Preliminary survey of the vegetation types of northern Suriname

BY

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PREFACE TO VOL. I, PART 2.

Thanks to a grant by the Netherlands Foundation for pure scientific research (Z.W.O.), Dr J. C. Lindeman, scientific officer at our institute, got the opportunity to study the vegetation types of the forest in the northern part of Suriname. In Suriname the study was strongly supported by the Chief Forest Officer Ir I. A. de Hulster. Through the latter important facilities were rendered to the study and the head of his Department for Forest inventarisation, Ir S. P. Moolenaar, was enabled to cooperate with Dr Lindeman. By this joint effort of a botanist and a forester I believe that the study has gained considerably.

More detailed accounts of the forest communities will be published in the near future. A somewhat shorter edition of the present work in Dutch appeared in 1955 under the title: "Voorlopig overzicht van de bostypen in het Noordelijk deel van Suriname", door J. C. Lindeman en S. P. Moolenaar.

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CONTENTS

CHAPTER I

Introduction

In this second part of "The Vegetation of Suriname" an effort is made to present general characterisations of the forest types occurring in the northern part of Suriname as a basis for later detailed studies in various directions. The forests are approached both from the point of view of the ecologist and from that of the forester. To complete the picture which is visualised on the map in the backslip, also the non-forest vegetation types are treated briefly. Detailed descriptions of the swamp types and other vegetation in the coastal area can be found in the first part of this series.

Data for this paper were taken from the forest inventory carried out by the Forest Service (Dienst 's Lands Bosbeheer) in Suriname and from the detailed surveys of small sample plots made by the first author during two years of field work.

The forest inventory is carried out in parallel transects, layed out at 500 m intervals as strips of 10 m wide and 4 km long, thus providing a sampling percentage of 2 %. Blocks of 4 by 8 km serve as exploration units for this work. These units are traced along the grid system of the aerophoto maps and then laid out in the field with the aid of a theodolite-boussole. In the transects all trees with a diameter of at least 25 cm at breast height are recorded while short notes are made on the occurrence of palms and important undergrowth species.

This systematic survey was started in the year 1949 and up to 1955 an area of over 150,000 ha had been covered, resulting in enumeration data of about 3,000 km of transects from which some figures are presented here as illustration. A detailed analysis of the present material must be postponed on account of the laborious work involved. A number of profile drawings is added to illustrate the differences in structure of the forest types.

The data gathered in the exploration surveys are based completely on the vernacular names used by expert native tree-spotters. In the detailed sample-plot surveys a tree-spotter was used also, but in addition numerous collections were made for later identification, as many vernacular names cover more than one species and a few trees were unknown. Where the records allowed exact identification of the present species, in the following descriptions Latin names are given followed by the vernacular name in brackets; where the species could not be indicated with certainty the vernacular name comes first.

The following general figures about the country may help to orientate the reader.

Suriname is situated on the northern coast of South America between 2° and 6° N. lat. and the meridians of 54° and 58° W. long. The country occupies a central position in the floral district of Guiana, which may be roughly limited by the Amazone River, the Rio Negro and the Orinoco River.

Suriname has a total area of 143,000 sq km. covered for the major part (75—80 %) by forest. An area of 63,000 sq km. North of the fourth degree of latitude has been photographed from the air and mapped. It is mainly to this area that the following survey is restricted.

Climate.

Owing to its geographical position close to the equator Suriname has a typical tropical climate.

The temperature is high the year around with an average of 26.1° C., while the monthly averages vary about 2° during the year. The highest temperatures occur in September and October, the lowest in January and February.

The mean daily variation amounts to 9.2° C. for Paramaribo, decreasing towards the coast and increasing landinward. In the rainy season the daily amplitude is considerably smaller, in the dry season larger. The figures for Paramaribo apply to open country, but under forest-cover the variations are always much smaller; in rain forest they rarely exceed 7° C. and during clouded rainy days they often drop to 2° C. Near the coast the trade winds blow all the year around from directions varying between ENE and E, but in the interior a marked differentiation in land and sea winds can be observed. The mean wind force in Beaufort scale is 1.4 for Paramaribo, decreasing to about 1.1 in the interior.

Suriname lies completely out of the paths of the Caribbean hurricanes, and gales occur rarely. Thunder storms, however, are often preceeded by violent squalls of wind which commonly fell forest giants here and there.

