confirmed here. It is likely that the difference between the habitat of the *Rhynchosporietum curvulae* and the *Byrsonimietum crassifoliae malosae* (and probably between all associations of the *Bulbostylidion lanatae*) is mainly hydrological.

On its northern side the savanna is over some distance not bordered by savanna wood or high forest, but by savanna scrub. Frequent species in this scrub are *Lincania incana*, *Pagamea capitata*, *P. guianensis*, *Retiniphyllum schomburgkii*, *Clusia fockeana*, *Conomorpha magnoliifolia*, *Humiria balsamifera*, *Marlierea montana*, *Bactris campestris*, *Ternstroemia punctata*, *Bombax flaviflorum*, and *Tetracera asperula*. The undergrowth, only present in the thinner parts, is formed mainly by *Scleria cyperina* and *Hypolytrum pulchrum*.

This scrub agrees very well with a type of savanna bushes described as the *Marlierea* type (VAN DONSELAAR 1965). These bushes are found on other savannas of the Sabanpasi type (e.g. Gros Savanna, De Jong Noord Savanna and the smaller savannas treated hereafter), scattered in vegetations of the *Rhynchosporietum curvulae*, and indicating a wet soil of loamy sand.

This relation — scrub and separate bushes of the same composition — is also met with on the white sand savannas (Kasipora and Zanderij type) more to the North. HEYLIGERS (1963) describes *Ternstroemia-Matayba* scrub and bushes, and *Clusia-Scleria* scrub and bushes.

East of the village Brownsweg some very small savannas of not more than a few hectares each were studied.¹⁾

These savannas are quite flat and their presence can be explained sufficiently by the hydrology of their loamy sand soils. Their vegetation is fairly uniform and belongs to the *Rhynchosporietum curvulae* (table XI, rec. 1, 2 and 3).

Bushes and larger scrub fragments of the *Marlierea* type are found everywhere in slightly elevated places. Table II shows their composition and the relation between size and number of species.

¹⁾ This was undertaken as part of a study on the Brokopondo Lake and its surroundings, set up by the Foundation for Scientific Research in Surinam and the Netherlands Antilles, and financed by the Netherlands Foundation for Tropical Research (Wotro).

TABLE II

Savannas E of Brownveg.		Marlierea bushes.									
Area (a2)		4	4	4	5	7	12	20	35	40	175
Number of shrub species		7	9	8	7	10	12	10	12	14	15
<u>Shrubs</u>											
<i>Marlierea montana</i> (Aubl.) Amsh.		x	x	a	a	x	a	a	x	a	a
<i>Clusia fockeana</i> Miq.		a	x	a	a	x	a	a	a	a	a
<i>Bactris campestris</i> Poepp.		x	x	x	x	x	x	x	x	x	x
<i>Bombax flaviflorum</i> Pulle		x	x	x	x	x	x	x	x	x	x
<i>Licania incana</i> Aubl.		x	x	.	x	x	a	a	a	x	a
<i>Paganea capitata</i> Benth.		x	x	x	x	x	x	.	.	a	a
<i>Rumiria balsamifera</i> (Aubl.) St.Hil.		x	x	a	.	x	x	x	x	x	x
<i>Retinophyllum schumburgkii</i> (Benth.) Mill.Arg.		.	.	.	.	.	.	.	.	.	.
<i>Ternstroemia punctata</i> (Aubl.) Sw.		.	.	.	.	.	.	.	.	.	.
<i>Conomorpha magnoliifolia</i> Mes		.	.	.	.	.	.	.	.	.	.
<i>Miconia ciliata</i> (L.C.Rich.) DC.		.	.	.	.	.	.	.	.	.	.
<i>Clusia nemorosa</i> G.F.W.Meyer		.	.	.	.	.	.	.	.	.	.
<i>Coccoloba latifolia</i> Lam.		.	.	.	.	.	.	.	.	.	.
<i>Matayba opaca</i> Radlk.		.	.	.	.	.	.	.	.	.	.
<i>Psychotria cordifolia</i> H.B.K.		.	.	.	.	.	.	.	.	.	.
<i>Protium spec.</i>		.	.	.	.	.	.	.	.	.	.
<u>Young trees</u>											
<i>Andira coriacea</i> Pulle		.	.	.	.	.	.	.	.	.	.
<i>Trattinickia burserifolia</i> Mart.		.	.	.	.	.	.	.	.	.	.
<u>Lianas and and other twiners</u>											
<i>Tetracera asperula</i> Miq.		x	x	x	x	x	x	x	x	x	x
<i>Caseytha filiformis</i> L.		x	x	.	.	.	.	.	.	.	.
<i>Tetrapteris squarrosa</i> Griseb.		.	.	.	.	.	.	.	.	.	.
<i>Clusia platystigma</i> Rym.		.	.	.	.	.	.	.	.	.	.
<u>Herbs</u>											
<i>Hypolytrum pulchrum</i> (Rudge) Pfeiff.		x	x	.	.	x	x	x	x	x	x
<i>Scleria cyperina</i> Willd.		x	x	.	.	x	x	.	.	.	.
<i>Epidendrum oncioides</i> Lindl.		.	.	.	.	.	.	.	.	.	.
<u>Mosses and lichens</u>											
<i>Octoblepharum oceanense</i> Mitt.		x	.	.	.	x	.	.	.	.	.
<i>Gladonia spec.</i>		x	x	x	.	.	.	.	.	.	.

3. SAVANNAS NEAR BERG EN DAL, NORTHERN SURINAM

The village Berg en Dal is situated on the western bank of the Surinam River, at the foot of a hill called Blauwe Berg. The top of this hill lies 85 m above sea-level, the elevation above the surrounding undulating land being about 75 m.

The northern part of the hill is covered by a rather low type of forest, the rest, at least on the higher levels, by savanna vegetation. To the south-west the savanna extends to some distance over a flat part of the adjoining country. The hill-part and the flat part of the savanna are more or less separated from each other by an open secondary scrub vegetation and cover areas of 18 and 25 ha respectively.

The hill-savanna was briefly dealt with on the basis of a small collection made by Dr. P. C. HEYLIGERS (VAN DONSELAAR 1965). It was then erroneously supposed to be one of the savannas classified by COHEN & VAN DER EYK (1953) as the Bosland type. However, up till now no savanna of this type has been the subject of a botanical investigation.

The savannas of Berg en Dal form part of the schist-hill landscape, and the flat savanna is even situated on a foot plain, like the savannas of the Bosland type. However, they do not agree with the description of the savannas of the last-named type which occur under natural, i.e. edaphic, savanna conditions.

The savannas under consideration are purely anthropogenic, i.e. the result of the cutting of forest and subsequent repeated burning. Already in the 18th century the area belonged to the plantation Berg en Dal, as shown on a map by DE LAVAUX (\pm 1750). When the slavery ended (1863) and the plantation was given up, some of the plantation labourers stayed in the village. Up to the present their descendants continue to put a heavy stamp on the scenery by practising shifting cultivation and burning the vegetation of the non-forested parts of the land.

TABLE III
Savannas near Berg en Dal.

Nr. of record	1	2	3	4
Month (1965)	VII	VIII	XII	XII
Area (m ²)	50	50	100	100
Cover (%), total	100	75	90	70
tree/shrub layer	2	15	-	-
herb layer	100	75	90	70
moss layer	5	-	-	-
Height (cm), tree/shrub layer (max.)	320	200	-	-
herb layer	120	70	70	60
1 a Ch. Rhynchospora-Trachypogonion (local)				
<i>Mimosa debilis</i> H.B.K.	(+)	.	.	.
<i>Mimosa camporum</i> Benth.	.	+	.	.
<u>Ch. Trachypogonetalia plumosae</u>				
<i>Bulbostylis junciformis</i> (H.B.K.) Kunth	1	1	+	1
<i>Mitracarpus discolor</i> Miq.	2	+	.	.
<i>Dichromena ciliata</i> Vahl	1	+	.	1
<i>Phyllanthus stipulatus</i> (Raf.) Webeter (local)	+	(+)	.	.
<i>Schwenckia americana</i> L.	.	+	1	.
<i>Bulbostylis capillaris</i> (L.) Kunth	.	.	.	.
var. <i>ternifolia</i> Clarke	2	(+)	.	.
<i>Eupatorium martiusii</i> DC.	+	.	.	.
<u>Ch. Panicetalia stenodis</u>				
<i>Panicum stenodes</i> Griseb.	.	.	.	1
<u>Ch. class</u>				
<i>Andropogon leucostachyus</i> H.B.K.	5	3	5	2
<i>Eupatorium amygdalinum</i> Lam.	2	1	.	+
<i>Clidemia rubra</i> (Aubl.) Mart.	2	+	.	.
<i>Hyptis atrorubens</i> Poit.	2	+	.	.
<i>Sipanea pratensis</i> Aubl.	1	+	2	1
<i>Melochia villosa</i> (Mill.) Fawc. & Rendle	+	.	.	.
<i>Scleria macrocoeca</i> (Liebm.) Steud.	+	.	.	.
<i>Aristida tinota</i> Trin. & Rupr.	.	1	2	2
<i>Paspalum plicatulum</i> Michx.	.	+	.	.
<i>Sida linifolia</i> Cav.	.	+	.	.
<i>Desmodium barbatum</i> (L.) Benth.	.	+	.	.
<i>Scleria hirtella</i> Sw.	.	.	1	+
<i>Coutoubea spicata</i> Aubl.	.	.	+	.
<i>Axonopus pulcher</i> (Nees) Kuhl.	.	.	+	+
1 b Axonopus fockei (Mes) Henr.				
<i>Melampodium camphoratum</i> (L.f.) Baker	1	3	.	4
<i>Eupatorium odoratum</i> L.	+	+	.	.
<i>Panicum rudgei</i> R. & S.	+	+	.	.
<i>Crotalaria stipularia</i> Desv.	+	+	.	.
<i>Jaquesontia guianensis</i> (Aubl.) Meissn.	1	.	.	.
<i>Curatigo scoronerifolia</i> (Lam.) Baker	+	.	.	.
<i>Cyperus sesquiflorus</i> (Torr.) Mattf. & Kük.	.	.	.	.
var. <i>minor</i> (Boeck.) Kük.	+	.	.	.
<i>Clidemia hirta</i> (L.) D. Don.	.	.	.	.
var. <i>elegans</i> (Aubl.) Griseb.	+	.	.	.
<i>Andropogon selloanus</i> (Hack.) Hack.	.	+	.	.
<i>Eupatorium pauciflorum</i> H.B.K.	.	+	.	.
/Eichl.	.	.	.	.
1/2 Casearia silvestris Sw. var. lingua (Camb.)				
<i>Tibouchina aspera</i> Aubl.	.	2	2	2
<i>Rhynchospora cephalotes</i> (L.) Vahl	.	+	1	+
<i>Amasonia campestris</i> (Aubl.) Moldenke	.	.	1	1
2 Miconia ciliata (L.C.Rich.) DC.				
<i>Davilla aspera</i> (Aubl.) R. Ben.	.	+	.	.
Other species				
<i>Byrsonima crassifolia</i> (L.) L.C.Rich., ed. and j. 2	2	(x)	.	.
<i>Vismia cayennensis</i> (Jacq.) Pers., juv.	+	.	.	.
<i>Pissidens elegans</i> Rrid.	1	.	.	.
Hepaticae, 2 spp.	+	.	.	.
Lichen spec.	+	.	.	.

The author studied these savannas in 1965, in collaboration with Mrs. Dr. W. A. E. VAN DONSELAAR-TEN BOKKEL HUININK.

The flat top of the Blauwe Berg bears a fairly uniform vegetation, as shown in table III, rec. 1. The dominating species is the grass *Andropogon leucostachyus*. Beside those in the table the following species may be named: *Wulffia baccata*, *Rolandra fruticosa*, *Passiflora foetida*, *Croton trinitatis*, *Piriqueta cistoides*, and *Cordia schomburgkii*. The heavy, red-brown topsoil has a loose, crumbling structure, and small worm-mounds appear on the surface.

The rather steep slopes (30° on the south-eastern side) are dissected by narrow gullies and have a rather uneven surface with outcropping boulders in many places. In general the vegetation resembles that of the top (rec. 2). Here too *Andropogon leucostachyus* is everywhere an important constituent of the herb layer, but in addition *Axonopus fockei* (as in rec. 2), *Paspalum plicatulum*, and *Aristida tinctoria* may locally attain a high abundance.

On parts of the slopes the vegetation is more shrubby. *Byrsonima crassifolia* treelets are found here more closely together than on the top. There are also patches of true scrub, with *Davilla aspera* as the dominating species. The most frequent of the other species are *Vismia cayennensis*, *Miconia ciliata*, and *Nepsera aquatica*.

Both open vegetation types may be classified as communities of the alliance Rhynchosporo-Trachypogonion. The only characteristic species of this alliance in northern Surinam, the rare *Buchnera rosea*, is not present, but the same holds for the more numerous characteristic species of the other Trachypogonetalia alliances and those of the other orders. Moreover *Andropogon leucostachyus* and *Aristida tinctoria* are differential species for the Rhynchosporo-Trachypogonion within the order Trachypogonetalia plumosi.

The two *Mimosa* species are remarkable. *Mimosa debilis* is found only on the top, *Mimosa camporum* on the slopes. Both species do not occur anywhere else in Surinam, either on savannas or in other places.

Very well represented is a group of species occurring in all sorts of open localities, provided they are not too wet (1 b in the table). This appears to be in accordance with the anthropogenic state of the savanna.

The flat savanna has a heavy and compact soil, the surface of which is either more grey, or more yellow and apparently wetter. Two vegetation types reflect these differences in habitat.

On the grey soil *Andropogon leucostachyus* is the dominant species, with *Aristida tinctoria* second (table III, rec. 3). Low scattered specimens of *Byrsonima crassifolia* may occur in this vegetation; *Vismia guianensis* is also present here and there.

