

# A SKETCH OF THE VEGETATION AND FLORA OF THE KAPPEL SAVANNA NEAR TAFELBERG, SURINAME. I

BY

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(Communicated by Prof. J. LANJOUW at the meeting of September 28, 1968)

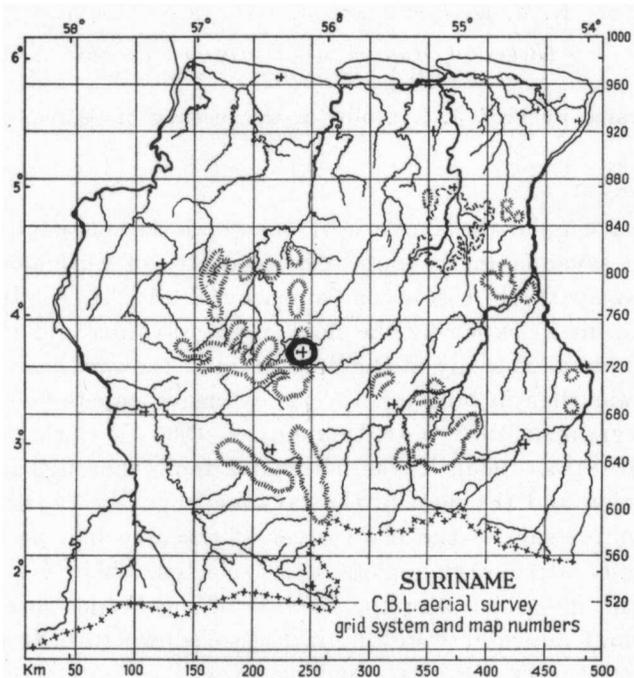
## *Introduction*

In February and early March, 1961, the senior author spent three weeks on a small savanna in the approximate centre of Suriname, South of Tafelberg, (map 1). He was accompanied by Mr. W. H. A. Hekking. The time was spent in exploring the flora of the savanna and the adjacent forest. As a detailed study of the vegetation of the savannas of northern Suriname was then in progress, several extensive papers being in preparation (HEYLIGERS, 1963; VAN DONSELAAR, 1965; VAN DONSELAAR-TEN BOKKEL HUIJINK, 1966), it was felt that a more thorough inventory of the vegetation and the flora of the savanna might be rewarding. When a general impression of the plant-cover of the area had been obtained, eight representative sample-plots were selected, their vegetation was analyzed and described after the method of the French-Swiss school of phytosociology, and pits were dug in the soil down to bedrock, samples being taken in every distinctive-looking layer. This work was carried out jointly by the senior author and W. H. A. Hekking; part of the floristic exploration was also done by or with Dr. R. M. Tryon, Harvard Herbarium, Cambridge, Mass. The results are here presented. It was felt that in order to integrate them with those obtained elsewhere in Suriname, the collaboration of a specialist familiar with the Suriname savannas in general was required. This was the junior author's task, who, after his prolonged work on the savannas of northern Suriname, later expanded his work to those of the southern part of the country. The preliminary results of the last-named study are in the press; more detailed field work is in progress as this paper goes to the press.

## *Acknowledgements*

The senior author wishes to express his great gratitude to the Netherlands Organization for the Advancement of Research in Surinam and the Netherlands Antilles "Wosuna" (now "Wotro") that sponsored his and Mr. Hekking's field work in Suriname; to the Suriname Department of Development (Departement van Opbouw), and especially to the Lareco

(Landdevelopment and Reclamation Co.), represented by Mr. S. Hop, who enabled him and Mr. Hekking to visit and study the Kappel savanna. Furthermore the authors are indebted to the Soils Laboratory, Royal Tropical Institute (Koninklijk Instituut voor de Tropen), Amsterdam, for the analyses of the soil samples. The help of several specialists in the identification of the material is acknowledged at the beginning of the species list (p. 506).



Map 1. The location of the Kappel savanna in the centre of Suriname.

#### *General notes and physiography*

The savanna described here was discovered from the air, and first visited by the Tafelberg Expedition conducted by Dr. D. C. Geijskes (1958). The Suriname pilot R. Kappel †, a member of that expedition, had always shown great interest in the savanna as a possible site for an airstrip, and it was named after him by the expedition (GEIJSKES, 1959). It is about 7 km South of the southernmost and loftiest point of the Tafelberg, at an altitude of almost 300 m (fig. 2). The main stretch of savanna is 5 km long and 1-1½ km wide. GEIJSKES's map shows two smaller, isolated patches of savanna to the East. The senior author and Mr. Hekking visited one, about one km in length, which is here named Lareco savanna as a sign of gratitude to the Lareco that, at the time of the visit, was building a modern airfield with associated structures, after the initial airstrip had been made by Geijskes and his team, and that provided board and shelter during the investigation.

To our present knowledge the Tafelberg is the easternmost extension of what is left of the Roraima sandstone formation, a thick cover of sediment of uncertain age of which only patchy remnants are now left, the westernmost being in south-eastern Colombia. As far as known to the writers, the Kappel savanna is the only savanna on Roraima sandstone that is situated at lower elevation, which gives it unusual interest. As the flora of the Roraima table-mountains becomes better known (GLEASON, 1929, 1931; GLEASON and KILLIP, 1939; MAGUIRE, 1948; LASSER and MAGUIRE, 1950; MAGUIRE *o.s.*, 1953, 1957; STEYERMARK, 1957, 1968), many species prove to extend over several of the "islands" of this geological formation, but it is difficult to separate geological-paleogeographical factors from ecological ones, the plateaus of these mountains being considerably higher than their surroundings, and it remains doubtful which factor is responsible for the disjunct distribution of the Roraima species. The Kappel savanna, surrounded on three sides by land of about the same elevation but with different subsoil, might furnish some interesting data pertaining to this problem. This is one of the reasons why the present paper is concluded by a list of species found on and around the savanna, with notes on their distribution in other parts of the country, the Roraima formation, etc. For this purpose the rather limited collections made by Dr. J. G. Wessels Boer in 1963 in the same area, and a few by a Suriname collector working for Mr. P. J. M. Maas in 1965, are also taken into account.

Another point of interest is the location of the Kappel savanna in the centre of Suriname, between the northern savanna belt and the isolated, much less extensive savannas of the southern part of the country (see VAN DONSELAAR, 1968). Although the floristic exploration of the Kappel savanna is by no means complete, it seems most unlikely that the savanna species discontinuously distributed from the northern to the southern savannas of the country all occur there, and the part it has played as a stepping-stone must at best be very limited, unless the situation was radically different in the past.

The area occupied by the savanna is not level, but has as a whole less relief than the vicinity. To the North the ground rises unevenly but steadily towards the base of Tafelberg, to the West and South the Roraima formation ends, and the landscape with its numerous small creek valleys is radically different, as a glance at the aerial photograph (fig. 1) will show. The savanna is traversed by some small and very shallow creeks, visible on this photograph as dark bands, caused by a kind of gallery vegetation of *Mauritia flexuosa*, *Bactris campestris*, *Oenocarpus oligocarpa*, *Clusia* spp., etc. The higher parts often have outcroppings of sandstone.

The Roraima substrate around the savanna is covered by a dense savanna wood. This was not systematically explored, which undoubtedly would have been very much worth-while, but a number of plants were collected, as stated in the enumeration at the end. In aspect it is similar

to luxurious savanna wood elsewhere in the country; it has many epiphytic mosses, orchids, and some ferns, and is characterized by the presence of two palms, *Attalea sagotii* and *Astrocaryum sciophilum*, that are common in not too densely shaded places (fig. 7).