The rainfall shows a marked periodicity, but only in a narrow belt along the coast the average figure for the driest month (October) drops below 40 mm; in general it remains above 60 mm as required by KÖPPEN for a tropical rainforest climate.

In exceptionally dry years which occur once about every 14 years the short wet season may even stay away and the period of drought is lengthened to 5 or 6 months. In those years the driest month can fall either in autumn or in spring and receives only about 20 mm rain.

For most observation stations the annual mean lies between 2000 and 2400 mm. We can distinguish a main wet season usually beginning in April and decreasing in intensity in July. In the first half of August the main dry season gradually sets in and lasts till December. The remaining part of the year (December to April) can be divided generally into a short wet and a short dry season, varying considerably with the year, both in length and

intensity. The wettest month is May with about 300 mm precipitation and the driest one October with about 65 mm.

The relative humidity of the air is high, the average for Paramaribo being 76—86 %. The diurnal variations in the forest are smaller than in the open; during the night relative humidity nearly always rises above 95 % and about midday it generally remains above 70 %. In the nightly hours of high humidity dew formation is frequent.

Geology and soil.

The greater part of Suriname belongs to the Guayana Shield which is of Praecambrian age and consists mainly of granites, granitodiorites and schists. These have been intruded by a number of very long dolerite dikes which show on the aerial photographs as low straight hilly ridges. In the centre of the country but one large block of the mesozoic Roraima sandstones, the Tafelberg or Table Mountain, has resisted erosion.

The old rocks in general are covered by very deeply weathered soils varying in structure from loamy sand to clay.

Lateritisation has resulted locally in the formation of ferritic caps on plateaus or in layers of small or larger ferrite concretions often surfacing in colluvial slopes.

Only incidentally in the mountainous interior we meet unweathered rock at the surface or under a thin layer of immature soil, as for example on granite domes like the Voltzberg.

Along the border of the old shield we find a series of sediments of much younger date which form belts all orientated about E-W and widening towards SW.

To the North the basement rocks dip away under the Zanderij formation which consists of coarse, bleached, white quartz sands and unbleached, yellow or brown sands and coarse-sandy clays. These sediments rest in part as a cover on the old basement rocks, in part they are scattered over it as remnants on a slightly higher elevation spared by erosion. When we go North, we enter the landscape of the old coastal plain, called the Coropina formation, consisting of sediments laid down in a shallow "wadden" sea behind offshore bars. This wadden landscape consists of silty loams and clays, sometimes overlying an impermeable subsoil of kaolinic clay. The bars in front of it are built out of very fine to fine sands and are very closely related in their morphology and in their vegetation to the ridges in the young coastal plain. Therefore the name ridge (in Suriname "rits") will be used in the following for all bars throughout the coastal area. The young coastal plain reaches up to the present coast line and is much narrower in the East than towards the West. It consists of heavy, blue sea clay upon which locally sand and shell ridges have been deposited at former coast lines. In the eastern and central part of Suriname most of these ridges are aggregated into bundles which more or less diverge westwards. In the western part of the coastal plain we find only scattered narrow and low ridges. Shell

ridges are limited to the central and western area alternating with sandy ridges.

The described pattern is dissected by a number of large rivers which are connected by transverse waterways. Towards the ocean they widen into vast estuaries at whose entrance shallow mud flats hamper the passage of large vessels. In the interior, shipping is limited by sand flats and rapids.

Vegetation types.

The following division into vegetation types is based upon the idea that under a generally homogeneous climate as occurring in Suriname the vegetation depends in first instance on the habitat which selected the species from those available in the area and, where possible, influenced their growth-form.

This selection resulted in very different combinations of species.

As in each combination the life-forms of the participant species together determine the aspect of the vegetation, physiognomy is an important feature of vegetation types which is much more accessible in inventories than the delimitation of characteristic combinations of species.

Though Suriname forms the central part of the floral district of the Guianas and thus is contained completely in the area of distribution of most species present, a number of species (including some important timber trees) have a distribution covering only part of the country, e.g. *Dicorynia guianensis* (*basralokus*), *Mora excelsa* (*mora*) and *Mora gonggrijpii* (*moraboekea*). Where such species play a predominant role they may give rise to distinct forms of forest, which therefore are not determined in first instance by the habitat, e.g. *mora* and *moraboekea*.

The influence of the habitat on the growth form of species we see demonstrated in euryoecious species which can resist a considerable adversity of conditions; in several species we observe that in unfavourable situations the normal tree-habit gives way to a true shrub-form.