The greater part of the savanna is covered by the vegetation corresponding with the sordid yellow soil (rec. 4). *Axonopus fockei* is the most abundant grass here, with *Andropogon leucostachyus*, *Aristida tinctoria* and/or *Axonopus pulcher* as codominant species. The slender *Panicum stenodes* comes to the fore locally, in places with much activity of worms, though the surface does not have a pronounced hog-wallow structure. These are probably the wettest places in this savanna.

The poverty in species makes it difficult to give the two communities a place in the general classification. They seem to form more or less a „summary” of the two types of the hill-savanna. However, the *Axonopus fockei* vegetation tends towards the *Axonopodium chrysitidis*.

The general impression is that this savanna is a relatively young anthropogenic savanna which is not yet “saturated” with species. On the long run it probably will develop into a savanna with the same character as e.g. the former (recently forested) savanna Mimili Okili (Coesewijne type) near Powaka (see VAN DONSELAAR 1965).

4. SAVANNAS NEAR CAYENNE, FRENCH GUIANA

The northern savanna-belt of Guyana and Surinam extends in French Guiana in a south-easterly direction. In northern French Guiana, however, the geological formations are not as regularly arranged as they seem to be in Surinam (see e.g. BOYÉ 1959, DOST 1963). Therefore it is not easy, if not impossible, to classify the savannas of northern French Guiana in the system of COHEN & VAN DER EYK (1953). The Watamalejo and Coesewijne types may be involved, but for the moment it seems preferable to avoid any subdivision.

On the basis of the description by BENOIST (1925) it was tried to compare the savanna vegetations of this region as good as possible with those of Surinam (VAN DONSELAAR 1965). During a visit together with Mrs. Dr. W. A. E. VAN DONSELAAR-TEN BOKKEL HUININK in September, 1965, there was an opportunity to learn, by some personal inspection, a little more about this relation. Savanna vegetations were studied haphazardly in the area south and west of Cayenne up to 7 km beyond Kourou. At a number of sampling stations without a definite size all species were registered, with simple notes concerning their abundance (d = dominant, a = abundant, x = present).

It is to be stressed that all savannas in northern French Guiana are burnt periodically and that several of them are grazed by cattle

(see e.g. Hooek 1960). In the short time available no data about the last-named factor (place, intensity, periodicity) could be collected.

A striking phenomenon on the savannas in the area examined is the abundance of *Byrsonima verbascifolia* (var. *villosa* fo. *spathulata*). Wherever it is present, this plant immediately catches the eye with its long spathulate, grey-green leaves and its bright-yellow racemes of flowers. In Surinam it is common only on a single savanna, viz. the Coesewijne Savanna (Coesewijne type), where it characterizes a well-defined association, the Dipteracantho-*Byrsonimatum verbascifoliae* (alliance Rhynchosporo-Trachypogonion). In French Guiana one would be inclined at first view to regard all vegetations with this conspicuous species as one entity. However, on closer examination, when all associate species are taken into consideration, at least two communities can be distinguished.

On the Savanna of Matiti, south-east of Kourou, large stretches are covered by a uniform vegetation with much *Byrsonima*, together with a number of characteristic species of the *Trachypogonetalia plumosi*, and much *Aristida tincta*, *Mesosetum cayennense*, and *Bulbostylis lanata* (table IV, rec. 2). Apart from the presence of the last one, the total combination of species points to the Rhynchosporo-Trachypogonion. This may be in accordance with the texture of the topsoil which appeared to consist of a grey loam. This community might provisionally be called "the xerophilous community of *Byrsonima verbascifolia*".

An example of another vegetation type with much *Byrsonima verbascifolia* was encountered on a savanna 7 km west of Kourou, south of the main road (table XII, rec. 6 and 7, photo 2). Here too *Bulbostylis lanata* is one of the most abundant associate species, but for the rest the preceding and the present vegetation differ in many respects. *Paspalum pulchellum*, *Rhynchospora barbata*, *R. tenuis*, and *R. globosa* are most numerous here. The topsoil is grey and fine-sandy. We have an example of a vegetation type belonging to the *Bulbostylidion lanatae*, called provisionally "the hygrophilous community of *Byrsonima verbascifolia*".

Another community that was frequently met and that may cover large areas is the *Rhynchosporietum curvulae*, also belonging to the *Bulbostylidion lanatae* and described from northern Surinam. It is characterized in the first place by the abundance of the tiny *Rhynchospora curvula*. Record 5 of table XI represents this vegetation type from a locality not far from the former, on a grey-brown, sandy-loamy soil. On the drier and more sandy side of its habitat this vegetation borders on a community consisting mainly of tall grasses (*Trachypogon plumosus*, *Schizachyrium riedelii*; table IV,

TABLE IV
 French Guiana. *Trachypogonetalia plumosi*.

Nr. of record	1	2	3
Total cover (%)	85	60	
1 a Ch. <i>Trachypogonetalia plumosi</i>			
<i>Ichthyothere terminalis</i> (Spreng.) Malme	x	x	x
<i>Schizochyrium riedelii</i> (Trin.) A. Camus var. <i>riedelii</i>	a	.	.
<i>Cassia hispidula</i> Vahl	x	.	.
<i>Bulbostylis junciformis</i> (H.B.K.) Kunth	x	.	.
<i>Mitracarpus discolor</i> Miq.	x	.	.
<i>Bulbostylis fasciculata</i> Utt.	.	x	.
<i>Mitracarpus microspermus</i> K. Schum.	.	x	x
<i>Cassia ramosa</i> Vog. var. <i>ramosa</i>	x	.	.
Ch. Curatello-Trachypogonion			
<i>Phaseolus longepedunculatus</i> H.B.K.	x	.	.
<i>Stylosanthes guianensis</i> (Aubl.) Sw. var. <i>gracilis</i> (H.B.K.) Vog.	x	.	.
<i>Rhynanthus ipecacuanha</i> (L.) Bail.	.	.	x
Ch. <i>Paspaletalia pulchellii</i>			
<i>Bulbostylis lanata</i> (H.B.K.) Clarke	.	a	.
<i>Comolia lythraioides</i> Naud.	.	x	.
Ch. class			
<i>Axonopus pulcher</i> (Nees) Kuhl.	a	.	d
<i>Trachypogon plumosus</i> (H. & B.) Nees	d	a	.
<i>Cassia cultrifolia</i> H.B.K.	x	x	.
<i>Axonopus purpurei</i> (Mex) Chase (D. Rh.-Trachypogonion)	a	x	.
<i>Leptocoryphium lanatum</i> (H.B.K.) Nees (idem)	x	x	.
<i>Rhynchospora barbata</i> (Vahl) Kunth var. <i>barbata</i> (idem)	.	a	.
<i>Aristida tinota</i> Trin. & Rupr. (idem)	.	x	.
<i>Eriosema simplicifolium</i> (H.B.K.) G. Don.	x	.	.
<i>Byrsonima verbascifolia</i> (L.) L.C. Rich. var. <i>villosa</i> Griseb. fo. <i>spatulata</i> Mds.	.	a	.
<i>Mesosetum cayennense</i> Steud.	.	x	.
<i>Glidemia rubra</i> (Aubl.) Mart.	.	x	.
<i>Eriosema crinitum</i> (H.B.K.) G. Don.	.	x	.
<i>Scleria micrococca</i> (Liebm.) Steud.	.	x	.
<i>Palicourea rigida</i> H.B.K.	.	x	.
<i>Sipanea pratensis</i> Aubl.	.	x	x
<i>Coutoubea spicata</i> Aubl. (D. Rh.-Trachypogonion)	.	.	x
<i>Eyptis atrorubens</i> Poit.	.	.	x
<i>Eupatorium amygdalinum</i>	.	.	x
<i>Polygala timouton</i> Aubl.	.	.	x
<i>Gerardia hispidula</i> Mart.	.	.	x
1/2 <i>Tibouchina aspera</i> Aubl.	.	x	x
<i>Scleria cyperina</i> Willd.	.	x	x
Number of species omitted from the table	1	1	-
Rec. 1	<i>Byrsonima crassifolia</i> juv. +.		
Rec. 2	Gram. spec. +.		

rec. 1). This vegetation fits best in the Curatello-Trachypogonion.

Between Cayenne and Stoupan, a village to the south, the savanna vegetation was recorded in several places. The habitats of the vegetation types examined here can be arranged in a series ranging from dry to very wet.

The vegetation represented by record 3 of table IV was met with on a low hill with a yellow-grey, sandy-loamy soil and many pebbles on the surface. *Axonopus pulcher* is the dominant species. The only alliance in which this community might be included is the Rhynchosporo-Trachypogonion.

Around this hill the ground is covered by a vegetation of the Rhynchosporium curvulae, very much like record 6 of table XI. This record, however, was made in another stretch of savanna that very gradually slopes down to a lower level with a

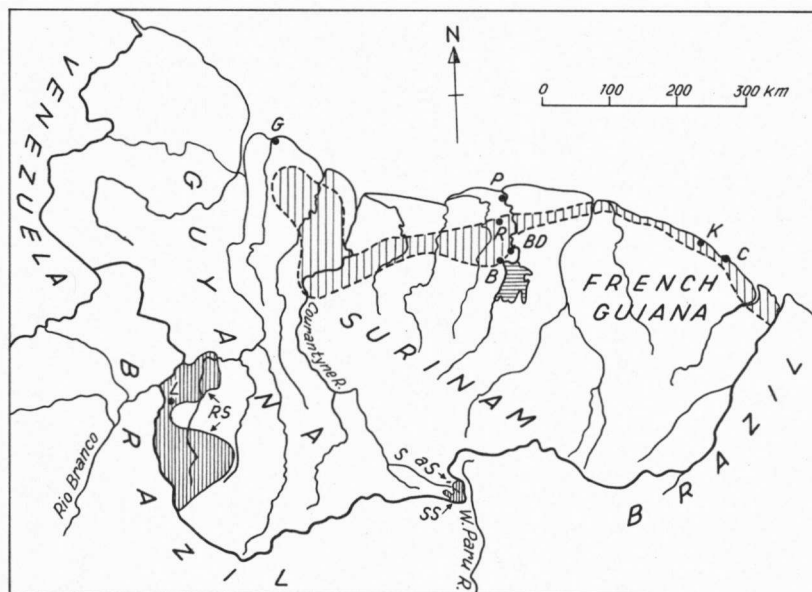


Fig. 1. The central part of the Guianas. Indicated are: The northern savanna area in Guyana, Surinam, and French Guiana (R = Republiek, B = Brownsweg, BD = Berg en Dal, K = Kourou, C = Cayenne), the Rupununi Savannas (RS; L = Lethem), the Sipaliwini Savanna (SS), the Sipaliwini River (S), the airstrip "Sipaliwini" (aS), Georgetown (G), Paramaribo (P).

lead-grey, loamy soil, and hummocks (i.c. worm-mounds) of 35 to 40 cm high on the surface (hog-wallow structure). In this lower part the vegetation consists largely of the tall *Rhynchospora globosa* and belongs to the *Rhynchosporium globosae* (alliance *Axonopodium chrysitidis*; table VI, rec. 1).

On a steeper slope another community was found interlaced between the *Rhynchosporium curvulae* and the *Rhynchosporium globosae*, viz. the *Rhynchosporium podospermae*. *Rhynchospora podosperma* has its optimum in this latter type which is the association of the *Bulbostylidium lanatae* occurring in the wettest places. In record 4 of table XII this can be seen by the presence of some characteristic species of the *Panicetalia stenodis*. The *Rhynchosporium globosae*, bordering the *Rhynchosporium podospermae* on the wetter side of its habitat, belongs to this order. It generally forms a narrow zone along watercourses in the savanna.

The watercourses and the wet depressions in the savanna can be recognized from afar not only by the tall *Mauritia flexuosa* palms but also by flowering shrubs of *Rhynchanthera grandiflora*. The vegeta-

tion belongs to the alliance Mauritio-Hypogynion and is represented by record 2 of table VI.

The whole series from *Rhynchosporetum curvulae*, *Rhynchosporetum podospermae*, *Rhynchosporetum globosae* to a Mauritio-Hypogynion community agrees completely with the situation found on the Gros Savanna and the De Jong Noord Savanna in northern Surinam (VAN DONSELAAR 1965).

One more community from the region south of Cayenne has to be mentioned. In table V record 1 represents a type closely resembling the *Panicetum stenodoidis*, an association of the Imperato-Mesosetion occurring on several savannas in northern Surinam. It was found on a stretch of savanna along the road to

TABLE V

French Guiana. Imperato-Mesosetion.				
Nr. of record		1	2	3
Total cover (%)		80		80
Layer of algae		x	x	-
1 a	<i>Ch. Paspaletalia pulchelli</i>			
	<i>Paspalum pulchellum</i> Kunth	a	a	.
	<i>Rhynchospora podosperma</i> C.Wright	(x)	x	.
	<i>Byrsonima crassifolia</i> (L.) L.C.Rich., orchard tree	.	.	x
	<i>Ch. Trachypogonetalia plumosi</i>			
	<i>Dichromena ciliata</i> Vahl	.	.	x
	<i>Phaseolus longepedunculatus</i> H.B.K.	.	.	x
	<i>Phaseolus pedunculatus</i> H.B.K. var. <i>olitoroides</i> (Benth.) Hassl.	.	.	x
	<i>Ch. Panicetalia stenodis</i>			
	<i>Axonopus chrysites</i> (Steud.) Kuhn.	.	.	x
	<i>Odontadenia nitida</i> (Vahl) Mill.Arg.	.	.	x
	<i>Ch. class</i>			
	<i>Aristida tinctoria</i> Trin. & Rupr. (D. Imp.-Mes.)	x	a	x
	<i>Echinolaena inflexa</i> (Poir.) Chase	x	x	x
	<i>Rhynchospora barbata</i> (Vahl) Kunth. var. <i>barbata</i>	a	a	.
	<i>Andropogon leucostachyus</i> H.B.K. (D. Imp.-Mes.)	x	x	.
	<i>Panicum stenodoides</i> Hubbard	x	.	.
	<i>Scleria hirtella</i> Sw.	(x)	.	.
	<i>Rhynchospora globosa</i> (H.B.K.) R. & S. (D. I.-Mes.)	.	a	.
	<i>Axonopus purpusii</i> (Mes) Chase (D. Imp.-Mes.)	.	x	.
	<i>Cassia cultrifolia</i> H.B.K.	.	x	.
	<i>Eriosema simplicifolium</i> (H.B.K.) G.Dom.	.	x	.
	<i>Byrsonima verbascifolia</i> (L.) L.C.Rich. var. <i>villosa</i> Griseb. fo. <i>spatulata</i> Rds.	.	x	.
	<i>Leptocoryphium lanatum</i> (H.B.K.) Nees	.	x	x
	<i>Imperata brasiliensis</i> Trin. (D. Cur.-Imperatetum)	.	.	a
	<i>Curatella americana</i> L. (D. Cur.-Imperatetum)	.	.	x
	<i>Clidemia rubra</i> (Aubl.) Mart.	.	.	x
	<i>Desmodium barbatum</i> (L.) Benth.	.	.	x
	<i>Eyptis atrorubens</i> Poit.	.	.	x
	<i>Eupatorium amygdalinum</i> Lam.	.	.	x
1 b	<i>Andropogon bicornis</i> L.	.	.	x
1 c	<i>Setaria gemiculata</i> (Lam.) Beauv.	.	.	x
1/2	<i>Tibouchina aspera</i> Aubl.	x	(x)	a
	<i>Scleria bracteata</i> Cav.	.	(x)	a
	<i>Amansia campestris</i> (Aubl.) Moldenke	.	.	x
2	<i>Miconia ciliata</i> (L.C.Rich.) DC.	.	.	x
	Other species			
	<i>Heliconia psittacorum</i> L.f.	.	.	x
	Number of species omitted from the table	1	-	9

Rec. 1 Gram. spec. +.