We considered the possibility that the absence of a closed tree cover on the savanna might be due to the thinness of the soil layer on the bedrock. A pit dug in the soil in a well-developed stretch of forest disproved this surmise. The soil layer was 35 cm thick, as compared with 20–60 cm (savanna scrub) to 70 cm at one point in the open savanna. It seems very likely that bad drainage at least in the wettest season, perhaps combined with water shortage during dry spells, is the main factor preventing forest growth on the savanna.

When the savanna was discovered, there were no signs of burning, and the borders were not sharp, the scrub passing gradually into the closed wood (fig. 3). The whole area was uninhabited at the time of its discovery, and for the maintenance of the savanna, probably also for its origin, fire does not seem to enter into the picture.<sup>1)</sup>

This brings up the problem of the age of the savanna, or, more precisely, whether it is at present expanding or contracting. Expansion, through clogging of creeks by sand eroded from sandstone bedrock, cannot be ruled out, but it seems more likely that erosion by creeks from the South and West where, i.a., at present some small waterfalls are situated, gradually reduces the extent of the badly drained areas, and that the forest is slowly encroaching upon the savanna. The problem should be studied by a geomorphologist.

### *The climate*

We are indebted to the Meteorological Service of Suriname for some figures of meteorological observations from the Tafelberg airfield on the savanna. Although these cover only a single year and are therefore of very limited absolute value, the relative distribution of rainfall and sunshine over that year (1960) gives some information worth mentioning.

As in northern Suriname, and opposed to the southernmost part of the country, the rainfall shows two pronounced maxima, one in April/May (1960: 527.1 and 520.9 mm, respectively), the other in December/February (1960: 218.1, 277.3, and 193.7 mm, respectively). Dry spells are in September (1960: 7.8 mm) and in March (1960: 51.1 mm). The cloudiness, however, seems to be more evenly distributed over the year than at Zanderij in the northern savanna belt, when the figures for the same year are compared, with at Kappel savanna considerably fewer days with-

<sup>1)</sup> The entire Tafelberg area, including the Kappel savanna, was recently proclaimed a nature reserve (SCHULZ, 1968). It is hoped that this will provide some effective protection for the Kappel savanna, as a considerable part was sacrificed for the construction of two airstrips and other parts were burned (see map 2).

PLATE I

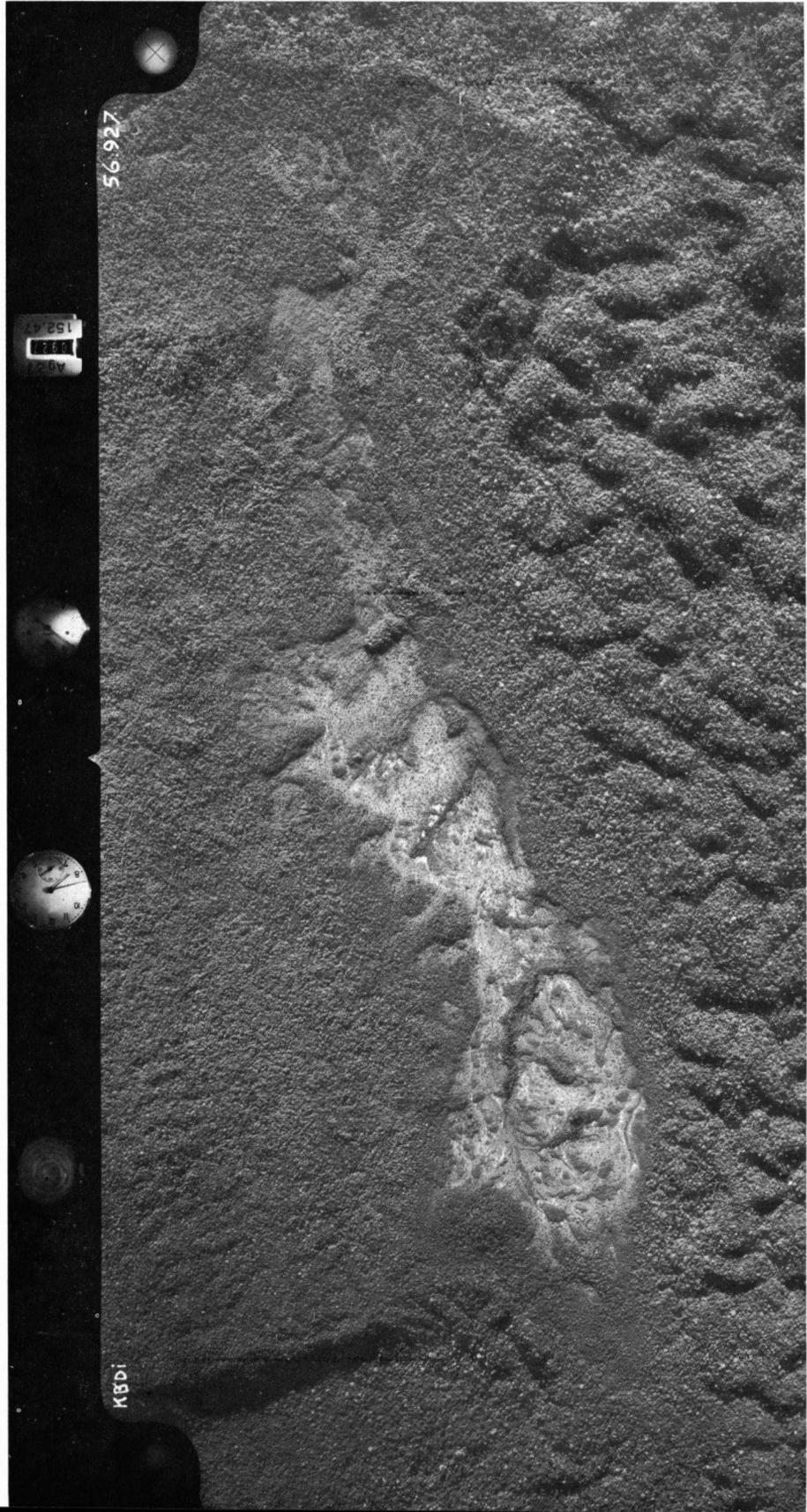


Fig. 1. Aerial photograph of the Kappel savanna and vicinity, 1 : 40,000. (Photogr. and copyright Centraal Bureau voor Luchtkartering, Paramaribo).

PLATE II



Fig. 2. The southern escarpment and loftiest point of Tafelberg, as seen from the Kappel savanna (photogr. by K. U. Kramer).

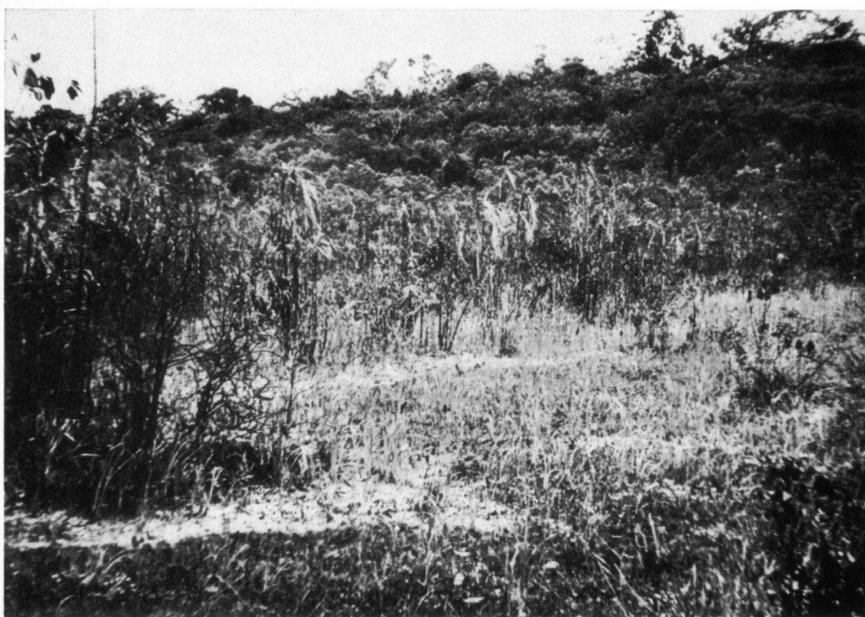


Fig. 3. Savanna scrub, mainly of *Bactris cappestris*, recently burned; in the background the transition from scrub to savanna wood (photogr. by K. U. Kramer).