Our division is intended for use in Suriname and for that reason we have tried to connect as far as possible with usual local names and views. On the other hand we have taken as a guide the scheme given by BEARD in 1944.

In both cases general habitat conditions and physiognomy are used as criteria. BEARD recognizes grouping at three levels: at the base a floristic grouping in associations and subordinate communities, then a physiognomic grouping in formations and at the top a habitat grouping in formation-series, each of which has an essential habitat character. At the present state of work we have refrained from defining and naming any associations but as far as possible we have used floristics in our descriptions. In general the placing of actual stands in a formation-series gave no difficulties and within the series the steps between formations are clear enough. In relation with the above-mentioned variation in habit of species, however, we found that certain communities occur which are floristically so closely related that they

fall apparently within the same association but differ in physiognomy a full formation-step. Therefore in the following chapters we have often used the term type in a broad sense to embrace now strict formations then formation-groups within a series.

On the other hand in some cases a closer relationship either physiognomically or floristically or both between members of different formation-series appeared to exist than within one series. As these relationships are recognized and expressed in the local names, we have let them prevail in our treatment.

The first point of deviation lies at the top of BEARD's scheme where he puts his rain forest as a separate formation followed by the seasonal formations as the first series radiating from it. The optimal vegetation on well-drained soils, which is called *high dry-land forest* in the Forest Service, shows considerable variations both in physiognomy and in composition in different areas; the most luxuriant forest is undoubtedly *rain forest* in the sense of BEARD, while less luxuriant stands have the aspect of his *evergreen seasonal forest*. As, however, in the whole range of variation all intermediates are found and the Suriname lowland is governed by fairly the same regional rainforest climate, we have followed RICHARDS and classified all high dry-land forests, which are floristically closely related, as rain forest in a broader sense. These are discussed in chapter IV.

At the time of publication of the Dutch version of this paper only BEARD's scheme of 1944 was available and not yet his revision, published in 1955, but one may wonder why we have not based ourselves on FANSHAWE's (1953) classification for the vegetation of British Guiana as the latter is an application of BEARD's original scheme to a country within the same floral district. It appeared, however, that a very considerable part of the communities distinguished by FANSHAWE have none or a rather distant relation to those we had to deal with. Apart from a much smaller range of habitats in our area this is due to remarkable floristic differences for two neighbouring countries. Besides, we felt essentially the same criticism as has been recently expressed by BEARD. Therefore we followed the lines indicated above, leaving further delimitation to the time when the gaps in our knowledge have been filled and an overall picture of Guiana can be drawn up. In this way we were also able to avoid the still existing controversy about the status of climaxes, and to give all well-recognizable communities a place according to their habitat and physiognomy independent of their degree of stability.

For British Guiana FANSHAWE has recognized evergreen seasonal forest and rain forest as distinct formations with their own associations, but in British Guiana the climate is much less homogeneous than in the northern part of Suriname. In his rainforest area total rainfall is higher than in Suriname and in the dry seasons the average monthly precipitation is at least 100 mm, whereas in the eastern region his evergreen seasonal forest grows under a much drier climate with more pronounced dry seasons than in Suriname and besides on light-textured and therefore rapidly draining soils.

The latter circumstance pushes the vegetation in the direction of the dry evergreen formations.

As a result of the climatic differences in British Guiana FANSHAWE found other seasonal formations too, and, moreover, in the upland regions he encountered montane formations.

In the area under consideration truely seasonal formations and montane formations are absent, thus only the 3 remaining series of dry evergreen, seasonal swamp and swamp formations had to be dealt with.

In the new setting BEARD gives the following division:

Dry evergreen formations

1 dry rain forest
2 dry evergreen forest
3 dry evergreen woodland and littoral woodland
4 dry evergreen thicket and littoral thicket
5 evergreen bushland and littoral hedge
6 rock pavement vegetation

Seasonal swamp formations

1 seasonal swamp forest
2 seasonal swamp woodland
3 seasonal swamp thicket
4 savanna

Swamp formations

1 swamp forest and mangrove forest
2 swamp woodland
3 swamp thicket
4 herbaceous swamp

Going from the coast landinwards we have to deal with the last series first. Here a difficulty was the arrangement of the vegetation types in wet places both by itself and in relation to BEARD's distinction in swamp and marsh or seasonal swamp formations.