Rec. 3 ch. cl.: *Miconia albicans* (Sw.) TRIANA x; 2: *Maprounea guianensis* AUUBL. juv. x; Irid. spec. x, *Phenakospermum guianense* x, *Solanum* spec. x, *Manihot* spec. x, fern spec. x, 2 spp. indet. x.

TABLE VI

French Guiana. <i>Panicetalia stenodis</i> .			
Nr. of record	1	2	3
Total cover (%)	95		
1 a Ch. <i>Panicetalia stenodis</i>			
<i>Rhynchospora glauca</i> Vahl	x	x	.
<i>Sauvagesia rubiginosa</i> St.Hil.	x	x	.
<i>Hypogynium virgatum</i> (Desv.) Dandy	x	.	.
<i>Raddiella nana</i> (Doell.) Swallen	x	.	.
<i>Turnera guianensis</i> Aubl.	.	x	.
<i>Panicum cyanescens</i> Nees	.	x	.
<i>Acisanthera recurva</i> (L.C.Rich.) Griseb.	.	.	x
Ch. Mauritio-Hypogynium			
<i>Rhynchanthera grandiflora</i> (Aubl.) DC.	.	a	.
Ch. class			
<i>Rhynchospora globosa</i> (H.B.K.) R. & S.			
(D. <i>Rhynchosporium globosae</i>)	a	.	.
<i>Hypolytrum pulchrum</i> (Rudge) Pfeiff.	x	a	.
<i>Echinochaena inflata</i> (Poir.) Chase	x	x	.
<i>Leptocoryphium lanatum</i> (H.B.K.) Nees	x	.	.
<i>Xyris atrovirens</i> Poit.	.	x	.
<i>Soleria hirtella</i> Sw.	.	x	.
1 b <i>Andropogon bicornis</i> L.	.	.	x
1 c <i>Panicum parvifolium</i> Lam. (D. Maur.-Hypogynium)	.	x	x
1 d (all D. Maurition-Hypogynium)			
<i>Eleocharis indica</i> Burm.f.	.	x	x
<i>Puirena umbellata</i> Rosab.	.	x	x
<i>Eleocharis spec.</i>	.	x	.
<i>Rhynchospora cyperoides</i> (Sw.) Mart.	.	.	x
<i>Cyperus haspan</i> L. ssp. <i>juncooides</i> (Lam.) Kunz.	.	.	x
<i>Montrichardia arborescens</i> (L.) Schott	.	.	x
1/2 <i>Tibouchina aspera</i> Aubl.	a	.	.
<i>Soleria cyperina</i> Willd.	a	.	.
Other species			
<i>Heliconia peittacorum</i> L.f.	.	x	x
<i>Cyperac. spec.</i>	.	a	.
Number of species omitted from the table	1	2	1

- Rec. 1 *Xyris spec. x.*
 Rec. 2 *Xyris spec. x, Sabicea cinerea x.*
 Rec. 3 *Xyris spec. x.*

the airfield Rochambeau, on a grey-yellow, heavy soil with some sand.

Finally some observations made on a savanna south-east of Tonate must be described. Here we came across a piece of orchard savanna similar to the Curatello-Imperatetum of Surinam (alliance Imperato-Mesosetion; table V, rec. 3). An open tree layer of gnarled *Curatella americana* stands above a more or less shrubby ground layer, 1.5 m high, with i.a. much *Imperata brasiliensis*. Just as in Surinam the vegetation contains some characteristic species of the Trachypogonetalia plumosi, but here they are combined with some characteristic species of the Panicetalia stenodis. The occurrence of the species of the last-named group is in accordance with the relative moistness of the habitat. The soil surface has a hog-wallow structure, which was not the case in the vegetations studied so far in Surinam.

This savanna vegetation-type has more or less the character of a secondary type of growth, as indicated by some young trees and species like *Phenakospermum guianense*, *Solanum spec.*, and *Manihot spec.*

In open spots in the orchard vegetation the picture is like record 2 of table V. This vegetation, with much *Paspalum pulchellum*, *Aristida tincta*, *Rhynchospora barbata*, and *R. globosa*, certainly also belongs to the Imperato-Mesosetion, but a further definition is not yet possible.

The vegetation in the bed of a savanna rivulet nearby is represented by record 3 of table VI. It may be recognized as a Mauritio-Hypogynion community, but the small number of species corresponding with the present ecological conditions also seems to indicate recent changes in the environment.

In general it may be said that the savannas in the region studied are poor in species compared with those in northern Surinam. It is not possible to explain this with so few observations available. Nevertheless the classification of the savanna vegetations of northern Surinam can in any case be applied as far down as the level of the alliances but in many instances even associations can be recognized.

5. THE SIPALIWINI SAVANNA, SOUTHERN SURINAM

5.1 TOPOGRAPHY; ECOLOGICAL CONDITIONS

The Sipaliwini Savanna is the smaller part of a large savanna complex situated on both sides of the frontier between Surinam and Brazil. The frontier is formed here by the flat watershed between the West Paru River, a tributary of the Amazon River, and the Sipaliwini River which belongs to the basin of the Courantyne River, one of the major Guianan streams. The complex belongs to the Paroe (= Paru) savanna-type of COHEN & VAN DER EYK (1953) and may be considered as one of the "campos gerais", as the savannas of the Amazon basin are called in Brazil. It is neither mentioned nor mapped in any botanical publication and does not even appear on one of the vegetation maps of the very concise Atlas do Brasil (1959). Only on the "Symposium on the biota of the Amazon basin", Belém, 1966, Mr. D. DE ANDRADE LIMA gave a complete review of all "campos gerais" and indicated the savanna complex under consideration on a self-made map (DE ANDRADE LIMA 1966).

The Sipaliwini Savanna covers an area of about 63,000 ha. It is bordered by forest except on the side of the frontier. Its surface is in general undulating or hilly, varying in altitude between about 275 and 375 m above sea-level. There is in the centre a miniature mountain massif with four tops reaching up to 554 m, called Vier Gebroeders. Several higher hills or mountains mark the frontier, of which Morro Grande do Cemiterio (596 m) is the most spectacular.

The greater part of the area is covered by a savanna vegetation

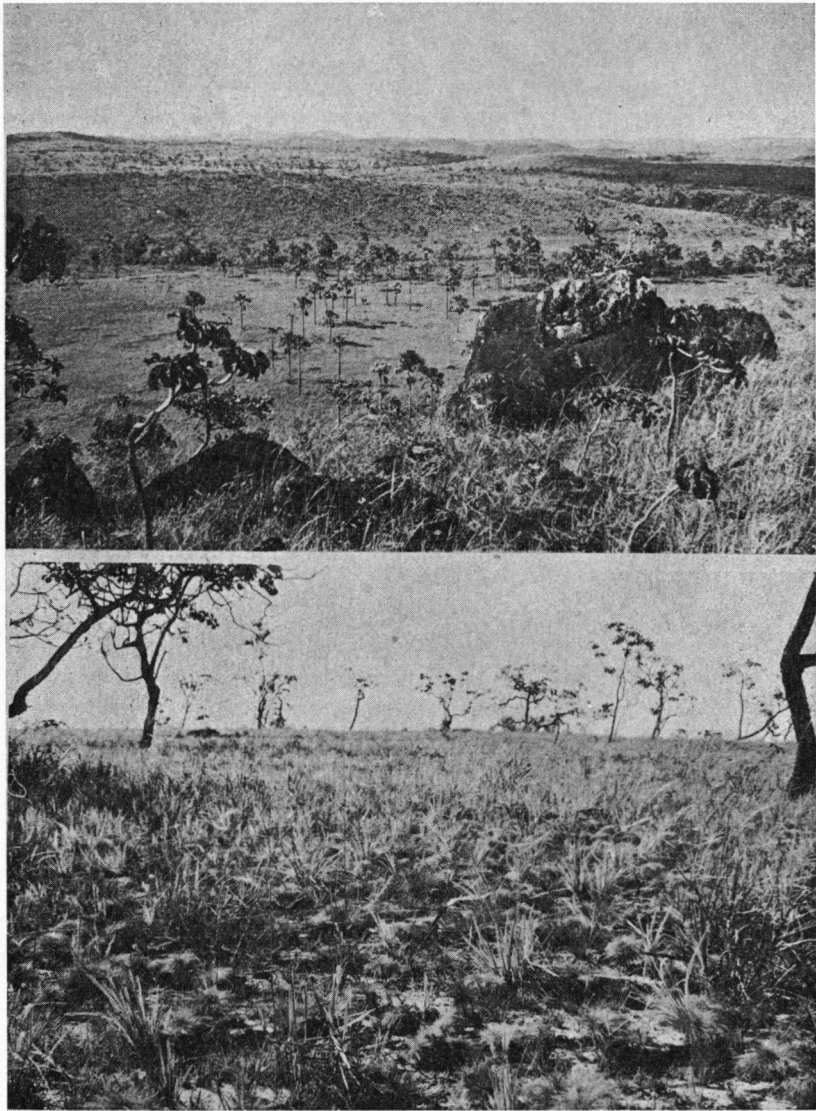


Photo 3. Sipaliwini Savanna, southern Surinam. In the foreground and background relatively dry hills of the "Sipaliwini landscape", in the centre a low stretch with *Mauritia flexuosa* palms.

Photo 4. Sipaliwini Savanna, southern Surinam. Relatively dry site with vegetation dominated by the grass *Paspalum albidulum* and the sedge *Bulbostylis spadiccea*.

consisting of a more or less continuous ground layer and scattered gnarled trees (photo 3). This type of savanna is generally known under the Brazilian name "campo sujo". Treeless stretches and orchard savanna ("campo limpo" and "campo cerrado", respectively) are less common.

The savanna is traversed by many rivulets and creeks, all tributaries of the Sipaliwini River, which in many localities are accompanied by stretches of gallery forest, swamp forest, scrub, open swamps, and pools. Other remarkable landscape elements are patches of high forest, nearly bare rocky outcrops, and large rocks on the tops and the sides of the hills ("dragon teeth").

A very fine description of the savanna was given by VAN LYNDEN (1939), the first explorer who reached this area.

DOST (1962) distinguished three landscape types on the Sipaliwini Savanna:

1. The *Sipaliwini landscape*, with rather high quartzite hills, narrow valleys, and mainly loamy soils. It occupies the greater part of the savanna.
2. The *Morro Grande landscape*, with many low and some high granite hills, wide valleys, and mainly sandy soils. It covers the north-eastern part of the savanna.
3. The *river-valley landscape*, consisting of the valleys of the larger creeks.

The savanna is uninhabited, but potsherds, stone arrow-heads, and grinding furrows give evidence of former occupation. It is visited frequently by semi-nomadic indians and, since a number of years, by balata bleeders and employees of the nearby airstrip. All these people set fire to the vegetation now and then, and it is likely that the savanna is subject to a severe burning - regime since many centuries. ZONNEVELD (1967), who studied the areal photographs of the region, is of the opinion that the major part of the savanna came into existence relatively recently as a result of the disappearance of the forest, probably starting from several edaphically conditioned nuclei.

An important difference between the climate of the Sipaliwini Savanna and the climate of northern Surinam is found in the distribution of the rainfall over the year. The data available from the airstrip "Sipaliwini", only a few kilometres outside the savanna border, show that this part of Surinam has only one precipitation optimum, viz. from April to August, corresponding with the "long rainy season" of the coastal area. A "short rainy season", in northern Surinam in December and January, is absent (see Fig. 2). Therefore the climate of the Sipaliwini Savanna agrees with, e.g.,

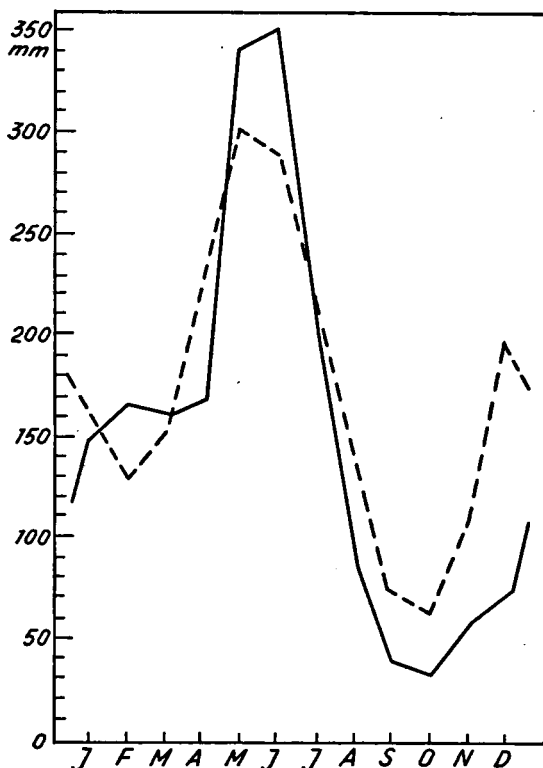


Fig. 2. Monthly rainfall at two stations. Airstrip "Sipaliwini", southern Surinam (April 1961—October 1966, based on data of the Meteorological Service, Paramaribo): full line. Republik, northern Surinam (after VOËTS 1959): broken line.

that of the northern Rupununi Savanna in southern Guyana (see EDEN 1964).