PLATE III

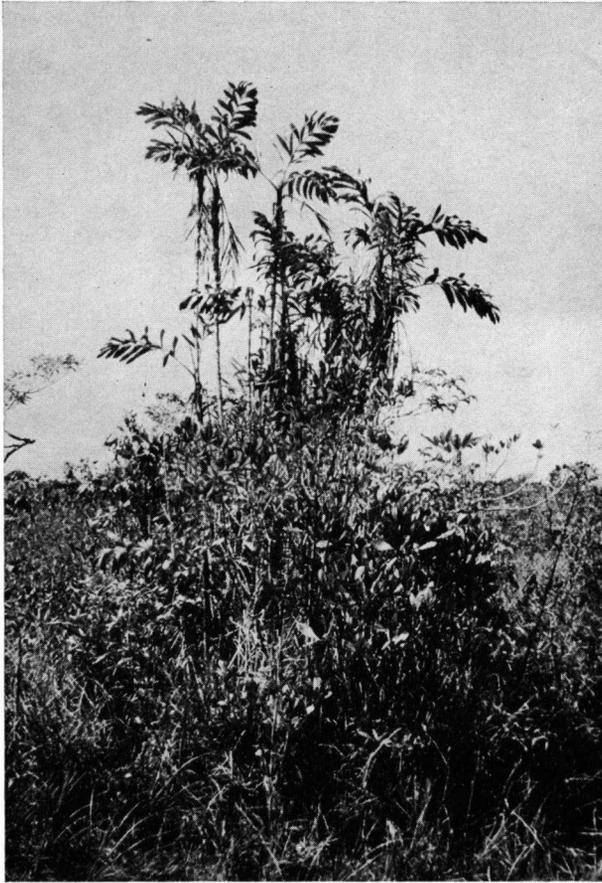


Fig. 4. A clump of *Bactris campestris*, *Clusia fockeana*, etc., typical for the scrub islands on the more open savanna (photogr. by K. U. Kramer).



Fig. 5. *Lindsaea pendula* in thicket of *Clusia* etc. (photogr. by K. U. Kramer).

PLATE IV

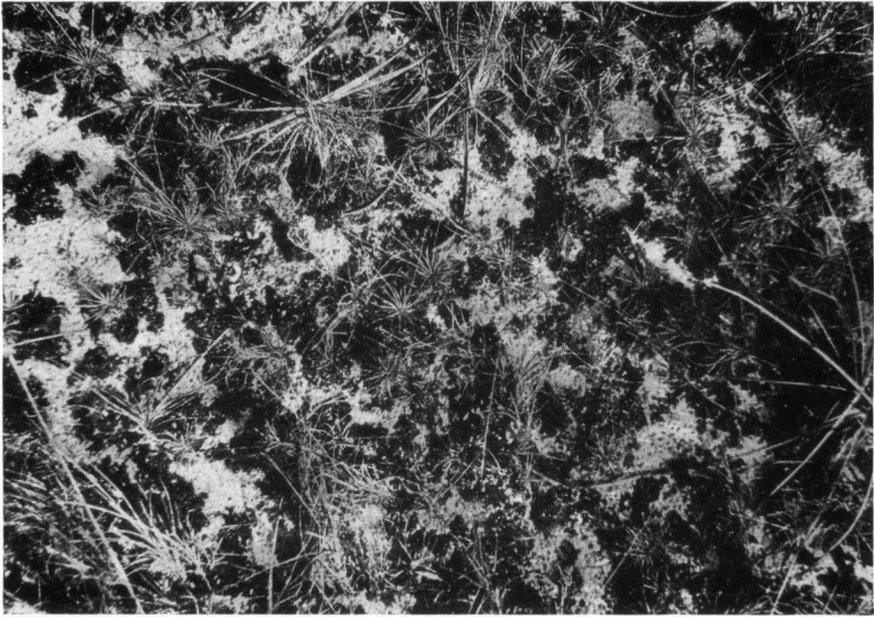


Fig. 6. An example of the wettest, most open parts of the savanna vegetation, consisting mainly of *Rhynchospora curvula*. The dark patches are a *Cyanophycea* (photogr. by W. H. A. Hekking).



Fig. 7. The savanna wood on Roraima sandstone near the Kappel savanna. The palms are *Astrocaryum sciophilum* (photogr. by K. U. Kramer).

PLATE V



Fig. 9. *Scleria cyperina*, frequent in savanna thickets  
(photogr. by W. H. A. Hekking).



Fig. 8. *Turnera glaziovii*, a frequent shrub of the savanna  
(photogr. by W. H. A. Hekking).

PLATE VI



Fig. 10. *Rapatea paludosa* var. *sessiliflora*, frequent by watercourses on the savanna almost confined to Tafelberg and the Kappel savanna (photogr. by W. H. A. Hekking)