The term "zwamp" is used in Suriname for all sites where virtually stagnant water is present at least part of the year. We, however, restrict the term swamp in accordance with BEARD to those areas where the soil stays moist to wet throughout the year and aeration of the soil is permanently inpeded.

The soils which are inundated part of the year and in the other part lie well above the ground-water table allowing aeration of the topsoil, but without strong desiccation, have been classified as "marsh". The strong desiccation demanded by BEARD in his original definition of marsh is left out as misleading since our marsh forests appear to fit into BEARD's series. On the other hand marsh is used here in a slightly narrower sense in favour of swamp than was done by LINDEMAN in "The vegetation of the coastal region of Suriname" (1953). In the recent revision of his scheme, however, BEARD appears to be in complete accordance with us on this point.

In the palm question too we had arrived at the same opinion as now held by BEARD, namely, that palms are prominent in habit but when we regard them as trees palm dominance is just a matter of a group of leading species in an assemblage: in other words, a case of variants of associations.

The swamp types and marsh or seasonal swamp forest are described together under the heading "wet vegetation types" in chapter II.

The other part of BEARD's seasonal swamp series which agrees with his original definition is treated in chapter III as our *wet savanna series*. The reason for this place under dry vegetation types is on the one hand that the periodical desiccation of the soil is expressed in the physiognomy by the xeromorphic habit of many species. On the other hand close floristic relationship exists with strictly dry types and these relations are readily recognized by the local population which combines all these vegetations under the head savanna ("sabana").

The other vegetation types in this chapter all belong to the dry evergreen formations which are represented by two parallel series quite distinct in habitat and floristics. The *dry savanna series* is found on deep, excessively drained white sands and shows close floristic relations with the wet savanna series. The *mountain savanna series* grows on shallow stony soils on plateaus of hills and low mountains and ends in BEARD's rock pavement vegetation on bare rock which we have called rock savanna. The name mountain savanna forest (in Dutch "bergsavannebos") was coined in 1949 when we found on the plateau of the Nassau Mountains a forest which our crew called savanna forest on account of its physiognomy, but which had a composition completely different from the lowland savanna forest. Later this type was encountered at much lower elevations, but here too the name is fitting as in Dutch "berg" just as the Suriname equivalent "birgie" in a generally flat country is currently used for hills as well. In English we suggest the term mountain savanna series avoiding the word "montane", as the series is evidently not montane in BEARD's sense, but edaphic.

Under the evergreen series BEARD lists also three littoral formations. As most of the coast of Suriname is muddy and occupied by mangrove only fragments of littoral hedge and thicket are found on a few beach ridges, viz. scrub of *Hibiscus tiliaceus* and palm groves of *Astrocaryum segregatum*, the latter in the estuaries. The characteristic *Coccoloba uvifera* is lacking in Suriname.

Besides the influence of salty sea winds and the rapid drainage of the sandy soil there is as a third factor: the markedly drier climate of a narrow coastal belt which would bring the littoral formations in an intermediate position between the dry evergreen and the seasonal series. In the low ridge forest up to about 1 km behind the coastline this is reflected by the presence of some spiny species like *Ximenia americana* and *Rosenbergiodendron formosum* and a giant columnar cactus of the *Cereus*-group, reminiscent of thorn woodland and cactus scrub. This forest, mentioned at the end of chapter IV, might then be classified as littoral woodland.

The last type of the series, the liane forest with an aberrant physiognomy which does not fit in any formation, is discussed in a separate chapter V.

CHAPTER II

WET VEGETATION TYPES

Mangrove forest.

In this formation we find forests and woods with one storey, forming a closed, regular canopy varying in height from 10 to 25 m according to conditions. Mangrove forest occurs along the coast as far as spring and storm tides flood the shore and in brackish swamps behind the coastal bar; furthermore along the estuaries and the river banks upstream beyond the salt limit approximately up to the point reached by tidal countercurrents. The undergrowth consists mainly of saplings with an occasional salt fern, *Acrostichum aureum.*

In broad lines the mangrove forest falls apart into two distinct types: the *Avicennia* (*parwa*) forest along the coast and on the levees of the lower rivers, and the *Rhizophora* (*mangro*) forest growing in the soft mud along the riverbanks. Both types occupy landinward an ever narrower strip which dissolves at last into separate trees along the banks.

In the *Avicennia* forest the soil is covered by thin vertical pneumatophores, whereas the *Rhizophora* forest is characterized by dichotomously branching stiltroots which grow arching downwards, not only from the trunk but also from older branches in the crown.