The Netherlands Foundation for Tropical Research (WOTRO) and the Surinam Forest Service enabled the author to visit the Upper Sipaliwini area in August and September 1966. Altogether about 4,500 ha in the western part, comprising stretches of the Sipaliwini and the river-valley landscape, were studied in some detail. The Morro Grande landscape was visited so briefly that only a general picture of its vegetation could be obtained.

5.2 PHYTOGEOGRAPHIC NOTES

From the open savanna and orchard-savanna vegetations of the Sipaliwini savanna, together with some other, small savannas in southern Surinam, about 314 registered species of vascular plants

are known. On the savannas of northern Surinam the same group is made up of about 288 species. The two areas have about 183 species in common, which means that about 131 species known from southern Surinam are absent from northern Surinam, whereas about 105 species of northern Surinam have not (yet) been found in southern Surinam.

About 40 species reach the northern limit of their area in southern Surinam.

Among the species originally described from the Sipaliwini Savanna nine have not been recorded so far from any other locality.

For further details on the phytogeography of the Sipaliwini Savanna and the other southern Surinam savannas, see VAN DONSELAAR (1968).

5.3 VEGETATION TYPES OF RELATIVELY DRY HABITATS

The tops and the sides of the hills in the western part of the savanna are largely covered by vegetations in which the grass *Trachypogon plumosus* and the sedge *Bulbostylis spadiccea* form the bulk of the herb layer (table VII). The other common species are mainly grasses (*Axonopus pulcher*, *Mesosetum cayennense*, *Aristida tinctoria*) and *Tibouchina aspera*. Among the scattered gnarled treelets *Salvertia convallariodora* is the most common; other frequent species are *Curatella americana*, *Byrsonima crassifolia*, and *Bowdichia virgilioides*.

Three communities may be distinguished. The one represented by record 1 of table VII is characterized by the abundance of *Paspalum albidulum*, a grass not recorded from anywhere outside this savanna (photo 4). The second community (rec. 2) lacks this species; from the third (rec. 3) which is relatively poor in species, the grasses *Paspalum contractum*, *Sporobolus cubensis*, *Lectocoryphium lanatum* and others are also absent. The last-named community occurs predominantly in the driest places, e.g. the tops of the highest hills.

On closer examination these communities will probably be described as two or three well-defined associations. Together they belong to an as yet undescribed alliance which fits best into the order Trachypogonetalia plumosi, although *Mesosetum tenuifolium*, *Curtia tenuifolia*, *Panicum stenoides*, and *Rhynchospora globosa* point more to the Paspalealia pulchelli. The alliance agrees best with the Rhynchosporo-Trachypogonion but it is set apart from it and the other Trachypogonetalia alliances by its characteristic species (including *Aristida recurvata*) which do not occur in northern Surinam, and by the absence of, e.g., *Galactia jussieuana* (ch. order), *Mesosetum loliiforme*, *Bulbostylis conifera*, *Cassia cultrifolia*, and *Eriosema crinitum* (all ch. class). From the other vegetation types

TABLE VII

Sipaliwini Savanna. Communities of <i>Trachypogon plumosus</i> and <i>Bulbostylis spadicea</i> .			
Nr. of record	1	2	3
Area (m ²)	225	320	200
Cover (%), tree layer	1.5	2	4
herb layer	80	75	80
Height (cm, max.), tree layer	500	600	200
herb layer	120	150	140
1 a Ch. <i>Trachypogonetalia plumosi</i>			
<i>Mitracarpus microsperrus</i> K.Schum.	+	+	.
<i>Richardia scabra</i> L.	+	+	.
<i>Paspalum gardnerianum</i> Nees	1	2	+
<i>Bulbostylis junciformis</i> (H.B.K.) Kunth	.	(x)	+
<i>Bulbostylis capillaris</i> (L.) Kunth	.	.	.
var. <i>temifolia</i> Clarke	(+)	.	.
<i>Buchnera rosea</i> H.B.K.	(+)	.	.
<i>Thrasya petrosa</i> (Trin.) Chase	.	1	.
<i>Bulbostylis fasciculata</i> Witt.	.	.	(1)
Ch. alliance and associations			
<i>Salvertia convallariiflora</i> St.Hil.	1	1	1
<i>Merremia sturensis</i> (H.B.K.) Hall.f.	+	+	+
<i>Sisyrinchium marchio</i> (Vell.) Steud.	+	+	+
<i>Paspalum contractum</i> Pilger	2	1	.
<i>Palicourea rigida</i> H.B.K.	1	+	.
<i>Polygala mollis</i> H.B.K. fo. <i>mollis</i>	+	+	.
<i>Barjonia</i> spec. (v.D. 3524)	(+)	(+)	.
<i>Ctenium cirrosus</i> (Nees) Kunth	+	.	1
<i>Schizachyrium riedelii</i> (Trin.) A.Camus	.	.	.
var. <i>multirameum</i> Henr.	.	+	1
<i>Paspalum albidulum</i> Henr.	3	.	.
<i>Declieuxia fruticosa</i> (Willd. ex R. & S.) Ktze.	(+)	.	.
Ch. class			
<i>Bulbostylis spadicea</i> (H.B.K.) Kük. (D. all., local)	3	3	3
<i>Axonopus pulcher</i> (Nees) Kublm. (idem)	1	1	2
<i>Mesosetum cayennense</i> Steud. (idem)	(x)	2	1
<i>Clidemia rubra</i> (Aubl.) Mart. (idem)	+	+	+
<i>Axonopus purpusii</i> (Nees) Chase (idem)	+	(x)	(+)
<i>Sporobolus cubensis</i> Hitchc. (idem)	1	2	.
<i>Byrsonima verbascifolia</i> (L.) L.C.Rich.	.	.	.
var. <i>villosa</i> Griseb. fo. <i>spatulata</i> Wds. (idem)	.	1	(+)
<i>Mesosetum tenuifolium</i> Swallen (idem; in N Suriname)	1	(+)	(+)
ch. <i>Bulbostylidion lanatae</i>	1	.	.
<i>Trachypogon plumosus</i> (H. & B.) Nees	2	2	3
<i>Aristida tinota</i> Trin. & Rupr. + <i>recurvata</i> H.B.K.	1	2	1
<i>Rhynchospora barbata</i> (Vahl) Kunth var. <i>barbata</i>	+	+	+
<i>Leptocoryphium lanatum</i> (H.B.K.) Nees	1	2	.
<i>Curatella americana</i> L.	1	+	.
<i>Buchnera palustris</i> (Aubl.) Spreng.	+	+	.
<i>Panicum stenodoides</i> Hubbard (D. Pasp. <i>pulchelli</i>)	+	+	.
<i>Curtia temifolia</i> (Aubl.) Knobl. (in N Suriname)	.	.	.
ch. <i>Syng.-Xyrr.</i>	(+)	+	.
<i>Scleria hirtella</i> Sw.	(+)	.	.
<i>Coutoubea spicata</i> Aubl.	(+)	.	.
<i>Rhynchospora globosa</i> (H.B.K.) R. & S. (D. P. <i>pulch.</i>)	.	(x)	.
<i>Polygala timoutou</i> Aubl.	.	(+)	.
<i>Eupatorium amygdalinum</i> Lam.	.	(+)	.
<i>Bulbostylis vestita</i> Kunth	.	.	(1)
1/2			
<i>Tibouchina aspera</i> Aubl.	1	1	1
<i>Rhynchospora cephalotes</i> (L.) Vahl	1	+	1
<i>Casearia silvestris</i> Sw. var. <i>lingua</i> (Camb.) Riobl.	+	1	+
<i>Lisianthus uliginosus</i> Griseb. var. <i>guianensis</i>	.	.	.
Griseb. (D. Pasp. <i>pulchelli</i>)	(+)	+	(+)
<i>Scleria cyperina</i> Willd.	(1)	.	1
<i>Miconia rufescens</i> (Aubl.) DC.	.	(+)	(+)
<i>Eugenia puniceifolia</i> (H.B.K.) DC. var. <i>puniceifolia</i>	.	.	+
Number of species omitted from the table	3	1	2
Rec. 1	ch. chl.: <i>Bowdichia virgilioides</i> H.B.K. +, <i>Miconia albicans</i> +; Orchid. spec. +.		
Rec. 2	<i>Coelorrhachis</i> spec. (v. D. 3531) +.		
Rec. 3	cf <i>Calliandra</i> spec. (v. D. 3608) +, Apoc. spec. (twining) +.		

observed on the Sipaliwini Savanna it differs furthermore by the presence of a series of species from *Bulbostylis spadicea* to *Mesosetum tenuifolium* (in the table).

A record from the northern Rupununi Savanna may be described for comparison. It represents the vegetation of a large stretch of "campo sujo" near Lethem. Ch. alliance: *Merremia aturensis*, *Aristida recurvata*; ch. order: *Cassia hispidula*, *C. flexuosa*, *Schizachyrium riedelii*, *Galactia jussieuana*; ch. class: *Trachypogon plumosus* (dom.), *Axonopus pulcher* (codom.), *Bulbostylis spadicea* (codom.), *B. conifera* (codom.), *Elyonurus adustus* (codom.), *Mesosetum cayennense*, *Eriosema cernitum*, *Byrsonima verbascifolia* var. *villosa* fo. *spathulata*, *Scleria micrococca*, *Curatella americana*, *Byrsonima coccolobifolia*, *Bowdichia virgilioides*; other species: *Scleria bracteata*, *Rhynchospora cephalotes*, *Cassytha filiformis*, *Buchnera elongata*, *Diodia rigida*, *Byrsonima crassifolia*, *Himatanthus articulatus*, *Antonia ovata*, *Roupala montana*, *Casearia celastroides*, *Connarus incomptus* var. *subcordatus*, *Rosenbergiodendron formosum*, *Hirtella* spec., 2 spp. indet.

This vegetation type has several species not recorded from Surinam that cannot be evaluated from the present point of view. Otherwise it is intermediary between the Rhynchosporo-Trachypogonion and the new alliance alluded to above.

Descriptions by MYERS (1936), TAKEUCHI (1960a, b), and EDEN (1964) give the impression that a number of communities resembling those mentioned above are widespread on the Rupununi Savannas, the Rio Branco Savannas, and the savannas of the southern Pakaraima Mountains. I should like to make the following observation. MYERS (1936) reported *Paepalanthus capillaceus* as one of the most abundant species in these vegetation types, and so did FANSHAWE (1952), probably on the basis of MYERS's paper. MYERS nowhere mentioned *Bulbostylis spadicea*. On the other hand, according to TAKEUCHI and EDEN, *Bulbostylis spadicea* is one of the main constituents of the present vegetation types, and the latter author found that *Paepalanthus capillaceus* occurs only in poorly and imperfectly drained places. It may therefore be assumed that the two species, which are certainly rather similar, were confused by MYERS, a mistake for which this entomologist can not be blamed.

5.4 VEGETATION TYPES OF WET HABITATS

The valleys of the larger creeks (river valleys sensu DOST) and the low-lying valleys between the hills of the Sipaliwini landscape have similar vegetation types. The variability in the composition of these types is correlated in the first place with the hydrology and in the second place with the structure and the texture of the soil. In dealing with these communities it will only be possible to mention incidental field observations on these factors. A clear picture of the floristic as well as the ecological relationships of the communities cannot be given.

In this section the vegetation of the valleys as far down as the watercourses and the shallow swamps will be dealt with.