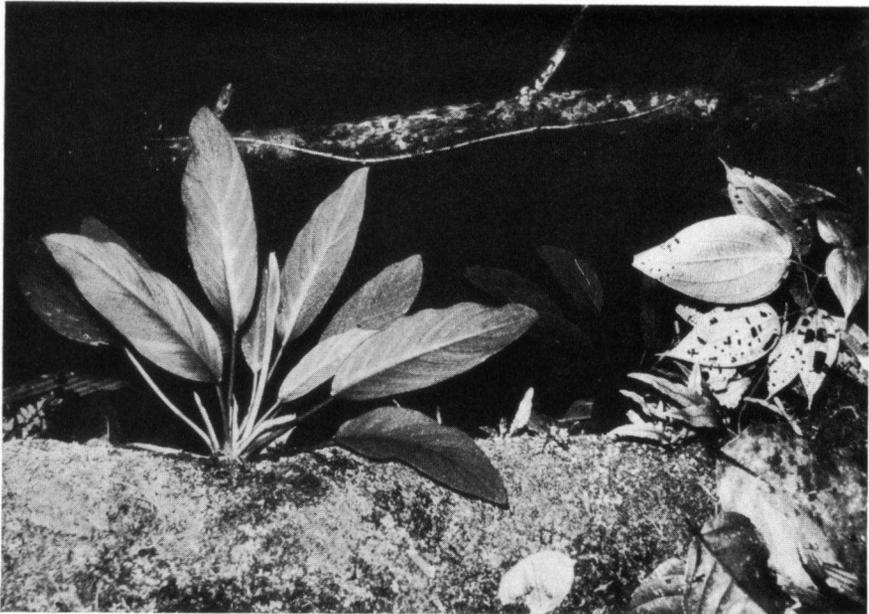
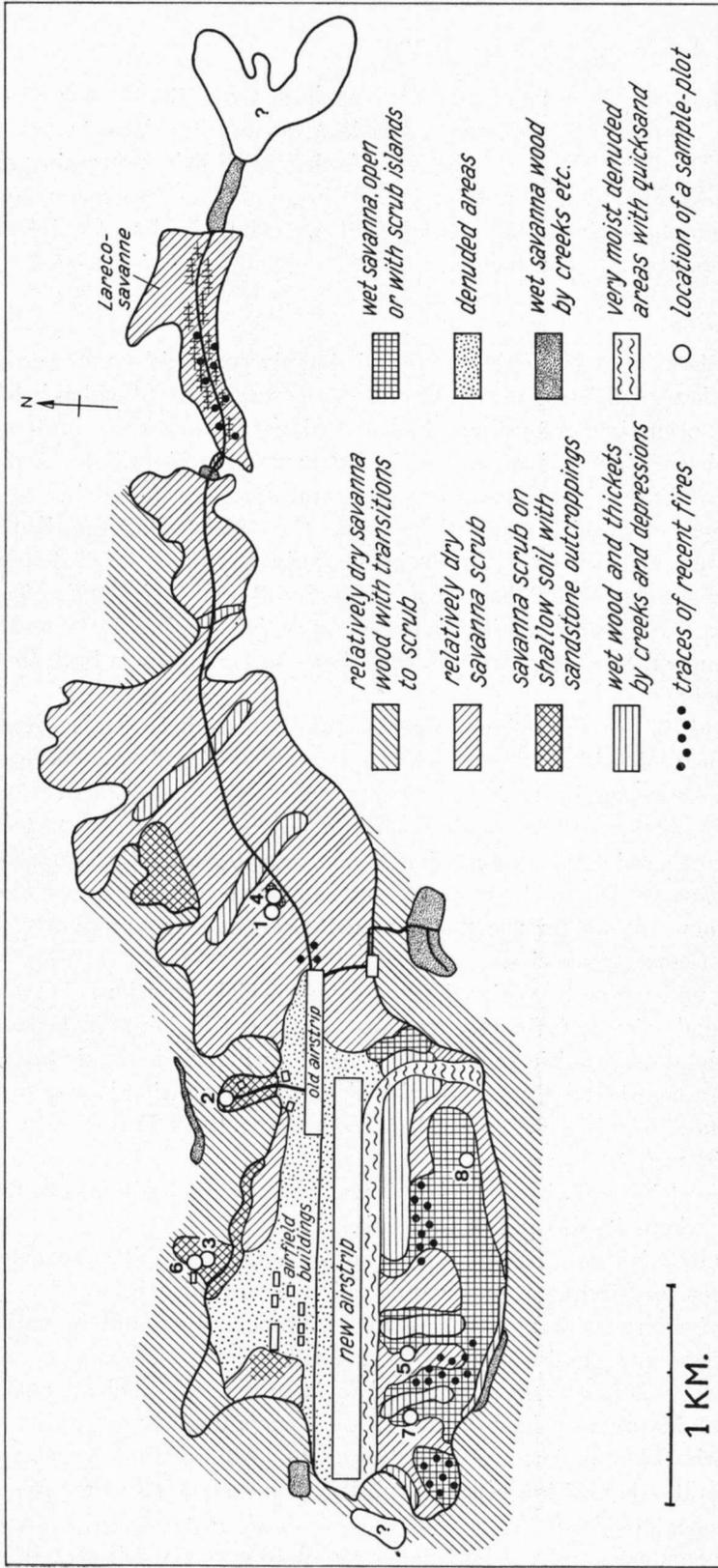


Fig. 11. *Schismatoglottis americana* on sandstone by a creek in the savanna wood. A species restricted to the Tafelberg area (photogr. by K. U. Kramer).



Map 2. The vegetation of the Kappel savanna, drawn after a sketch made in the field by the senior author. The condition is that of February, 1961; the boundaries between the various types of plant cover are only approximations and as a rule not very sharp.

out sunshine and also much fewer with sunshine from 91 to 100 % of the time. This stands to reason when the location of the Kappel savanna South of Tafelberg, West of the van Asch van Wijck Mountains and East of the Wilhelmina Mountains is kept in mind. The presence of some plants as epiphytes in savanna scrub that are otherwise forest epiphytes might be related to this factor.

### *The vegetation*

The undisturbed part of the savanna is largely covered by more or less closed thickets, consisting of shrubs and small trees many of which belong to species occurring everywhere in the Guianas in savanna scrub and wood, such as *Licania incana*, *Clusia fockeana*, *Miconia ciliata*, *Retiniphyllum schomburgkii*, *Pagamea capitata*, and *Bactris campestris*.

A number of species occur throughout the thickets on the Kappel savanna and are otherwise in Suriname only known from Tafelberg; these are *Euceraea nitida*, *Turnera glaziovii* (fig. 8), and *Aulomyrcia albido-tomentosa*; *Byrsonima eugeniifolia*, *Conomorpha fulvo-pulverulenta*, and an as yet unnamed *Sterigmatopetalum* species have so far not even been found on Tafelberg.

The scrub is not quite homogeneous; the variation is shown by the three records of table I. The first two were made in places where the sandy soil above the bedrock was 50–60 cm thick; in record 3 this is only 20 cm. The latter record contains as interesting species *Sterigmatopetalum guianense*, otherwise only known from Tafelberg; *Pleurisanthes parviflora*, *Miconia phaeophylla*, and an as yet undetermined species of *Erythroxylum*, all three new species for the flora of Suriname; and an apparently undescribed *Couratari* species.

Several undergrowth species deserve some special attention. *Axonopus ramosus*, endemic to Suriname, grows on Tafelberg in joints in bedrock, but elsewhere on granitic rocks in depressions where it is dominant and may form a peat layer. Eventually this *Axonopus* vegetation is overgrown by thickets of *Clusia nemorosa* and *C. panapanari* (VAN DONSELAAR and SCHULZ, in prep.).

*Lindsaea stricta* var. *jamesoniiiformis* was in Suriname only known from Tafelberg where it also grows in scrub.

*Apteria aphylla* var. *hostmanniana* and *Leiphaimos aphyllus*, two small saprophytes, are frequent in savanna thickets and also in woods.

*Gleichenia flexuosa* was elsewhere in Suriname only found in various more or less open, moist places by cuts in the soil.

Except for *Scleria cyperina* (fig. 9) and *Schizaea pennula* which are equally widespread in savanna bushes and in open savanna, the other species of the herb layer all have their optimum in open savanna vegetation.

The overall composition of the shrub layer, and especially the presence of *Bactris campestris*, *Retiniphyllum schomburgkii*, *Pagamea capitata*, and *Marlierea montana*, and the herb layer, point to a sandy soil that in the

TABLE I

nr. of record . . . . .	1	2	3
area (m <sup>2</sup> ) . . . . .	100	100	100
cover (%), total . . . . .	90		95
tree/shrub layer . . . . .	75	40	80
herb layer . . . . .		30	
height tree/shrub layer (m) . . . . .	5½	4	

*Tree/shrub layer*

Licania incana . . . . .	2	2	1
Clusia fockeana . . . . .	1	2	2
Bactris campestris . . . . .	2	2	1
Henriettea vs succosa . . . . .	+	+	1
Retiniphyllum schomburgkii . . . . .	+	(x)	1
Miconia ciliata . . . . .	+	+	+
Coccoloba excelsa . . . . .	+	+	r
Clusia panapanari . . . . .	1	2	1
Euceraea nitida . . . . .	1	2	2
Byrsonima eugeniifolia . . . . .	2	+	+
Turnera glaziovii . . . . .	r	+	+
Sterigmapetalum spec. . . . .	+	+	+
Marlierea montana . . . . .	1		
Tibouchina aspera . . . . .	+		
Ouratea surinamensis . . . . .	+		
Humiria balsamifera var. guianensis . . . . .	+		
Tetracera asperula . . . . .	1	1	
Pagamea capitata . . . . .	r	1	
Conomorpha fulvo-pulverulenta . . . . .	+	+	
Sapot. spec. I . . . . .		+	
Sapot. spec. II . . . . .		+	
Ternstroemia punctata . . . . .		+	
Tabebuia insignis . . . . .		+	
Dolioscarpus spec. . . . .	+		+
Conomorpha magnoliifolia . . . . .	r		+
Ormosia costulata . . . . .		2	r
Dimorphandra hohenkerkii . . . . .		+	+
Aulomyrcia albido-tomentosa . . . . .		+	+
Myrcia sylvatica . . . . .		+	r
Myrcia floribunda . . . . .			+
Davilla aspera . . . . .			+
Mesochites trifida . . . . .			+
Malanea macrophylla . . . . .			+
Annon. spec. . . . .			+
Byrsonima obversa . . . . .			r
Bombax flaviflorum . . . . .			r
Sterigmapetalum guianense . . . . .			+
Pleurisanthes parviflora . . . . .			+
Miconia phaeophylla . . . . .			+
Erythroxylum spec. . . . .			r
Couratari spec. nov. . . . .			1