Where the rivers are distinctly brackish the *Rhizophora* belts are sometimes interrupted by low groups of the third mangrove tree, *Laguncularia racemosa* (*akira*). It is along these stretches that all three *Rhizophora* species can be found together, seaward and along the coast only *Rhizophora mangle* s.s. occurs, whereas upstream this species is absent and *Rhizophora harrisonii* disappears before *Rhizophora racemosa.*

In contrast to *Rhizophora*, *Avicennia* demands a rather solid soil consisting at least of settled silt. Where the coast grows by silting *Avicennia* can follow and consolidate the accrescence as a pioneer.

Only locally near the mouth of the large rivers one finds a mixed mangrove forest containing besides the three mangrove species occasional trees of a few other species like *Pterocarpus officinalis* (*watrabébé*) or *Carapa guianensis* (*krappa*).

Open swamps.

Open water occurs almost exclusively in the salt and brackish swamps in and directly behind the *Avicennia* forest along the coast; these shallow bodies of water probably result from intrusions of the sea or from fires.

In general, open water is readily invaded by pioneer communities which in turn are followed by an apparently rather stable vegetation of tall herbs.

As a pioneer in salt and locally in fresh swamps *Eleocharis mutata* can form extensive pure stands. In slightly brackish and fresh water usually we find a pioneer association of floating aquatics (*Nymphaea* and *Nymphoides*, *pankoekoewiwirie*) which can be succeeded in still rather deep to deep water by an association of grasses with partially floating stems and *Polygonum* species, forming together a floating mat.

In sluggish rivers a similar mat can grow out from the banks and cover at last the total water surface with a strong peat layer (up to 2 m thick) which completely inhibits any navigation. This is for instance the case in a considerable section of the Nanni Creek and the Coesewijne River.

The tall herbaceous swamp vegetations can be divided in several types according to the dominance of one or a few species (LINDEMAN 1953). Between these dominants we find a number of other herbs and vines. Important species are: *Typha angustifolia* (*langagrassie*), *Cyperus articulatus* (*adroen*), *Cyperus giganteus* (*papajagrassie*), *Montrichardia arborescens* (*mokomoko*), *Rhynchospora corymbosa* and *gigantea* (*zwamp baboennefie*) and *Leersia hexandra* (*warappagras*).

As a peculiarity the swaying swamps may be mentioned here. These are up to several meters deep and covered by a thick floating peat-layer with a vegetation of mainly Cyperaceae. This vegetation has a remarkable affinity to that of the wet savannas.

Swamp wood.

The swamp woods vary widely in appearance from an open scrub to a low closed one-storey forest, 10—15 m high. Where *Triplaris surinamensis* (*mierenhout*) is locally abundant, this species can form an open upper storey casting very little shadow. This form may represent an initial stage of the next formation type, the swamp forest following a fire, but such a succession has not yet been established.

A layer of herbs is only met where enough light is available. Sometimes the herb stratum is completely absent, but where the wood is low and open it is dense and very closely related to the vegetation of the open swamps in the vicinity, often with numerous vines.

In general palms are infrequent. Near the coast we may find *Desmoncus* species (*bambamakka*), more landinward where the water is completely fresh *Euterpe oleracea* (*pina*), *Bactris* cf. *pallidispina* (*kiskismakka*) or *Mauritia flexuosa* (*maurisie*).

Epiphytes are scarce, lianes restricted to a few species like *Paullinia pinnata, Corynostylis arborea* and *Cissus parkeri.*

The water is brackish or fresh and normally covers the soil the whole year around. This soil consists of heavy clay sometimes covered by a layer of *pegasse* (the local name for detritus and peat).

Swamp wood is found mainly in the young coastal plain. It is very thin-stemmed and poor in species, with often one or two dominants. In the brackish swamps near the coast we find *brantimakka* scrub (*Machaerium lunatum*) and *koffiemama* groves (*Erythrina glauca*), virtually without accompanying species. In slightly brackish and fresh water occur extensive stands of *Pterocarpus officinalis* (*watrabébé*) and *zwamppanta* (the *Tabebuia insignis* group, i.e. including the var. *monophylla* and *Tabebuia aquatilis*). In other localities a more mixed swamp wood grows with, besides *Pterocarpus* and *Tabebuia*, *Triplaris surinamensis* (*mierenhout*), *Annona glabra* (*zwampzuurzak*), *Genipa americana* (*taproepa*), *Simaba multiflora* (*kanamboelie*), *Chrysobalanus icaco* (*pruim*) and *Ficus* spp. All these types have no economical importance whatsoever.