At first view one would be inclined to divide the present group into two parts, one consisting of tall and another one of low vegetations. The first part would be characterized by the combination of *Trachypogon plumosus*, *Axonopus gentilis*, *Bulbostylis stenocarpa*, and *Tabebuia caraiba* (except for the first species not known from northern Surinam), and the second by *Paspalum pulchellum*, *Rhynchospora*

TABLE VIII

<u>Sipalivini Savanna. Paspaletalia pulchelli.</u>					
Fr. of record	1	2	3	4	5
Area (m ²)	100	200	20	35	100
Herb layer, cover (%)	100	100	95	95	100
height (cm, max.)	180	50	60		
<u>Ch. Paspaletalia pulchelli</u>					
<i>Paspalum pulchellum</i> Kunth	3	2	2	2	4
<i>Comolia lytharioides</i> Naud.	1	1	1	2	+
<i>Rhynchospora graminea</i> Witt.	2	.	2	4	4
<i>Curtia tenuifolia</i> (Aubl.) Knobl.	.	+	+	1	+
<i>Burmannia capitata</i> (J.F.Gmel.) Mart.	1	+	1	.	.
<i>Burmannia flava</i> Mart.	.	.	1	.	.
<i>Persea hirsuta</i> Aubl.	.	.	+	1	+
<i>Sauvagesia sprengelii</i> (St.Hil.)	.	.	+	+	+
<i>Drosera</i> vs <i>capillaris</i> Poir.	.	.	.	.	+
<i>Abolboda pulchella</i> H. & B.	.	.	.	.	+
<i>Lisianthus coerulescens</i> Aubl.	.	.	.	.	+
<u>Ch. alliance and associations</u>					
<i>Rhynchospora</i> spec (v.D. 3604)	1	+	.	.	.
<i>Utricularia triloba</i> Benj.	.	.	+	.	+
<i>Paspalum maculosum</i> Trin.	.	.	1	.	.
<u>Ch. Panicoetalia stenodis</u>					
<i>Sauvagesia rubiginosa</i> St.Hil.	+	.	.	.	.
<i>Scleria setacea</i> Poir.	+	.	.	.	.
<i>Axonopus chrysitae</i> (Steud.) Kuhl.	.	.	+	.	.
<i>Pyrogynium virgatum</i> (Desv.) Dandy	.	.	.	+	.
<i>Rhynchanthera grandiflora</i> (Aubl.) DC.	.	.	.	.	+
<u>Ch. class</u>					
<i>Rhynchospora globosa</i> (H.B.K.) R. & S.	4	2	3	1	2
<i>Rhynchospora barbata</i> (Vahl) Kunth var. <i>barbata</i>	.	+	2	1	3
<i>Aristida tinota</i> Trin. & Rupr.	+	3	1	2	+
<i>Echinolaena inflexa</i> (Poir.) Chase	+	+	+	+	+
<i>Scleria hirtella</i> Sw.	+	+	1	.	1
<i>Bulbostylis stenocarpa</i> Kük.	2	1	.	.	.
<i>Axonopus gentilis</i> Henr.	+	1	.	.	.
<i>Dichromena ciliata</i> Vahl	+	1	.	.	.
<i>Curatella americana</i> L.	+	+	.	.	.
<i>Eupatorium amygdalinum</i> Lam.	+	+	.	.	.
<i>Trachypogon plumosus</i> (H. & B.) Nees	3	3	1	.	.
<i>Ryrtis atrorubens</i> Poit.	+	1	+	.	.
<i>Polygala subtilis</i> H.B.K.	+	.	1	.	.
<i>Eriosema simplicifolium</i> (H.B.K.) G.Don.	+	+	+	.	.
<i>Panicum stenodoides</i> Hubbard	.	1	.	.	.
<i>Tabebuia caraiba</i> (Mart.) Bur.	.	+	(+)	.	.
<i>Leptocoryphium lanatum</i> (H.B.K.) Nees	.	3	.	2	.
<i>Axonopus purpusii</i> (Mex) Chase	.	+	.	+	.
<i>Elephantopus angustifolius</i> Sw.	+	.	.	(+)	.
<i>Lisianthus trini</i> Hack.	.	.	2	.	.
<i>Buchnera palustris</i> (Aubl.) Spreng.	.	.	+	+	+
<i>Schizachyrium brevifolium</i> (Sw.) Nees	.	.	.	1	.
<i>Panicum nervosum</i> Lam.	.	.	.	.	2
Number of species omitted from the table	3	1	1	4	3

- Rec. 1 ch. cl.: *Andropogon leucostachyus* +; 1 d: *Buettneria scabra* +; *Utricularia* spec. +.
- Rec. 2 ch. cl.: *Schultesia pohliana* PROGEL +.
- Rec. 3 ch. cl.: *Scleria micrococca* +.
- Rec. 4 ch. Pan. stenodis: *Cuphea gracilis* +; 1/2: *Lisianthus uliginosus* var. *guianensis* +; *Lycopodium cernuum*, L. +, Gram. spec. +.
- Rec. 5 ch. cl.: *Syngonanthus caulescens* +, *Utricularia amethystina* St. Hil. +; 1 d: *Mauritia flexuosa* juv. +.

graminea, and *R. barbata*. However, if all species are taken into account, and especially those with a better known indicative value, the main lines of the classification may be drawn in accordance with the existing system. It is very well possible, though, that a more extensive study would have revealed still other connections.

The records 1 and 2 of table VIII were made in relatively wide and flat valleys with a loamy soil. In both *Trachypogon plumosus*, *Rhynchospora globosa*, and *Paspalum pulchellum* are among the predominant species, and a tiny *Rhynchospora* (v. D. 3604) was found only in this community.

Related vegetation types were recorded under wetter conditions, in a flat valley (rec. 5) as well as in a zone at the foot of the hills (rec. 3 and 4). Here the place of *Trachypogon plumosus* is taken over by some other grasses.

The whole group may be included in the *Paspaletalia pulchelli*. A new alliance should probably be distinguished, differing from the rest of the order by the combination of much *Rhynchospora graminea* and *R. globosa*, and by the absence of, e.g., *Panicum micranthum*, *Lagenocarpus tremulus*, and *Axonopus purpusii*.

A very particular vegetation type occurs on sandy soil in very wet valleys among the hills (table IX, rec. 1 and 2). It is distinguished from all other savanna communities known in Surinam by a series of small species nearly all restricted to the South of the country (*Acisanthera limnobios*, *Sauvagesia tenella*, etc.). On its drier side *Rhynchospora armerioides* and *Schultesia pohliana* locally may determine the aspect of the vegetation. This community may provisionally be included in the *Axonopodion chrysitidis*, but a point could be made for placing it in a separate alliance belonging either to the *Panicetalia stenodis* or the *Paspaletalia pulchelli*.

Record 3 of table IX represents the vegetation of a zone bordering a shallow swamp. Here the surface has low hummocks built by worms, a first stage in the formation of a hog-wallow structure. The vegetation resembles the *Rhynchosporetum globosae*, an association of the *Axonopodion chrysitidis* described from the savannas of the Sabanpasi type and also found in French Guiana (see table VI, rec. 1).

Finally a vegetation type has to be mentioned that was recorded from two stretches along watercourses (table IX, rec. 4 and 5). The soil surface shows the same relief as in the case of the last-named community. Tall grasses (*Trachypogon plumosus*, *Leptocoryphium lanatum*, *Axonopus gentilis*, *Paspalum plicatulum*, *Andropogon bicornis*) make up the bulk of the vegetation, accompanied, i.a., by smaller quantities of *Sorghastrum stipoides* and *Tripsacum dactyloides* that are characteristic for this community. Gnarled treelets belonging to

TABLE IX

<u>Sipaliwini Savanna, Axonopodium chrysitidis.</u>					
Fr. of record	1	2	3	4	5
Area (sq)	50	225	20	200	150
Cover (%), tree layer	-	-	-	-	8
herb layer	50	95	100	100	100
Height, tree layer (m, max.)	-	-	-	-	12
herb layer (cm, max.)	30	-	80	230	250
1 a Ch. Panicetalia stenodis					
<i>Cuphea gracilis</i> H.B.K.	1	1	+	+	+
<i>Hypogynium virgatum</i> (Desv.) Dandy	+	+	.	+	.
<i>Eriochrysis cayennensis</i> P. Beauv.	1	2	.	.	.
<i>Rhynchanthera grandiflora</i> (Aubl.) DC.	+	.	.	.	.
<i>Sauvagesia rubiginosa</i> St.Hil.	.	.	+	.	+
<i>Rhynchospora glauca</i> Vahl	.	.	.	1	.
<i>Panicum cyanescens</i> Nees	.	.	.	+	+
<i>Sebastiania linearifolia</i> Lamj.	.	.	.	.	+
<u>Ch. Axonopodium chrysitidis and associations</u>					
<i>Aoisanthera limbobios</i> (DC.) Triana	1	1	.	.	.
<i>Sauvagesia tenella</i> Lam.	1	1	.	.	.
<i>Cyperus unioloides</i> R.Br.	1	1	.	.	.
<i>Utricularia lloydii</i> Mexl.	1	1	.	.	.
<i>Utricularia pusilla</i> Vahl	1	+	.	.	.
<i>Rhynchospora spec.</i> (v.D. 3618)	+	2	.	.	.
<i>Scleria spec.</i> (v.D. 3617)	.	+	.	.	.
<i>Rhynchospora armerioides</i> Presl	+	.	.	.	.
<i>Aoisanthera bivalvis</i> (Aubl.) Cogn.	+	.	.	.	.
<i>Gerardia hispidula</i> Mart.	2	2	+	.	.
<i>Lipocarpha humboldtiana</i> Nees	2	1	.	+	.
<i>Axonopus chrysitis</i> (Steud.) Kuhl.	.	.	2	.	.
<i>Crotalaria pterocaula</i> Desv.	.	.	.	+	+
<i>Sorghastrum stipoides</i> (H.B.K.) Nash	.	.	.	+	+
<i>Lushae paniculata</i> Mart. & Zucc.	.	.	.	.	1
<i>Tripsacum dactyloides</i> (L.) L.	.	.	.	.	+
<u>Ch. Paspaletalia pulchelli</u>					
<i>Rhynchospora graminea</i> Witt.	2	4	.	.	.
<i>Paspalum pulchellum</i> Kunth	.	2	1	.	.
<i>Comolia lythraroides</i> Naud.	(+)	.	.	.	.
<i>Curtia tenuifolia</i> (Aubl.) Knobl.	.	+	+	.	.
<u>Ch. class</u>					
<i>Rhynchospora globosa</i> (H.B.K.) R. & S.	1	.	2	2	.
<i>Eriosema simplicifolium</i> (H.B.K.) G.Dom.	.	+	+	+	+
<i>Syngonanthus caulescens</i> (Poir.) Ruhl.	2	+	.	.	.
<i>Scleria micrococca</i> (Liebm.) Steud.	.	2	.	.	.
<i>Erianthus trinitii</i> Hack.	.	1	.	.	.
<i>Phyllanthus stipulatus</i> (Raf.) Webster	.	+	.	+	1
<i>Aristida tinota</i> Trin. & Rupr.	.	.	2	.	.
<i>Panicum stenodoides</i> Hubbard	.	.	1	.	.
<i>Echinoloma inflexa</i> (Poir.) Chase	.	.	+	1	.
<i>Trachypogon plumosus</i> (H. & B.) Nees	.	.	4	3	4
<i>Leptocoryphium lanatum</i> (H.B.K.) Nees	.	.	1	3	2
<i>Axonopus gentilis</i> Henr.	.	.	1	2	2
<i>Balbostylis stenocarpa</i> Kük.	.	.	1	+	1
<i>Hyptis atrorubens</i> Poit.	.	.	+	1	1
<i>Scleria hirtella</i> Sw.	.	.	1	+	.
<i>Elephantopus angustifolius</i> Sw	.	.	+	+	.
<i>Paspalum plicatulum</i> Michx.	.	.	+	2	2
<i>Adiantum serrato-dentatum</i> Willd.	.	.	.	3	2
<i>Tabebuia caraiba</i> (Mart.) Bur.	.	.	.	(+)	2
<i>Eriosema violaceum</i> (Aubl.) G.Dom.	.	.	.	+	1
<i>Stylosanthes guianensis</i> (Aubl.) Sw. var. <i>gui.</i>	.	.	.	+	+
<i>Andropogon leucostachyus</i> H.B.K.	.	.	.	.	1
<i>Tephrosia purpurea</i> (L.) Pers.	.	.	.	.	1
1 b					
<i>Panicum rudgei</i> R. & S.	.	.	.	1	.
<i>Cassia patellaria</i> DC.	.	.	.	+	+
<i>Andropogon bicornis</i> L.	.	.	.	.	3
1 c					
<i>Eleocharis retroflera</i> (Poir.) Urb.	1	2	.	.	.
1 d					
<i>Buettneria scabra</i> Loefl.	.	.	+	1	+
Number of species omitted from the table					
	5	-	1	2	8

- Rec. 1 ch. cl.: *Rhynchospora barbata* var. *barbata* +, *Buchnera palustris* +, *Schultesia pohliana* +; 1 c: *Scleria pterota* PRESL +, *Melasma melampyroides* (L. C. RICH.) PENNELL +.
- Rec. 3 ch. cl.: *Schizachyrium brevifolium* +.
- Rec. 4 ch. cl.: *Eupatorium amygdalinum* +; 1 d: *Mauritia flexuosa* juv. +.
- Rec. 5 ch. cl.: *Desmodium barbatum* +, *Riencourtia oblongifolia* GARDN. +, *Sipanea pratensis* +, *Sida linifolia* +; ch. Trach. plum.: *Dichromena ciliata* +; ch. Maur.-Hyp.: *Pavonia julianae* +; 1/2 *Rhynchospora cephalotes* +; 2: *Roupala montana* +.

several species are frequent: *Curatella americana*, *Byrsonima crassifolia*, *Bowdichia virgilitoides*, *Tabebuia caraiba*, and *Luehea paniculata*.

As far as the classification at hand goes the community fits best in the *Axonopodium chrysitidis* but it might also be placed in a new alliance.

5.5 VEGETATION TYPES OF SHALLOW WATERCOURSES AND DEPRESSIONS

The soil surface of the flat watercourses and shallow depressions has a hog-wallow structure. There is a tree layer of scattered *Mauritia flexuosa* palms and a high, luxuriant ground layer comprising many small shrubs (table X). Though there is ample variation, the different communities obviously form an entity. The tall grasses *Hypogynium virgatum*, *Andropogon bicornis*, *Coelorachis aurita*, and *Paspalum plicatulum* are important constituents of the vegetation, together with beautifully flowering shrublets like *Jussiaea rigida*, *Rhynchanthera grandiflora*, *Melochia villosa*, and *Pavonia julianae*. Locally in somewhat lower places, *Paspalum plicatulum* and *Clibadium armani* may be dominant together.

We have here one or several associations belonging to the *Mauritio-Hypogynion* (order *Panicetalia stenodis*), the alliance comprising all vegetation types of savanna rivulets and depressions.

A similar vegetation was recorded in 1959 on the northern Rupununi Savanna. It occurred in a depression south-east of Lethem near the Kanuku Mountains. Ch. *Panicetalia stenodis*: *Panicum stenodes*, *P. cyanescens*, *Scleria setacea*, *Sauvagesia rubiginosa*, *Rhynchanthera grandiflora* (dom.); ch. class: *Curatella americana* juv., *Cassia cultrifolia*, *Polygala subtilis*, *Rhynchospora podosperma*; 1 b: *Waltheria americana*; 1 c: *Panicum parvifolium*, *Paspalum pumilum*; 1 d: *Mauritia flexuosa*, *Rhynchospora cyperoides*; other species: *Xyris macrocephala*, vs *Andropogon* spec. (dom.), Gram. spec. (dom.).

This vegetation is not nearly as rich as the comparable types on the Sipaliwini Savanna described above. In this respect it resembles more the communities described from French Guiana in section 4 (see table VI, rec. 2 and 3).