*Herb layer*

Lagenocarpus tremulus . . . . .	2	2	1
Panicum nervosum . . . . .	+	2	2
Hypolytrum pulchrum . . . . .	2	+	2
Raddiella nana . . . . .	+	+	+
Xyris spec. . . . .	+		
Syngonanthus gracilis var. koernickeanus . . . . .	+		
Abolboda americana . . . . .	+		
Paspalum polychaetum . . . . .	r	+	
Mesosetum loliiforme . . . . .		1	
Rhynchospora graminea . . . . .		+	
Syngonanthus spec. . . . .		+	
Xyris malmeana . . . . .		+	
Paspalum pulchellum . . . . .		2	+
Rhynchospora curvula . . . . .		1	+
Sauvagesia sprengelii . . . . .		2	+
Scleria cyperina . . . . .	2	2	2
Schizaea pennula . . . . .	+		
Lindsaea stricta var. jamesoniiformis . . . . .	(x)	(x)	+
Leiphaimos aphyllus . . . . .	+		
Apteria aphylla var. hostmanniana . . . . .	r		
Axonopus ramosus . . . . .		2	r
Gleichenia flexuosa . . . . .			2

*Moss layer*

Cladonia sandstedei . . . . .	2	+	1
Sphagnum palustre . . . . .	2		
Leucobryum martianum . . . . .	2		
Sematophyllum subsimplex . . . . .			+

TABLE II

nr. of record . . . . .	4	5	6	7	8
area (m <sup>2</sup> ) . . . . .	36	32	50	110	
cover (%), total . . . . .			90	90	90
shrub layer . . . . .	1	—	80	80	40
herb layer . . . . .	75	60			
moss layer . . . . .	—	—	x	x	20
algal layer . . . . .	66	30	x	x	

*Species of open savanna vegetations*

Ch. association Rhynchosporium curvulae					
Rhynchospora curvula . . . . .	2	2	1	2	.
Ch. alliance Bulbostylidion lanatae					
Bulbostylis lanata . . . . .	+	2	.	.	.
Drosera cayennensis . . . . .	1	+	.	.	.
Ch. association Syngonantho-Lagenocarpum					
Abolboda grandis . . . . .	.	.	.	.	2
Ch. alliance Syngonantho-Xyridion					
Paspalum polychaetum . . . . .	1	r	.	(x)	+
Syngonanthus gracilis var. koernickeanus . . . . .	.	+	.	+	.
Xyris vs spathacea . . . . .	.	.	.	.	1
Ch. order Paspalealia pulchelli					
Lagenocarpus tremulus . . . . .	1	2	2	2	2
Paspalum pulchellum . . . . .	+	+	2	2	2
Sauvagesia sprengelii . . . . .	1	+	+	+	+
Rhynchospora graminea . . . . .	1	2	.	2	.
Abolboda americana . . . . .	+	.	.	+	1
Bulbostylis circinata . . . . .	.	1	.	.	.
Comolia lythrarioides . . . . .	.	r	.	.	.
Perama hirsuta . . . . .	.	.	.	+	.
Syngonanthus umbellatus . . . . .	1	.	.	.	+
Drosera capillaris . . . . .	.	.	.	1	.
Utricularia fimbriata . . . . .	.	.	.	.	+
Ch. class Leptocoryphio-Trachypogonetea					
Panicum nervosum . . . . .	1	+	2	+	2
Hypolytrum pulchrum . . . . .	2	.	(x)	.	+
Raddiella nana . . . . .	r	.	1	.	+
Mesosetum loliiforme . . . . .	.	1	.	2	.
Rhynchospora barbata . . . . .	.	.	.	1	+
Polygala adenophora . . . . .	.	.	.	+	.

*Species of open savanna vegetations and swamps*

Lycopodium carolinianum var. meridionale . . . . .	.	.	.	1	.
Xyris fallax . . . . .	.	.	.	.	r

*Species of open savanna vegetations and savanna bushes*

Scleria cyperina . . . . .	.	.	(x)	.	.
Schizaea pennula . . . . .	.	.	.	.	r

*Other species*

Utricularia spec. . . . .	r	r	r	.	.
Spiranthes spec. . . . .	.	+	.	r	.
Pogonia unifoliata . . . . .	.	+	.	.	.
Axonopus ramosus . . . . .	.	.	r	r	.
Lycopodium duidae var. guianense . . . . .	.	.	.	1	.
Utricularia hispida . . . . .	.	.	.	+	.
Leucobryum martianum . . . . .	.	.	+	.	+
Cladonia sandstedei . . . . .	.	.	.	1	+
Sphagnum palustre . . . . .	.	.	.	.	+
Cyanophyceae . . . . .	4	2	1	2	+

TABLE III

Texture of some soil samples (see the text and the additions to the tables).

	1 record 1	2 record 4	3 savanna wood
coarse sand (2000-300 mu) . . . . .	31,84 %	36,62 %	19,98 %
fine sand (300-50 mu) . . . . .	60,75 %	60,65 %	69,17 %
silt (50-2 mu) . . . . .	7,16 %	2,73 %	9,35 %
clay (< 2 mu) . . . . .	0,25 %	—	1,50 %

wet season may be completely waterlogged for prolonged periods. There are affinities to HEYLIGERS's *Clusia-Scleria* scrub and bushes (1963) and VAN DONSELAAR's *Marlierea* scrub and bushes (1965, 1969). The modest part *Humiria balsamifera* plays is striking.

Open savanna (table II) is less extensive. There are some fairly large patches of almost or quite shrubless vegetation, e.g. where records 1 and 2 were made. In some instances the open herbaceous vegetation includes some low shrubs, either scattered (record 3) or concentrated in small islands (record 4, fig. 4). These shrubs are all of species occurring in the thickets as described above. Special mention may be made of *Lindsaea pendula* (fig. 5) and *Lycopodium duidae*, both new to Suriname, that are confined to, or at least prefer, the scrub islets on the open savanna. Both are members of the sandstone flora of the Guayana Highland.

Widespread and often important constituents of the open savanna vegetation are *Lagenocarpus tremulus*, *Paspalum pulchellum*, *Rhynchospora graminea*, and *Panicum nervosum*. These, and the species combination as a whole, place the entire vegetation in the *Paspaletalia pulchelli*, in the Guianas the order of savanna-vegetation types of wet, even very wet soils. [It is striking that in the present area *Panicum micranthum* H.B.K. and *Leptocoryphium lanatum* (H.B.K.) Nees, elsewhere widespread, are lacking, and that *Rhynchospora barbata* is so insignificant.] The word "wet" applies to the situation prevailing during the rainy season when the soil layer in which the plants root is saturated with water for a considerable time and the water table may periodically even exceed the surface. In dry periods, however, the soil is bone-dry for a long time, apart from a brief period after a rain-shower. In the present case, and in the case of many other natural savannas, the alternation of excess and shortage of water is a consequence of the combination of little relief, the poorly permeable, shallow subsoil, the strongly permeable topsoil, and the fluctuation of rainy and dry seasons.