In this connection can also be mentioned several communities which form fringes along the river banks where these are not exposed to strong currents. The plants root in the narrow zone which is not inundated only around low tide where the rivers are tidal, or at low water in the end of the dry season. Some of these fringes are scrubby, e.g., along the brackish part almost pure stands of *Machaerium lunatum* (*brantimakka*) alternating with stretches of mangrove or *Montrichardia arborescens* (*mokomoko*); in the fresh-water tidal zone stands of *Zygia cauliflora* (*moeserkie*), pure or mixed with shrubby trees of *Tabebuia aquatilis* (*zwamppanta*) and still higher upstream *Inga* scrub.

Other fringes consist of low trees; as such a mixture of *Bombax aquaticum* (*watracacao*) and *Pterocarpus officinalis* (*watrabébé*) is very common in the fresh-water tidal zone.

Swamp forest.

Swamp forest is at least 20 m high and two storeys are more or less easily distinguishable. The upper storey forms an irregular, but fairly closed canopy with in general small crowns between 18 and 30 m high. The lower storey consists mainly of saplings of the canopy species; typical understorey species are only *Diospyros guianensis* (*blakaoema*) and the *kiskismakka* palm (*Bactris* cf. *pallidispina*). *Euterpe oleracea* (*pina*) is usually abundant growing in large clumps. The mature specimens of this palm reach into the canopy and attain a height of 25 m.

Generally a considerable percentage of the trees (*Virola*, *Symphonia*) shows a distinctly horizontal branching. Buttresses and stiltroots are numerous, epiphytes and lianes infrequent.

The soil consists in general of heavy clays; it is inundated most of the year and stays at least damp in the dry season. Litter is incompletely decomposed as a result of bad aeration and accumulates to a more or less strong layer of pegasse.

A herb stratum is nearly always present, but varies widely in density and composition with local conditions. On constantly wet spots where the forest is not too dark, one finds *Montrichardia arborescens* (*mokomoko*). Charac-

teristic trees of the formation are *Virola surinamensis* (*baboen*), *Symphonia globulifera* (*matakki*), *Triplaris surinamensis* (*mierenhout*), *Pterocarpus officinalis* (*watrabébé*), *Tabebuia insignis* (*zwamppanta*) and *Simaba multiflora* (*kanamboelie*).

On account of the other species present and of the situation in the landscape we can distinguish the following types:

A. Swamp forest in the younger parts of the young coastal plain and on alluvial areas along the rivers. This forest is best characterised as *Triplaris forest* ("*mierenhoutbos*"), because *Triplaris* makes up an important part of it, whereas this species is virtually absent in the other two types. This kind of forest probably is to be regarded as an intermediate stage between swamp wood and the next type B (see below).

The *Triplaris* forest is very poor in species and of the characteristics of the formation *Symphonia* is lacking constantly. *Euterpe* usually plays a subordinate role and in the herb stratum we meet (*kleine paloeloe*) *Heliconia* sp.), *Ischnosiphon* spp. (*warimbo*), *Renealmia* spp. (*masoesa*) and *Costus niveus* (*witte sangrafoe*). Little accumulation of pegasse takes place.

In the northern part of the Suriname swamp area this type occurs in extensive stands. These have been without economical value up to the present, but this may change in the near future as *Triplaris* has been recognized as a potential source for mine wood.

B. Swamp forest in the older parts of the young coastal plain is marked by an abundance of *Symphonia* and *Virola surinamensis*. Except *Triplaris* the other characteristic species are frequent and in addition there occur trees like *Caryocar microcarpum* (*ruwe sopohoedoe*), *Licania macrophylla* (*sponshout*), *Cynometra hostmanniana* (*watrabirie*), *Copaifera guianensis* (*hoepel*), *Macoubea guianensis* (*mappa*) and *Ficus* spp. Besides *Euterpe* (*pina*) which is usually abundant, the palms *Mauritia flexuosa* (*maurisie*) and *kiskismakka* (*Bactris cf. pallidispina*) may be present. The undergrowth consists generally of *kleine paloeloe* (*Heliconia* sp.), *Calathea grandis* (*pagarawiwirie*) and *rode sangrafoe* (*Costus* sp.).