5.6 COMPARISON WITH SOME OTHER SAVANNAS IN NORTHERN SOUTH AMERICA

In the foregoing the vegetation types of the western part of the Sipaliwini Savanna were repeatedly compared with the savanna vegetations of northern Surinam, and sometimes with those of French Guiana or the northern Rupununi Savanna. For the rest it is difficult to draw a comparison with other savannas of the Guianas and the Amazon region. In the first place few papers on

TABLE X

Sipaliwini Savanna, Mauritic-Hypogynion.				
Nr. of record		1	2	3
Area (sq)		50	200	25
Cover (%), tree layer		-	4	-
herb layer		100	100	80
Height, tree layer (m, max.)		-	9	-
herb layer (cm, max.)		250	170	-
1 a Ch. Panicetalia stenodis				
<i>Hypogynium virgatum</i> (Desv.) Dandy		2	1	2
<i>Cuphea gracilis</i> H.B.K.		1	2	+
<i>Desmodium oajanifolium</i> (H.B.K.) DC.		+	+	+
<i>Soleria setacea</i> Poir.		+	+	2
<i>Eriochrysis cayennensis</i> P. Beauv.		.	2	.
<i>Panicum cyanescens</i> Nees		.	.	3
<i>Saurageia rubiginosa</i> St. Hil.		.	.	1
<i>Sebastiania linearifolia</i> Lamj.		.	.	(+)
Ch. Mauritic-Hypogynion				
<i>Rhynchanthera grandiflora</i> (Aubl.) DC.		2	2	1
<i>Coelorachis aurita</i> (Steud.) Henr.		3	1	+
<i>Pavonia julianae</i> Witt.		1	1	.
<i>Ischaemum guianense</i> Kunth		+	1	.
<i>Clididium aruanii</i> (Balbis) Schults-Rip.		.	2	.
<i>Diodia sarmentosa</i> Sw.		.	+	.
<i>Diodia pulchripetala</i> Brem.		.	+	.
<i>Sacciolepis myuros</i> (Lam.) Nees		.	.	1
<i>Panicum spec.</i> (v.D. 3554)		.	.	1
Ch. Aronopodium chrysitidis				
<i>Aronopus chrysites</i> (Steud.) Kuhl.		.	.	2
<i>Schultesia brachyptera</i> Cham.		.	.	+
Ch. class				
<i>Melochia villosa</i> (Mill.) Pavo. & Rendle		2	2	2
<i>Leptocoryphium lanatum</i> (H.B.K.) Nees		3	.	.
<i>Axonopus gentilis</i> Henr.		1	.	.
<i>Klephantopus angustifolius</i> Sw.		1	.	.
<i>Paspalum plicatulum</i> Michx.		2	4	.
<i>Eriosema violaceum</i> (Aubl.) G. Don.		1	1	.
<i>Eriarthus trinitii</i> Hack.		+	+	.
<i>Rhynchospora globosa</i> (H.B.K.) R. & S.		1	.	2
<i>Bulbostylis stenocarpa</i> Kük.		+	.	1
<i>Eyptis atromubens</i> Poit.		+	.	1
<i>Adiantum serrato-dentatum</i> Willd.		.	1	.
<i>Phyllanthus stipulatus</i> (Raf.) Webster		.	+	1
<i>Imperata brasiliensis</i> Trin.		.	.	1
<i>Echinolaena inflexa</i> (Poir.) Chase		.	.	1
1 b <i>Andropogon bicornis</i> L.		1	.	2
1 c <i>Setaria geniculata</i> (Lam.) Beauv.		1	.	1
1 d <i>Jussiaea rigida</i> Miq.		2	1	1
<i>Cyperus haspan</i> L. ssp. <i>juncooides</i> (Lam.) Kük.		1	1	1
<i>Buetneria scabra</i> Loeffl.		+	1	1
<i>Jussiaea nervosa</i> Poir.		+	.	.
<i>Mauritia flexuosa</i> L.f., ad. and juv.		.	1	.
1/2 <i>Rhynchospora cephalotes</i> (L.) Vahl		1	.	.
Number of species omitted from the table		-	1	4
Rec. 2	<i>Cassipha filiformis</i> +.			
Rec. 3	ch. cl.: <i>Schizachyrium brevifolium</i> +, <i>Panicum stenodoides</i> +; ch. Pasp. pulch.: <i>Curtia tenuifolia</i> +; <i>Syngonanthus spec.</i> +.			

this subject have been published, in the second place most of them do not contain descriptions of well-defined sites with their vegetation, and in the third place such descriptions, if present, only comprise a selection of the most abundant species. Therefore only a general picture of the position of the Sipaliwini Savanna with regard to the other savannas of the Guianas and Amazonia can be obtained.

The following papers concerning the Amazon savannas may be summed up. DUCKE (1907), HUBER (1908), and EGLER (1960) dealt with the savannas of the Ariramba River. The savannas near

Monte Alegre and those south of Erreré were mentioned by DUCKE (1909) and BOUILLENNE (1930), the former also by DE ANDRADE LIMA (1959). BOUILLENNE (1930) moreover treated the savannas near Santarem and those of the Serra Itauajury. The most complete paper is one of the oldest, viz. the one by CHERMONT DE MIRANDA (1907) on the savannas of the island Marajó.

The Rio Branco-Rupununi savanna complex, partly Amazonian, partly Guianan, was treated by several authors. Famous are the books by Richard SCHOMBURGK (1847—48). The Rio Branco Savannas were briefly studied by TAKEUCHI (1960a, b). General information about the Rupununi Savannas was provided by MYERS (1936) and HILLS (1961, 1964, 1965), more special information by EDEN (1964), GOODLAND (1965, 1966), LOXTON et al. (1958), and STARK et al. (1959).

Taking all these papers into consideration one gets the impression that the flora of the Sipaliwini Savanna represents an arbitrary section in a continuum. It has a portion of its species in common with the savannas in the North of the Guianas, another portion with the "campos gerais" more to the South, still another portion with the Rio Branco-Rupununi complex. There is a gradual shifting in whatever direction one moves. Therefore at present no limits expressing a discontinuity in the distribution of the savanna species in this part of South America can be drawn.

With regard to the vegetation types it seems possible to maintain a single hierarchic classification for the whole of the Guianas and probably also for the Amazon region. With the advancement of research the hierarchic classification will have to be extended and improved. How far we are at the moment will be discussed in section 7.

6. A SAVANNA SW OF THE AIRSTRIP "SIPALIWINI", SOUTHERN SURINAM

About 2 km south-west and south of the airstrip "Sipaliwini" there are two small savannas in the forest, the western one of which was visited in September 1966.

The savanna under consideration covers an area of about 250 ha. Actually it consists of a mosaic of open savanna and savanna scrub, surrounded by savanna woodland that gradually passes into high forest. The savanna is quite flat and has a soil of light-coloured, pure or only slightly loamy sand. It is obvious that the water level is high during the rainy season. There were traces of burning.

The greater part of the open savanna is covered by one single vegetation type, the *Rhynchosporium curvulae* (see table XI, rec. 7; photo 5).

In slightly higher places the assortment of species changes little, but *Rhynchospora curvula* disappears and *Rhynchospora globosa* and

TABLE XI
Rhynchosporetum curvulae

Nr. of record	A	1	2	3	4	5	6	7
Place	NS	NS	NS	NS	NS	FG	FG	SS
Month	IV	XII	XII	I	XII	IX	IX	II
Area (m ²)		600	18	30	100			25
Cover herb layer (%)	50-60	70	60	55	85		65	65
Height herb layer (cm)	25	35	35		40			
Layer of algae	x	x	x	x	x	†	x	x
1 a <u>Ch. Rhynchosporetum curvulae</u>								
<i>Rhynchospora curvula</i> Griseb.	V 1-2	3	2	3	1	a	a	3
<u>Ch. Bulbostylidion lanatae</u>								
<i>Bulbostylis lanata</i> (H.B.K.) Clarke	I 1	+	+	+	2	a	.	2
<i>Mesosetum tenuifolium</i> Swallen	V 1	1	1	1	.	.	.	1
<i>Rhynchospora rhizomatosa</i> Lindeman ined.	III 1-2	1	2	.	3	.	.	.
<i>Abolboda pulchella</i> H. & B.	I +	.	.	.	.	.	.	1
<i>Drosera cayennensis</i> Sagot	-	.	.	1	.	.	.	.
<i>Bulbostylis conifera</i> Kunth, small form	I +	.	.	2	.	.	.	.
<u>Ch. Paspalotalia pulchelli</u>								
<i>Sauvagesia sprengelii</i> St.Hil.	IV +1	1	1	+	.	x	x	2
<i>Paspalum pulchellum</i> Kunth	V 2	2	2	2	2	.	x	.
<i>Rhynchospora graminea</i> Witt.	II +2	1	1	1	+	.	.	1
<i>Lagenocarpus tremula</i> Nees	V +1	2	1	.	1	.	.	.
<i>Panicum sioranthum</i> H.B.K.	V 1-2	1	2	1	.	.	.	.
<i>Cosolia lythracioides</i> Naud.	IV +	+	.	.	.	.	.	1
<i>Pennisetum hirsutum</i> Aubl.	-	+	.	.	.	.	.	+
<i>Rhynchospora podosperma</i> C.Wright	I 1	.	.	.	.	x	x	.
<i>Drosera capillaris</i> Poir.	-	+	.	.	.	x	x	.
<i>Utricularia fibriata</i> Kunth	-	.	.	.	.	x	x	.
<u>Ch. Panicotalia stenodis</u>								
<i>Panicum cyanescens</i> Nees	-	.	.	.	.	x	x	.
<u>Ch. class</u>								
<i>Rhynchospora barbata</i> (Vahl) Kunth.								
var. <i>barbata</i>	V 2	2	1	2	2	a	a	1
<i>Rhynchospora globosa</i> (H.B.K.) R. & S.	I 1	+	.	.	+	a	a	+
<i>Panicum nervosum</i> Lam.	IV +	+	+	+	.	.	.	1
<i>Hypolytrum pulchrum</i> (Rudge) Pfeiff.	IV 2	1	.	.	+	.	.	.
<i>Polygala adenophora</i> DC.	IV +	.	.	+	.	.	.	+
<i>Leptocoryphium lanatum</i> (H.B.K.) Nees	III +	+	.	.	1	.	.	.
<i>Buchnera palustris</i> (Aubl.) Spreng.	II +	.	+	.	.	.	x	.
2 <i>Marlierea montana</i> (Aubl.) Amsh.								
III +	.	.	.	.	+	.	.	.
Other species								
<i>Cassytha filiformis</i> L.	-	.	.	.	+	.	.	+
Number of species omitted from the table	15	5	1	-	2	2	2	5

Column A ch. cl.: *Polygala longicaulis* IV +, *Sipanea pratensis* III +, *Coutoubea spicata* II +, *Hyptis lantanaefolia* PORT. I +, *Mesosetum cayennense* I +, *Aristida tinctoria* I +, *Trachypogon plumosus* I +, *Panicum stenodoides* I +, *Xyris glabrata* GRISEB. I +; ch. Pasp. pulch.: *Rhynchospora tenuis* I 1; ch. Bulb. lan.: *Byrsonima crassifolia*, orchard tree II +, idem juv. II +—1; 1/2: *Scleria cyperina* II +, *Rhynchospora cephalotes* I +, *Amasonia campestris* I +; 2: *Bactris campestris* I +.

Rec. 1 ch. Syng.-Xyr.: *Abolboda americana* +, *Xyris paraensis* POEPP. +; ch. Pan. stenodis: *Raddiella nana* +; *Catasetum spec.* +, *Utricularia spec.* +.

Rec. 2 ch. Pasp. pulch.: *Bulbostylis circinata* 1.

Rec. 4 ch. cl.: *Coutoubea spicata* +; *Byrsonima crassifolia* juv. +.

Rec. 5 ch. Pasp. pulch.: *Lisianthus coeruleus* x; *Borreria verticillata* (L.) G. F. W. MEYER x.

Rec. 6 ch. Pan. stenodis: *Sauvagesia tenella* x; Gram. spec. x.

Rec. 7 ch. cl.: *Mesosetum loliifolium* (HOCHST.) CHASE +; ch. Syng.-Xyr.: *Panicum siccaneum* TRIN. 1; *Utricularia adpressa* ST. HIL. 2, *Xyris spec.* 1, *Syngonanthus spec.* +

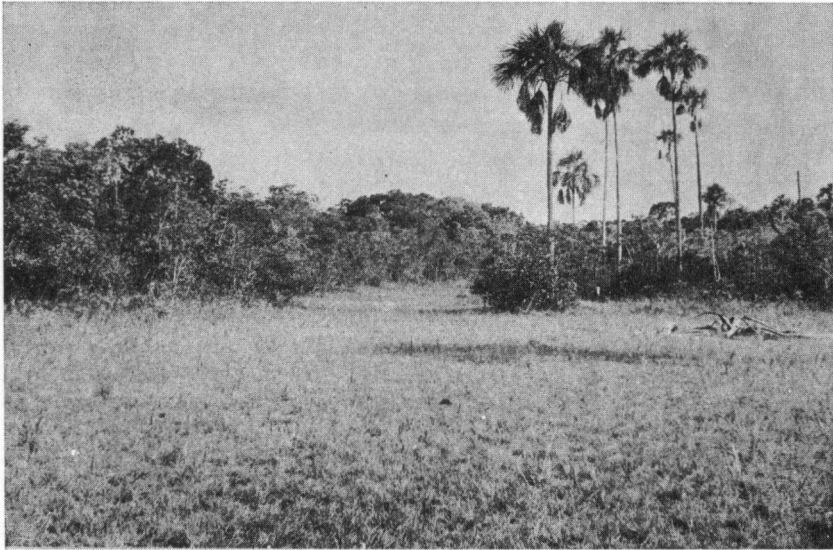


Photo 5. Sand savanna SW of the airstrip "Sipaliwini", southern Surinam. *Rhynchosporetum curvulae*. In the background savanna scrub and *Mauritia flexuosa* palms.

Paspalum pulchellum come to the fore. This is another community of the *Bulbostylidion lanatae*.