On closer inspection we can distinguish two associations, both already described from other parts of the country.

A large part of the vegetation belongs to the *Rhynchosporetum curvulae* (records 4-7, fig. 6). It is classed in the alliance *Bulbostylidion lanatae* and is known from northern and southern Suriname and from French Guiana (VAN DONSELAAR, 1965, 1969). So far it was always met with on slightly coloured, mostly somewhat loamy, i.e., not entirely leached sand. On the Kappel savanna it turns up for the first time in places where several cm of the topsoil are entirely bleached (records 5 and 6).

Record 8 represents another association, the *Syngonantho-Lagenocarpetum tremuli* (subass. *typicum*), of the alliance *Syngonantho-Xyridion*, occurring on moist white-sand savannas in northern Suriname (VAN DONSELAAR, 1965). This is not only shown by the characteristic species (in the sense of faithful taxa) but also by the presence of *Panicum nervosum*,

*Sphagnum palustre*<sup>1)</sup>, and the algal layer which are absent from other associations of the Syngonantho-Xyridion. HEYLIGERS (1963) gave an excellent description of this type of vegetation, under the name "*Lagenocarpus tremulus* vegetation. *Panicum nervosum* variant, *Panicum micranthum* subvariant". The scrub islands are perhaps identical with his "*Licania incana* subvariant" which VAN DONSELAAR called the sub-association licanietosum incanae.

This vegetation type agrees with the association described from northern Suriname, not only in its species spectrum but also in the tendency towards formation of mounds, connected with a beginning of hog-wallow structure of very humose soil, caused by earthworms which were actually observed in record 8. Undoubtedly the phreatic level is higher than in the Rhynchosporietum curvulae. It is impossible to conclude from the colour of the soil whether it is actually more strongly leached.

Some further remarks on the tables seem indicated. *Syngonanthus umbellatus*, *Drosera capillaris*, and *Utricularia fimbriata* are in northern Suriname characteristic species of the alliance Syngonantho-Xyridion, but in southern Suriname and French Guiana they extend to associations classed in other alliances of the Paspaletalia pulchelli. Therefore they are listed as characteristic species of the order.

Furthermore, the table shows that *Paspalum polychaetum* and *Syngonanthus gracilis* var. *koernickeanus*, two more characteristic species of the Syngonantho-Xyridion in northern Suriname, on the Kappel savanna also occur in vegetations assigned to the Bulbostylidion lanatae. This suggests a locally greater ecological amplitude. For a definite conclusion the number of records is, however, too small.

In this connection a more general problem of the classification of wet savanna vegetation presents itself. In northern Suriname it is possible to draw a sharp line between the types that occur on a thick layer of entirely bleached, pure white sand (Syngonantho-Xyridion), and the types of reddish brown, often slightly loamy sand (Bulbostylidion lanatae). The Kappel savanna is an example of a place where, through gradual leaching, a stage was reached in which the roots of the herbaceous plants are partly located in the leached toplayer and partly below it, or at least where they come into contact with the ground water that has passed the subsoil. In such places we may expect the occurrence of vegetation types that are less easily classed in the present system.

Finally the question comes up whether the composition of the vegetation and flora sheds any light on the problem of the age of the savanna. Its vegetation types are equally rich in species as are identical or closely related types elsewhere in Suriname, and more so than in French Guiana (VAN DONSELAAR, 1969). The absence of the savanna plants *Leptocoryphium*

<sup>1)</sup> HEYLIGERS (1963) and VAN DONSELAAR (1965) use for this species the synonyms *S. antillarum* and *S. kegelianum*, respectively.

*lanatum* and *Panicum micranthum*, very widespread and common in the Guianas, is certainly remarkable, as stated above, but the vegetation as a whole furnishes no arguments in favour of the view that this is a relatively young savanna, not yet reached by all potential colonists.

*Additions to the tables*

Record 1

Exposition ENE, inclination 5°.

No rocks at the surface. Much litter. No traces of burning. Inhabited terrestrial termitary (10 cm) and underground ants' nest (*Camponotus*).

Soil: 0- 1 cm white sand;

- 1-57 cm dark grey-brown, humic sand; densely rooted to the bottom (see table III column 1), earthworms present;
- 57- cm soft, pale yellow sandstone, here and there penetrated a few centimeters by roots with ferruginous cover.

Many epiphytes, crustose lichens, and epiphytic hepatics: *Pleurothallis hexandra*, *Maxillaria* spec., *Brom.* spec., *Tillandsia bulbosa* (10 cm above the ground), *Phthirusa squamulosa*, *P. savannarum*, *Polypodium lycopodioides* var. *salicifolium* (15-25 above the ground), *P. triseriale*, *P.* spec., *Hymenophyllum polyanthos* (down to the ground).

Record 2

Exposition NNE, inclination 10°.

Sandstone around the plot and occupying one third of its area. The sandstone layers disappear with a slight inclination to SSE. Partial cover of litter. No traces of burning; few or no ants.

Soil (pit 0.75 m from outcropping rock):

- 0- 2 cm slightly coloured sand, gradually passing into
- 2-50 cm brown, humic sand, with many roots;
- 50- cm soft, white sandstone, here and there with channels filled with dark sand as above.

Some lichens in depressions, on rocks, and also on the branches of the shrubs. One epiphytic orchid at the stem base of *Euceraea nitida*.

Record 3

Exposition NE, inclination 10°.

Only scattered sandstone outcroppings. Litter mainly of *Andira*. No traces of burning. One underground termitary; no ants' nests. Several dead trees and shrubs. Only one seedling of a *Loranthacea*.

Soil: 20 cm grey-brown, humic sand on yellow-white sandstone.

## Record 4

Exposition ENE, inclination 5°.

No traces of burning. Outside the plot many dead shrubs, probably killed by drought. An *Usnea* and another lichen on the surrounding shrubs.

Soil: 0–10 cm grey-brown sand;  
 10–30 cm pale grey-brown sand (see table III column 2);  
 30–45 cm yellow-brown sand;  
 45– cm sandstone.

## Record 5

Exposition NE, inclination very slight.

No traces of burning; no termitaries or ants' nests.

Soil: 0– 6 cm white sand;  
 6–35 cm reddish sand with white spots, slightly mottled; with rather many roots;  
 35–70 cm brown, humic sand, with few roots;  
 70– cm pale yellow sandstone, here and there with channels filled with dark sand as above.

## Record 6

Exposition E, inclination 15°.

Few outcropping rocks. Some litter from surrounding shrubs. No traces of burning.

Soil: 0– 0,5 cm pale, leached sand;  
 0,5–10 cm red-brown, humic sand;  
 10– cm soft, white sandstone.

In the sample-plot scattered low shrubs: *Dimorphandra hohenkerrii*, *Clusia fockeana*, *Euceraea nitida*, *Byrsonima* spec., *Marlierea montana*, *Dolioscarpus* spec., *Tetracera asperula* (all +), *Turnera glaziovii* (r).

## Record 7

Exposition NNE, inclination 5°.

15 m W of depression with *Mauritia flexuosa*. No traces of burning. One inhabited terrestrial termitary.

Soil: 0–1,5 cm yellowish, leached sand;  
 1,5–15 cm dark, grey-brown sand;  
 15–35 cm pale yellow-brown sand;  
 35– cm pale brown, very wet sand.  
 Sandstone probably at about 90 cm.

In the open vegetation that covers most of the plot small bush islands occur. They have a height of 2,5 m, apart from *Bactris campestris* that reaches up to 4,5 m. The other constituent species are: *Clusia fockeana*,

*Euceraea nitida*, *Byrsonima* spec., *Pagamea capitata*, *Licania incana*, *Retiniphyllum schomburgkii*, *Tabebuia insignis*, *Ternstroemia punctata*, *T. dentata*, *Marlierea montana*, *Humiria balsamifera*, *Conomorpha fulvo-pulverulenta*, *Tetracera asperula*, *Doliocarpus* spec., *Lindsaea pendula*, *L. stricta* var. *jamesoniiformis*, *L. stricta* var. *parvula*, *Abolboda grandis*, *Sphagnum palustre*, *Leucobryum martianum*. Epiphytes on the branches of the shrubs: cf *Bifrenaria* spec. (on *Ternstroemia punctata*) and several hepatics.

#### Record 8

Exposition E, inclination very slight.

Very few outcrops of sandstone. S of wet wood with *Mauritia flexuosa*. Here and there some litter around the bushes. No traces of burning. One inhabited termitary; no activity of ants; earthworms present.

Soil: 0-32 cm dark brown, humic sand;  
32-60 cm paler brown, humic sand;  
60- cm sandstone.

Roots penetrate down to the sandstone.

Small bush islands scattered in the open vegetation consisting of: *Clusia fockeana*, *C. panapanari*, *Byrsonima* spec., *Retiniphyllum schomburgkii*, *Tabebuia insignis*, *Bactris campestris*, *Euceraea nitida*, *Marlierea montana*, *Tetracera asperula*. The twining parasite *Cassytha filiformis* (on the two last-named species) reaches up to a height of 4 m.

#### ANNOTATED LIST OF VASCULAR PLANTS

The following list is an enumeration of all species found on the Kappel savanna proper and in the adjoining savanna wood on Roraima substrate. The species collected by Wessels Boer in the forest south of the savanna on granitic substrate are only included if they are of special floristic interest. Families, genera, and species are in alphabetical sequence. The collections are cited as follows: KH=Kramer and Hekking (sometimes collected by or with R. M. Tryon, Jr.); WB=Wessels Boer; and Maas. The first set of specimens is in the Utrecht herbarium.

The notes after the name give information about the local station etc. (K); the occurrence on Tafelberg, and, if any, on other Roraima table mountains (R; these data are largely based on the literature, chiefly the papers cited on p. 497); the ecology and distribution in Suriname (S); and, where necessary and known, the general distribution<sup>1)</sup>, although this is as a rule omitted when the species has been fully dealt with in the Flora of Suriname. An asterisk \* marks a species not previously reported from the country.

<sup>1)</sup> The now obsolete name "British Guiana" is only used to prevent ambiguity and has no political implications.

We are greatly indebted to a number of taxonomists for their considerable help with the identification of the material. These are Dr. C. E. B. Bremekamp, Utrecht (*Rubiaceae*), Dr. B. Maguire, New York (*Clusia*), Dr. R. McVaugh, Ann Arbor (*Myrtaceae*), the late Mr. N. Y. Sandwith, Kew (various groups), Dr. J. J. Wurdack, Washington (*Melastomataceae*), and our colleagues at the Botanical Museum and Herbarium, Utrecht, notably Dr. A. M. W. Mennega and Dr. J. C. Lindeman.

#### APOCYNACEAE

*Lacmellea aculeata* (Ducke) Monachino WB 1535. K: In savanna wood.

S: A common shrub or small tree, often on sandy substrate.

*Mandevilla subspicata* (Vahl) Markgraf KH 3091. K: In savanna scrub.

R: Tafelberg. S: Widespread in the country.

*Mesechites trifida* (Jacq.) Müll. Arg. KH 3303. K: In savanna scrub.

S: Very widespread, but not usually on savannas.

#### ARACEAE

*Anthurium andersonii* Schott WB 1572. K: South of the savanna. S:

Twice found in Suriname; see JONKER and JONKER (1968).

*Caladium bicolor* (Aiton) Vent. KH 3060. K: In moist savanna wood.

S: Widespread and common.

*Philodendron linnaei* Kunth KH 3059. K: Epiphytic in very moist savanna wood. S: Widespread, but not common.

*Philodendron tessmannii* K. Krause WB 1575. K: South of the savanna.

S: Twice before collected in the mountains of Suriname; see JONKER and JONKER, l.c.

*Schismatoglottis americana* Jonker et Jonker KH 2961. K: By creek in savanna wood; not rare (fig. 11). S: Endemic to Tafelberg and vicinity; see JONKER and JONKER, l.c.

#### BIGNONIACEAE

\**Schlegelia paraensis* Ducke WB 1565. K: In savanna wood. S: Once before collected: A. Mennega 528, (Tanjimama R.). Amazonian Brazil.

*Tabebuia insignis* (Miq.) Sandw. KH 2949, 3270. K: Widespread and often common in savanna thickets; mostly shrubby. S: Frequent in moist forests and on wet savannas. The plants from the Kappel savanna are somewhat atypical.

#### BOMBACACEAE

*Bombax flaviflorum* Pulle = *Rhodognaphalopsis fl.* (Pulle) Robijns KH 3016.

K: Savanna thickets, by sandstone outcroppings. S: A typical savanna shrub or small tree, in northern Suriname on white sand. From eastern Venezuela to Suriname.

## BORAGINACEAE

*Cordia nervosa* Lam. WB 1518. K: By creek on savanna. R: Tafelberg, Kaieteur Plateau. S: Not otherwise known. British and French Guiana. A species of sandy and sandstone substrate.

## BURMANNIACEAE

*Apteria aphylla* (Nutt.) Bernh. var. *hymenantha* (Miq.) Jonker KH 2926. K: In savanna scrub. R: Tafelberg; Ptari-tepuí.

*Dictyostega orobancheoides* (Hooker) Miers var. *parviflora* (Benth.) Jonker KH 2889. K: In dense savanna wood. R: Tafelberg, Mt. Roraima. S: This and the preceding species are widespread and probably not rare but often overlooked.

## CAESALPINIACEAE

*Dimorphandra hohenkerkii* Sprague et Sandw. KH 3053, WB 1517. K: A common small tree in savanna wood, here and there in savanna thickets. This is probably the plant called "dakama" by GELJSKES (1959), said to be dominant in several places round the savanna. S: Tafelberg and a few other localities, often stated to be locally common. Not confined to sand, ecological preference uncertain. British and French Guiana.

## CHRYSOBALANACEAE

*Licania incana* Aublet KH 2910. K: A very common shrub on the savanna. R: Tafelberg, Kaieteur savanna, etc. S: Common in savanna bushes, savanna scrub, savanna wood, and savanna forest.

## CONNARACEAE

\**Connarus fasciculatus* (DC.) Planch. WB 1569. K: Forest on granite south of the savanna. S: A few collections from the mountains; not previously reported in the literature. Amazonian Brazil.

## CYCLANTHACEAE

\**Cyclanthus bipartitus* Poiteau WB 1507. K: By watercourse in forest. S: Not previously reported, but known by three other collections from the interior. Widespread in Central and northern South America.

*Dicranopygium pygmaeum* (Gleason) Harling ssp. *pygmaeum* WB 1506. K: By waterfall in forest. British Guiana and Suriname.

## CYPERACEAE

*Becquerelia tuberculata* (Boeck.) Pfeiffer KH 3027. K: By moist depression, among palms, on the savanna. See KOYAMA (1967).

*Bulbostylis circinata* Kunth KH 2943. K: Uncommon, on open savanna. S: Not rare on the northern savannas, on wet sand to sandy loam.