A third community is found in still wetter and more sandy places than the preceding ones. The very thin vegetation consists mainly of small plants, like, e.g., *Drosera sessiliflora*, *D. esmeraldae* (vel aff.), *Rhynchospora junciformis*, and *Utricularia* div. spp. (i.a. the blue-flowering *U. amethystina*).

Marlierea montana is the dominant species in the savanna scrub, just as on wet loamy sand in northern Surinam (see section 2; table II). Other frequent species are *Clusia nemorosa*, *Cordia schomburgkii*, *Coccoloba mollis*, *Tetracera asperula*, *Miconia ciliata*, *Licania micrantha*, *Hirtella paniculata*, and *Humiria balsamifera* var. *balsamifera*. A common shrub bordering the savanna woodland and scrub is *Macairea pachyphylla*; less common is *Hirtella bicornis*.

7. REVIEW OF THE RESULTS AND DISCUSSION

If the results of the present study are compared with the classification of savanna vegetations in VAN DONSELAAR (1965) the following can be said with regard to the position of a number of species in the system.

Even if the scope of the classification would be restricted to

northern Surinam, some of the species could be said to have been evaluated wrongly.

Scleria micrococca can not be regarded as a characteristic species of the Sclerio-Trachypogonetum, though it may have its optimum in this association of the Curatello-Trachypogonion. Because of its wide sociological range it has to be listed among the characteristic species of the class.

Burmannia capitata, on the other hand, has a narrower amplitude than assumed before. It is a characteristic species of the *Paspaleta lia pulchelli*, though sometimes being present in vegetation types of a wetter habitat.

Panicum rudgei is not restricted to savanna vegetations. It is sometimes common by roadsides and belongs to the group of species occurring in all sorts of open places (group 1b).

A number of species have a wider range outside northern Surinam. The clearest cases will be cited here.

In French Guiana *Paspalum pulchellum* may be abundant in communities of the Imperato-Mesosetion, connecting this questionable alliance somewhat more closely to the rest of the order (table V).

Bulbostylis lanata in French Guiana may also be numerous in the xerophilous community of *Byrsonima verbascifolia* which belongs to the Rhynchosporo-Trachypogonion. This makes its position as a characteristic species of the *Bulbostylidion lanatae* doubtful (see table IV, rec. 2).

Byrsonima verbascifolia var. *villosa* fo. *spathulata*, in northern Surinam confined to an association of the Rhynchosporo-Trachypogonion on a single savanna, is found elsewhere also in other alliances of the *Trachypogonetalia plumosi* as well as of the *Paspaleta lia pulchelli* (see tables IV, V, VII, XII). In general it is to be regarded as a characteristic species of the class.

Echinolaena inflexa probably belongs to the characteristic species of the class. Outside of northern Surinam it does not have its optimum in the *Panicetalia stenodis* (see table V, VIII, XI).

Outside of northern Surinam some species shift to other vegetation types. *Phyllanthus stipulatus* (= *P. diffusus* KLOTZSCH) and *Elephantopus angustifolius* which in northern Surinam are characteristic for the *Trachypogonetalia plumosi* and the Curatello-Trachypogonion, respectively, occur on the western Sipaliwini Savanna only in communities of the *Paspaleta lia pulchelli* and the *Panicetalia stenodis* (see tables VIII, IX, X).

Mesosetium tenuifolium is a characteristic species of the *Bulbostylidion lanatae* on the savannas of the Sabanpasi type in northern Surinam, e.g. near Brownsweeg. On the western Sipaliwini Savanna the species is restricted to the communities of *Trachypogon plumosus*

TABLE XIII
Rhynchosporium podospermae and hygrophilous community
of *Byrsonima verbascifolia*

Nr. of record	1	2	3	4	5	6	7
Place	NS	NS	NS	FG	Rup	FG	FG
Mouth	IV	IV	IV	IX	II	IX	IX
Area (m ²)	150	100	50				
Total cover (%)	65	75	60	95		65	95
Height herb layer (cm)	40	40	15				
Layer of algae	-	-	-	x	-	x	x
1 a Ch. <i>Rhynchosporium podospermae</i>							
<i>Rhynchospora podosperma</i> C.Wright	1	1	2	d	x	x	x
D. Community of <i>Byrsonima verbascifolia</i>							
<i>Byrsonima verbascifolia</i> (L.) L.C.Rich. var. <i>villosa</i> Griseb. fo. <i>spatulata</i> Mds.	.	.	.	.	.	a	a
Ch. <i>Bulbostylidion lanatae</i>							
<i>Bulbostylis lanata</i> (H.B.K.) Clarke	+	1	.	.	x	a	a
<i>Mesosetum tenuifolium</i> Swallen	.	2	1	.	.	.	.
<i>Drosera cayennensis</i> Sagot	+	.	.	.	.	.	.
<i>Abolboda pulchella</i> H. & B.	.	.	.	.	x	.	.
<i>Byrsonima crassifolia</i> (L.) L.C.Rich., orchard tree	+	.	4	.	.	.	.
<i>Bulbostylis spadiosa</i> (H.B.K.) Kunth	.	+	.	.	.	.	.
<i>Rhynchospora curvula</i> Griseb.	.	.	.	.	.	.	x
Ch. <i>Paspaletalia pulchella</i>							
<i>Paspalum pulchellum</i> Kunth	2	2	2	a	.	d	a
<i>Lagenocarpus tremulus</i> Nees	+	+	.	.	.	.	.
<i>Panicum micranthum</i> H.B.K.	.	2	1	.	.	x	.
<i>Comolia lythraeioides</i> Hand.	+	+	.	.	.	.	x
<i>Sauvagesia sprengelii</i> St.Hil.	.	.	.	.	x	x	x
<i>Bulbostylis circinata</i> (Nees) Kunth	.	.	1	.	.	.	.
<i>Rhynchospora tenuis</i> Link	+	.	.	.	.	.	a
<i>Lisianthus coerulescens</i> Aubl.	.	.	.	.	.	.	.
<i>Abolboda americana</i> (Aubl.) Lanj.	.	.	.	.	.	.	.
<i>Lagenocarpus amazonicus</i> (Clarke) Pfeiff.	.	.	.	.	.	.	x (x)
<i>Utricularia fimbriata</i> Kunth	.	.	.	.	.	.	.
<i>Polygala appressa</i> Benth.	.	.	.	.	.	.	x
Ch. <i>Panicetalia stenodis</i>							
<i>Rhynchospora glauca</i> Vahl	+	.	.	.	.	.	.
<i>Panicum cyanescens</i> Nees	.	.	.	.	x	x	x
<i>Turnera guianensis</i> Aubl.	.	.	.	.	x	.	.
<i>Schultesia brachyptera</i> Cham.	.	.	.	.	x	.	.
<i>Hypogynium virgatum</i> (Desv.) Dandy	.	.	.	.	.	x	.
<i>Scleria setacea</i> Poir.	.	.	.	.	.	x	.
Ch. class							
<i>Rhynchospora barbata</i> (Vahl) Kunth var. <i>barbata</i>	2	2	2	a	x	a	a
<i>Rhynchospora globosa</i> (H.B.K.) R. & S.	.	1	1	x	x	.	.
<i>Leptocoryphium lanatum</i> (H.B.K.) Nees	+	+	.	.	.	.	x
<i>Echinolaena inflexa</i> (Poir.) Chase	.	.	.	.	x	.	x
<i>Buchnera palustris</i> (Aubl.) Spreng.	+	+	.	.	.	x	.
<i>Polygala adenophora</i> DC.	+	+	+	.	.	.	.
<i>Hypolytrum pulchrum</i> (Rudge) Pfeiff. (D. <i>Bulbostylidion lan.</i>)	2	.	1	.	.	.	.
<i>Panicum stenodoides</i> Hubbard	2	.	+	.	.	.	.
<i>Polygala longicaulis</i> H.B.K.	+	.	.	.	.	.	.
<i>Aristida tinota</i> Trin. & Rupr.	.	.	.	.	.	.	x
1/2 <i>Scleria cyperina</i> Willd.							
<i>Tibouchina aspera</i> Aubl.	1	.	.	.	.	.	.
Number of species omitted from the table							
	8	5	-	-	5	1	1

- Rec. 1 ch. cl. *Andropogon leucostachyus* +, *Axonopus purpusii* +, *Panicum nervosum* +; 1/2 *Rhynchospora cephalotes* +, *Amasonia campestris* +; 2: *Marlierea montana* juv. +, *Bactris campestris* +; *Catasetum* spec. +.
- Rec. 2 ch. cl.: *Trachypogon plumosus* +, *Anoxopus pulcher* +, *Sipanea pratensis* +.
- Rec. 5 ch. cl.: *Bulbostylis conferta* x; *Aristida setifolia* x, *Mesosetum rottboellioides* x.
- Rec. 6 *Xyris* spec. x.
- Rec. 7 Gram. spec. x.

and *Bulbostylis spadiosa*, belonging to the *Trachypogonetalia plumosi*. However, on the sand savanna south-west of the airstrip

“Sipaliwini” the species turns up in the *Rhynchosporium curvulae*, belonging to the *Bulbostylidion lanatae* (see table VII; XI, rec. 7).

On the western Sipaliwini Savanna *Axonopus pulcher*, *Axonopus purpusii*, *Mesosetum cayennense*, *Sporobolus cubensis*, and *Clidemia rubra*, which in northern Surinam occur in many different savanna vegetation-types and are therefore characteristic species of the class, were found only in the communities of *Trachypogon plumosus* and *Bulbostylis spadicea* on the western Sipaliwini Savanna (see table VII).

White-sand savannas are not included in the present study. But a number of species that in northern Surinam are restricted to the white sands were nevertheless met with.

Cassia ramosa, in northern Surinam a characteristic species of the Cassio-Trachypogonion, was found in French Guiana in a community of the Curatello-Trachypogonion on coloured sand (see table IV, rec. 1).

A large part of the characteristic species of the Syngonantho-Xyridion of northern Surinam prove not to be restricted to white sand. *Abolboda americana* and *Xyris paraensis* occur even, although rarely, in the *Rhynchosporium curvulae* near Brownsweg (see table XI, rec. 1). In the *Bulbostylidion lanatae* in French Guiana and in the new *Paspaletalia* alliance on the Sipaliwini Savanna *Curtia tenuifolia*, *Lisianthus coeruleus*, and *Drosera capillaris* were found, in the former furthermore *Rhynchospora tenuis* (also on the northern Rupununi Savanna), *Lagenocarpus amazonicus*, *Polygala appressa*, and *Utricularia fimbriata*.

With regard to the classification of the communities the present results may be summarized as follows.

Order Trachypogonetalia plumosi.

On the Sipaliwini Savanna the group of closely allied “communities of *Trachypogon plumosus* and *Bulbostylis spadicea*” was encountered (table VII). It is likely that future investigations will justify distinguishing a number of associations belonging to a new alliance. This alliance would be most closely related to the *Rhynchosporo-Trachypogonion*. In this connection may be mentioned a vegetation recorded from the northern Rupununi Savanna that is intermediate between the present new alliance and the *Rhynchosporo-Trachypogonion* (see p. 292).

Alliance Curatello-Trachypogonion.

A community belonging to this alliance is represented in record 1 of table IV from French Guiana. The presence of *Cassia ramosa* and the abundance of *Axonopus purpusii* are remarkable.

Alliance Rhynchosporo-Trachypogonion.

Several new communities belonging to this alliance were met with: on the hill-savanna near Berg en Dal (table III, rec. 1 and 2), and in French Guiana (table IV, rec. 2 and 3), where in particular a xerophilous community with much *Byrsonima verbascifolia* (var. *villosa* fo. *spathulata*) probably covers large areas.

Order Paspaletalia pulchelli.

A number of communities from the Sipaliwini Savanna, all characterized by the combination of much *Rhynchospora graminea* and *Rhynchospora globosa*, may be taken together as a new alliance of this order, though they show important physiognomic differences (table VIII). This alliance might be the southern counterpart of the Imperato-Mesosetion, in the same way as the Rhynchosporo-Trachypogonion has a southern counterpart in the "communities of *Trachypogon plumosus* and *Bulbostylis spadicea*".

Alliance Bulbostylidion lanatae.

Associations of this alliance were studied on some savannas of the Sabanpasi type in northern Surinam near the places from where they were originally described, on savannas in French Guiana, and on a savanna in the Upper Sipaliwini area.

Table XI presents all data available of the Rhynchosporium curvulae, an association of wet loamy sand. The first column (A) summarizes the records made on the Gros Savanna and the De Jong Noord Savanna (VAN DONSELAAR 1965). The records 1-4, made on the De Jong Zuid Savanna and other savannas near Brownsweeg, agree fairly well with the latter, apart from the low total estimates for *Hypolytrum pulchrum*. The same holds for the record from the sand savanna south-west of the airstrip "Sipaliwini" (nr. 7), though *Rhynchospora rhizomatosa* (so far not found outside northern Surinam) is not present there. In French Guiana the composition of the community is a little different and probably reflects wetter conditions (rec. 5 and 6).

All collected records of the Rhynchosporium podospermae, the association of the Bulbostylidion lanatae occurring on the wettest sites, are presented in table XII. The first three records were made on the Gros Savanna in 1959 (VAN DONSELAAR 1965). The record from French Guiana (nr. 4) shows a vegetation with some characteristic species of the Panicetalia stenodis which may indicate a relatively wetter habitat. This is also true for

record 5 from the northern Rupununi Savanna, made in 1959 in a depression north-west of Manari.

Finally the hygrophilous community of *Byrsonima verbascifolia* occurring in French Guiana has to be mentioned (table XII, rec. 6 and 7).

Alliance Imperato-Mesosetion.

Several communities belonging to the Imperato-Mesosetion were encountered in French Guiana (table V), one of which resembles the *Panicetum stenodoidis* (rec. 1), another one being identical with the *Curatello-Imperatetum* from northern Surinam (rec. 3).

Alliance Axonopodion chrysitidis.