- Bulbostylis lanata* (H.B.K.) Clarke KH 2935, 3283. K: Common in open savanna vegetation. S: A common savanna plant, as in general in the Guianas, on wet loamy sand, extending to the southern savannas of Suriname.
- Calyptracarya glomerulata* (Brongn.) Urban KH 2887, 3258. K: In savanna woods. S: A common forest plant, as elsewhere in the Guianas; see KOYAMA, l.c.
- Hypolytrum jenmanii* Clarke KH 3252. K: By ravine in savanna wood. See KOYAMA, l.c.
- Hypolytrum pulchrum* (Rudge) Pfeiffer KH 2916, 3276, 3296. K: Very common in open savanna vegetation and savanna scrub; soon sprouting after burning. S: In northern Suriname on wet loamy sand and heavier soil types. See KOYAMA, l.c.
- Lagenocarpus tremulus* Nees KH 2904. K: As the preceding. S: Tafelberg; northern and southern savannas, on wet (loamy) sand.
- Rhynchospora barbata* (Vahl) Kunth var. *glabra* Maury KH 2944, WB 1526. K: Uncommon in open savanna vegetation. S: In northern Suriname only on wet white-sand savannas. R: Tafelberg, Kaieteur Plateau.
- Rhynchospora curvula* Grisebach KH 2905, 3282. K: Common, especially in open savanna. S: Northern and southern savannas, on wet sand to sandy clay loam. R: Kaieteur Plateau, Ptari-tepuí.
- Rhynchospora cyperoides* Mart. WB 1527. K: By trail on savanna; apparently uncommon, not found in any sample plot. S: Very common in moist places, in savanna rivulets and swamps.
- Rhynchospora graminea* Uittien KH 2906, 3277. K: Frequent on open savanna. S: Northern and southern Suriname, on wet (loamy) sand savannas. R: Kaieteur savanna, West to the base of Mt. Duida. Amazonian savannas.
- Scleria cyperina* Willd. KH 2903, WB 1525, Maas 3384. K: Common in thickets on the savanna (fig. 9). S: From northern to southern Suriname, on savannas. R: Mt. Roraima and other table-mountains.
- Scleria stipularis* Nees KH 2963. K: By creek at edge of savanna, rare. S: Widespread in moist places, but not usually on savannas.

## DILLENACEAE

- Davilla aspera* (Aublet) R. Ben. KH 3042, 3302. K: A more or less climbing shrub, uncommon in thickets; nearly all flowers open at the same time. S: Widespread in savanna bushes and borders of scrub and forest. R: Kaieteur Plateau.
- Doliocarpus calinea*. J. F. Gmelin KH 3090. K: Uncommon in thickets, S: A common savanna shrub, often  $\pm$  climbing, on wet sand. KH 3291 represents another species of the same genus, apparently not yet recorded from Suriname, but at present indeterminable.
- Tetracera asperula* Miq. KH 2915. K: Frequent in savanna scrub. S: Idem.

## DROSERACEAE

*Drosera capillaris* Poiret KH 2938. K: Open, wet savanna, much less common than the following. S: In northern and southern Suriname on wet sand.

*Drosera cayennensis* Sagot KH 3041, 3260, 3280. K: Frequent on open, wet savanna. S: Northern savannas, on loamy sand; southern savannas. R: Ptari-tepuf; and elsewhere in Venezuela. For both species, see MAGUIRE and WURDACK (1957).

## ERIOCAULACEAE

*Syngonanthus gracilis* (Bong.) Ruhl. var. *koernickeanus* Ruhl. KH 2928, 3081. K: Not rare in open savanna and open woods. S: Northern and southern wet sand savannas. R: Tafelberg, Kaieteur savanna, etc. See LINDEMAN and GÖRTS (1968).

*Syngonanthus umbellatus* (Lam.) Ruhl. KH 3024, 3285, 3309. K: Not rare on open savanna. S: Northern and southern wet sand savannas. R: Tafelberg, Kaieteur savanna.

## ERYTHROXYLACEAE

*Erythroxylum* spec. KH 3305. K: A shrub, 3/4 m, in savanna thicket. Not one of the species previously known from Suriname.

## EUPHORBIACEAE

*Croton tafelbergicus* Croizat KH 2947. K: A shrub in savanna thicket, not common. S: Endemic to the Tafelberg area; see JABLONSKI (1967).

*Micrandra spruceana* (Baillon) R. E. Schultes WB 1548. S: S. slope of Tafelberg; found on Tafelberg by Maguire. Amazonian Brazil.

## FLACOURTIACEAE

*Eucaea nitida* Mart. KH 2911. K: A frequent shrub in savanna thickets. S: Otherwise only known from Tafelberg. R: Mt. Roraima, Ptari-tepuf, Cerro Isibukuri.

## GENTIANACEAE

*Leiphaimos aphyllus* (Jacq.) Grisebach KH 2925. K: In *Bactris* clumps on the savanna. S: A widespread saprophyte of forests and, occasionally, savannas.

\**Tachia guianensis* Aublet KH 3007, WB 1540. K: In savanna wood. S: Two other collections, Maguire 24098, Tafelberg Creek, and 24611, Tafelberg. Not previously recorded. North Brazil, British Guiana to eastern Colombia.

## GESNERIACEAE

*Lembocarpus amoenus* Lwbg. KH 3076, 3251. K: On sandstone rocks by creeks; locally frequent. S: Endemic in the mountains; not previously collected on sandstone.

*Napeanthus macrostoma* Lwbg. WB 1577. K: Among granitic boulders South of the savanna. S: Known by two other collections. Described from Amapá, Brazil.

## GRAMINEAE

*Axonopus ramosus* Swallen KH 2907. K: In open places in thickets. S: Described from Tafelberg; known from a few other collections from the interior. See LINDEMAN and GÖRTS (1968) and VAN DONSELAAR and SCHULZ (in prep.).

*Chloris radiata* L. KH 3051. K: Airfield; probably introduced.

*Ichnanthus nemoralis* (Schrader) Hitchc. et Chase KH 3062. K: Among sandstone boulders by creek in moist wood.

*Mesosetum loliiforme* (Hochst.) Chase KH 2917. K: Not rare in open places on the savanna. S, R: A typical savanna grass, widespread from northern to southern Suriname and on the Kaieteur savanna.

*Olyra ecaudata* Doell KH 3064. K: In wood by creek, on sandstone.

*Olyra micrantha* H.B.K. KH 3063, 3259. K: With the preceding. S: Not common in the forests of the interior. R: Tafelberg.

*Panicum nervosum* Lam. KH 2914, 3278. K: Common in various types of savanna vegetation. S: Frequent on wet savannas. R: Tafelberg.

*Paspalum polychaetum* Mez KH 3013. K: As the preceding, but less common. S: In northern Suriname on wet white-sand savannas. R: Tafelberg.

*Paspalum pulchellum* Kunth KH 2909, 3279. K: Common in thickets and on open savanna. S: A widespread savanna grass in northern and southern Suriname, on wet (loamy) sand.

*Raddiella nana* (Doell) Swallen KH 2919, 3008. K: An uncommon dwarf grass, mostly in the shade of shrubs and other tall plants. S: Widespread on the savannas of northern and southern Suriname, but not often collected and probably mostly overlooked. R: Tafelberg and other Roraima table-mountains.

## GUTTIFERAE

*Clusia fockeana* Miq. KH 2901, 3263, 3268. K: Frequent in thickets; small plants in open vegetation. Also common in adjoining savanna wood and gallery vegetation along watercourses. S: Tafelberg; widespread and common in various types of vegetation, especially savannas.

*Clusia panapanari* (Aublet) Choisy KH 2948. K: Frequent in thickets. S: On rocks in the interior (see VAN DONSELAAR and SCHULZ, in prep.); in savanna woods; as an epiphyte in high forest. R: Tafelberg.

\**Tovomita obscura* Sandwith KH 3035. K: Moist savanna wood by creek. Described from British Guiana, from an entirely different kind of vegetation (*Mora gonggrijpii* forest).