In French Guiana a vegetation type was found that matches the *Rhynchosporium globosae* of northern Surinam (table VI, rec. 1). A community occurring under the same circumstances (i.e., bordering a swampy place) on the Sipaliwini Savanna also resembles this association (table IX, rec. 3).

Two other communities that fit best into this alliance were recorded on the Sipaliwini Savanna (table IX, rec. 1 and 2; 4 and 5 respectively). Up till now it was assumed that the soil of the vegetation types belonging to the *Axonopodion chrysitidis* is heavy and has a hog-wallow structure at the surface. However, the soil of the former of the two communities is sandy and completely flat. On the one hand there is no reason to reject the possibility of including a community associated with such a soil type in this alliance, but on the other hand the community under consideration has a floristic composition that actually places it between the *Axonopodion chrysitidis* and the supposed new alliance of the *Paspaletalia pulchelli* (table VIII). Moreover, the community contains a large group of species differentiating it from any other savanna vegetation-type found so far. It is possible that further investigations will show the necessity of putting this community in a distinct alliance, and of revising the whole system as far as the *Paspaletalia pulchelli* communities on heavier soil types and the *Axonopodion chrysitidis* are concerned.

Alliance Mauritio-Hypogynion.

On the Sipaliwini Savanna this alliance is represented by one or more communities rich in species and, as far as recorded, always with *Rhynchanthera grandiflora* as one of the outstanding species

(table X). The records from French Guiana, on the other hand, are poor in species (table VI, rec. 2 and 3). It is remarkable that a record from the northern Rupununi Savanna is more in agreement with the records from French Guiana than with those from the Sipalini Savanna (see p. 296).

During the present study it became again clear that, on the one hand, the composition of the savanna communities in general is primarily correlated with the hydrology of the soil, but that, on the other hand, the texture of the soil in several instances plays an equally or nearly equally important part. This emerges particularly in the communities of the wetter and heavier soil types. This interferes with the attempt to maintain a hierarchic classification that expresses in a simple and convenient way the floristic as well as the ecological relations between its different subdivisions.

Nevertheless it may be said that the new data tally largely with the classification presented before. Nearly all communities encountered can be given a place in one of the described alliances, or, if a new alliance is required, in one of the existing orders.

There are indications, however, that future investigations on savannas still farther from northern Surinam, the area where the original classification was worked out, might necessitate a complete revision, in order to reach a classification that does justice to the geographical variations in the savanna vegetations of the whole of northern South America.

SUMMARY

The vegetation was studied of a number of savannas in northern and southern Surinam, and in French Guiana. The results are compared in particular with the vegetation classification proposed earlier for northern Surinam, and with some records from the northern Rupununi Savanna, Guyana (VAN DONSELAAR 1965).

The savannas studied near Brownsweeg (northern Surinam) have vegetation types that correspond completely with those of some other savannas of the same geological-pedological type more to the North, as described before. New is the finding of a type of scrub bordering the savanna, being the scrub equivalent of a type of bushes described earlier as the *Marlierea* type.

On the top and the slopes of the Blauwe Berg near Berg en Dal (northern Surinam) an anthropogenic savanna has developed. Two new vegetation types are recorded here that belong to the alliance Rhynchosporo-Trachypogonion. At the foot of the hill a flat savanna supports a vegetation that gives the impression of being of recent origin and unbalanced.

It appears possible to apply the existing classification to the

communities found on savannas near Cayenne (French Guiana). In this area the conspicuous *Byrsonima verbascifolia* (var. *villosa* fo. *spathulata*) occurs in several undescribed vegetation types that belong to various entities. A xerophilous and a hygrophilous community of *Byrsonima verbascifolia* are distinguished, belonging to the Rhynchosporo-Trachypogonion and the Bulbostylidion lanatae, respectively.

On the Sipaliwini Savanna in southern Surinam most vegetation types do not fit into one of the existing alliances. However, if new alliances would be described, it should be possible to include them into the existing orders. There probably is an alliance, called here "communities of *Trachypogon plumosus* and *Bulbostylis spadicea*", that might be regarded as the southern counterpart of the Rhynchosporo-Trachypogonion in the order Trachypogonetalia plumosi, and a supposed alliance with much *Rhynchospora graminea* and *R. globosa* might have the same position with regard to the Imperato-Mesosetion in the order Paspaletalia pulchelli. Among the communities that might be included in the alliance Axonopodion chrysitidis there is one occurring on sandy soil without a hog-wallow structure at the surface. Floristically it has connections with the Paspaletalia pulchelli but it also has many characteristic species of its own. Whether this community has to be placed in a distinct alliance will have to depend on the results of further investigations in this area. Anyhow, more data are needed for the drafting of a complete picture of the rich and interesting Sipaliwini Savanna.

On a savanna south-west of the airstrip "Sipaliwini" (southern Surinam) the vegetation consists mainly of communities belonging to the Bulbostylidion lanatae.

Summarizing the above-mentioned results, one may say that a number of communities not studied before are added to the picture of the savanna vegetation of the Guianas. It proved possible to integrate these communities without much difficulty in the classification presented earlier that so far has functioned as a practical framework.

ZUSAMMENFASSUNG

Beobachtungen an Savannen vegetationstypen in den Guayanas

Die Vegetation einiger Savannen in Nordsurinam, Südsurinam und Französisch-Guayana wurde untersucht. Die Ergebnisse werden besonders verglichen mit einer schon früher vorgeschlagenen Vegetationsklassifikation und mit einigen Aufnahmen der nördlichen Rupununisavanne in Guayana, dem ehemaligen Britisch-Guayana (VAN DONSELAAR 1965).

Die bei Brownsweg (Nordsurinam) untersuchten Savannen

haben Vegetationstypen, die denjenigen anderer, schon früher bearbeiteter, mehr nördlich gelegener Savannen desselben geologisch-pädologischen Typs ganz ähnlich sind. Es wurde ein neuer, die offenen Savannen begrenzender Typ von Gestrüpp gefunden. Er ist als Gestrüppäquivalent eines Buschtyps, der früher als *Marlierea*-typ beschrieben worden ist, zu betrachten.

Auf dem Gipfel und den Hängen des Blauen Berges bei Berg en Dal (Nordsurinam) hat sich eine anthropogene Savanne entwickelt. Zwei neue Vegetationstypen wurden hier angetroffen, beide dem Verband Rhynchosporo-Trachypogonion angehörend. Eine flache Savanne am Fuß des Berges trägt eine Vegetation, die rezent entstanden und noch nicht ausgeglichen zu sein scheint.

Es ergibt sich, daß die vorhandene Klassifikation auch auf die Pflanzengesellschaften einiger Savannen bei Cayenne (Französisch-Guayana) zutrifft. In dieser Gegend findet sich die auffällige *Byrsonima verbascifolia* (var. *villosa* fo. *spathulata*) in mehreren unbeschriebenen Vegetationstypen, die verschiedenen Einheiten angehören. Es wurde eine xerophile und eine hygrophile Gesellschaft von *Byrsonima verbascifolia* unterschieden, die den Verbänden Rhynchospora-Trachypogonion bzw. Bulbostylidion lanatae zugeteilt werden können.

Die meisten Vegetationstypen der Sipaliwinisavanne (Südsurinam) passen nicht in einen der beschriebenen Verbände. Wenn aber neue Verbände dafür beschrieben würden, so könnten diese in den bestehenden Ordnungen untergebracht werden. Es ist wohl ein Verband zu unterscheiden, hier „Gesellschaften von *Trachypogon plumosus* und *Bulbostylis spadicea*“ genannt, der als ein südliches Gegenstück des nördlichen Rhynchosporo-Trachypogonion-Verbandes in der Ordnung Trachypogonetalia plumosi zu betrachten wäre, und vermutlich steht ein Verband mit viel *Rhynchospora graminea* und *R. globosa* in demselben Verhältnis zum Imperato-Mesosetion-Verband in der Ordnung Paspaletalia pulchelli. Unter den Gesellschaften, die dem Verband Axonopodion chrysitidis zuzurechnen sind, gibt es eine auf sandigem Boden ohne Hügel-und-Schlenken-Struktur. Sie hat floristische Beziehungen zu den Paspaletalia pulchelli, aber hat auch manche eigene Kennarten. Die Entscheidung, ob diese Gesellschaft in einem neuen Verband unterzubringen ist, muß von weiteren Untersuchungsergebnissen abhängig gemacht werden. Überhaupt ist noch viel weitere Arbeit erforderlich, bevor das Bild der Vegetation der reichen und interessanten Sipaliwinisavanne vollständig ist.

Die Vegetation einer Savanne südwestlich des Flugplatzes „Sipaliwini“ (Südsurinam) besteht hauptsächlich aus Gesellschaften des Verbandes Bulbostylidion lanatae.

Als Zusammenfassung der obenerwähnten Ergebnisse kann man

sagen, daß eine Anzahl von bisher nicht bekannten Gesellschaften dem Gesamtbild der Savannenvegetation der Guayanas hinzugefügt worden ist. Es hat sich gezeigt, daß diese Gesellschaften ohne viel Mühe in die früher veröffentlichte Klassifikation eingefügt werden können, so daß diese als ein praktisches Rahmenwerk brauchbar bleibt.

RESUMO

Observações sobre vegetações de savana nas Guianas

A vegetação foi estudada em várias savanas ao norte e sul de Suriname, e na Guiana Francêsa. Os resultados foram comparados, em particular, com a classificação de tipos de vegetação obtida antes no norte de Suriname e com alguns dados da parte norte da Savana Rupununi, Guiana Inglesa, agora „Guyana” (VAN DONSELAAR 1965).

As savanas estudadas perto de Brownsweg (norte do Suriname) possuem tipos de vegetação que correspondem completamente com aqueles de outras savanas do mesmo tipo geológico-pedológico mais ao norte, já descritos antes. Foi encontrada aí uma faixa arbustiva bordejando a savana que é nova e, equivalente ao tipo de capões descrito anteriormente como o tipo de *Malierea*.

No topo e nas vertentes do Blauwe Berg perto de Berg en Dal (norte do Suriname) uma savana antropogênica encontra-se desenvolvida aí. Dois tipos novos de vegetação são aí apontados que pertencem a aliança Rhynchosporo-Trachypogonion. No sopé de colina encontra-se uma savana plana que apresenta uma vegetação dando a impressão se sêr de origem recente e em desequilíbrio.

Parece sêr possível aplicar a classificação existente das comunidades encontradas nas savanas próximas à Cayenne (Guiana Francêsa). Nessa área a conspícua *Byrsonima verbascifolia* (var. *villosa* fo. *spathulata*) ocorre em vários tipos vegetais não descritos que pertencem a entidades diversas. Uma comunidade xerófila e uma higrófila de *Byrsonima verbascifolia* são definidas, pertencendo a primeira ao Rhynchosporo-Trachypogonion e, a segunda ao *Bulbostylidon lanatae*.

Na Savana Sipaliwini ao sul de Suriname a maioria dos tipos de vegetação não se acomodam a nenhuma das alianças existentes. Entretanto, se novas alianças fossem criadas, seria possível incluí-las nas ordens existentes. É provávelmente uma aliança chamada aquí „comunidades de *Trachypogon plumosus* e *Bulbostylis spadicea*” que pudesse sêr considerada como correspondente sulino do Rhynchosporo-Trachypogonion na ordem Trachypogonetalia plumosi, e uma aliança com muita *Rhynchospora graminea* e *R. globosa* que pudesse estar na mesma situação em relação ao

Imperato-Mesosetion da ordem Paspaletalia pulchelli. Entre as comunidades possíveis de sêr incluídas na aliança Axonopodion chrysitidis, é uma que se encontra em solo arenoso, mas sem a superfície com caneluras reticuladas que é chamada „hog-wallowed” em inglês e „kaw-foetoe” no Suriname. Além das conexões florísticas com a Paspaletalia pulchelli tem muitas espécies características próprias. Se esta comunidade tem que sêr localizada numa aliança separada, dependerá dos resultados de investigações futuras nesta área. Em tôdo caso mais dados são necessários para a delineação dum desenho completo da rica e interessante Savana Sipaliwini.

Na savana SW do compo d'aterrisagem „Sipaliwini” (sul do Suriname) a vegetação consiste, a maioria, de comunidades de Bulbostylidion lanatae.

Reunindo os resultados acima mencionados, podemos dizer que um número de comunidades não estudados antes são acrescentados à pintura da vegetação das savanas das Guianas. Também evidenciou-se sêr possível integrar estas comunidades sem muitas dificuldades não classificação apresentada antes, que até agora funciona como moldura prática.

Manuscript closed March 24th, 1968.

Explanation of the tables

Categories of species

- 1 a savanna species
- 1 b species of savanna and other open places
- 1 c species of very wet savanna, savanna rivulets and other very wet places
- 1 d species of savanna rivulets and depressions, and of swamps
- 1/2 species of savanna and savanna bushes (ev. scrub)
- 2 species of savanna bushes (scrub, woodland, etc.)
- Ch. characteristic species (= faithful taxon)
- D. differential species (or taxon)

The scale for the *total estimate* of abundance and coverage of each species

- + sparsely present, degree of cover very small
- 1 numerous, but degree of cover small; or rather sparsely, but degree of cover higher (up to 5 %)
- 2 very numerous, or degree of cover 5—25 %
- 3 any number, degree of cover 25—50 %
- 4 any number, degree of cover 50—75 %
- 5 any number, degree of cover 75—100 %
- x present
- a abundant
- d dominant

A figure or a letter between brackets means that the species was found in the vegetation, but outside the sample plot under consideration.

The scale for the *presence* of the species in a community

- I species present in 1—20 % of the records
- II species present in 20—40 % of the records

- III species present in 40—60 % of the records
 IV species present in 60—80 % of the records
 V species present in 80—100 % of the records

ACKNOWLEDGMENTS

The author is indebted to Dr. K. U. KRAMER for critical remarks and correction of the English and the German text, Mrs. F. M. LINDEMAN-TORGÓ and Dr. J. C. LINDEMAN for the translation of the summary in Portuguese, Mrs. Dr. W. A. E. VAN DONSELAAR-TEN BOKKEL HUININK for her share in the field work and valuable criticism during the interpretation.

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