Accumulation of pegasse is strong and layers to a depth of several meters are said to occur, but the authors have met only layers up to 1½ m.

C. Swamp forest on the lowest parts of the old coastal plain, the low areas behind the levees of the rivers and in ever wet widenings of creek valleys. Notwithstanding the fact that this forest must still be called poor in species it is richer than the preceding types and combined with this relative richness there is no dominance of one or a few species. Besides the above-mentioned species the following have a high presence: *Eschweilera subglandulosa* (*manbarklak*), *Eschweilera corrugata* (*oemanbarklak*), *Cynometra hostmanniana* (*makraka*), *Cordia tetrandra* (*tafrabong*), *Ceiba pentandra* (*kankantrie*), *Spondias mombin* (*mopé*) and *mirkiehoedoe* (*Sapium* spp.). To the palms are added here *Maximiliana maripa* (*maripa*) and *Iriartea exorrhiza* (*iengiprasara*), while among the herbs especially in the old

coastal plain *Spathanthus unilateralis* (*grote ananswawai*) often takes an important part. *Ischnosiphon* spp. (*warimbo*) are regularly present.

A layer of pegasse is only moderately developed.

Strong indications lead to the assumption that all swamp vegetations take part in a developmental pattern. Starting from open water, the succession may take place along several seres which converge towards the next formation, the marsh forest. The general sequence is via herbaceous swamp, swamp wood and swamp forest towards marsh forest. *Euterpe* attains its optimum in the pre-last stage where the upper parts of the adventitious roots around the stem base can provide a permanently good aeration of the root-system. *Triplaris*, which can rejuvenate only under sufficient illumination, gets a chance to become dominant especially after fires. As soon as the canopy is closed the species is doomed to disappear as a result of old-age mortality. Several observations indicate that swamp forest of type A can give way to type B. On the other hand, however, type B can develop directly from swamp wood, a *Triplaris* stage being passed over.

Concluding we may say that the time of complete inundation governs the species number of the swamp forest. Estimations of samples at the Agricultural Experiment Station have shown that the stagnant swamp water is practically devoid of oxygen. The longer such water covers the soil, the smaller is the number of species and the more homogeneous the forest.

In a deep swamp at the Doksie Creek, a small tributary of the Lower Coppename River, an inventory of 1800 hectare gave a total of 13 tree species with diameters of 25 cm and more, and an average of 5 species per hectare. On the other hand along the Perica, a tributary of the Cottica River, in an area with swamps which regularly fall dry in the long dry season, thus with a tendency to marsh conditions, 24 tree species occurred with an average of 10 species per hectare.

With 110—130 trees of 25 cm diameter and over per ha. the stem number in swamp forest is fairly low. The average basal area, as calculated from the diameters at breast height, amounts to 13 m^2 per ha.

Most species have fairly short boles of moderate to bad shape. *Virola* and *Symphonia*, however, form in general fine, long and straight boles. The size of the diameter classes drops steeply from the third class (25—34 cm) on and at the Doksie Creek a tree of class seven was already rare. The distribution of the smaller diameters is often very irregular, probably as a result of poor rejuvenation. For *Virola*, for instance, it is known that good seed years alternate with several bad ones, whereas the soil must be wet, but not inundated for a good germination. Therefore we may expect a good seedling crop but once in several years.

In extremely dry years the water table may drop so far that the top layer of pegasse desiccates completely and introduces fire hazard. Under these circumstances a fire once started may transform large areas of swamp forest into open swamps. It is well known among the older people that in the extremely long and dry season of 1928 the country was burning over wide

areas. Most of these fires were certainly man-made, but it is probable that self-ignition of dried pegasse was responsible for part of them.

Marsh or seasonal swamp forest.

Under this heading we have combined the forests with two storeys on periodically inundated areas like the eroded flats of the old coastal plain, low parts of the ridges, levees of rivers and large creeks and at last the creek valleys in the hill country.

Characteristic for this formation in the coastal plain is certainly the hog-wallow structure of the soil, in Suriname called "kawfoetoes", i.e. cows' feet. The surface is formed here by a locally uniform, but from place to place varying pattern of knobs or polygons separated by a network of small gullies. Usually the knobs are rather small and the gullies vary in depth between 10 and 25 cm. Sometimes, however, polygons of several meters across may be found and gullies up to 60 cm deep and wide.

As yet little is known about the origin of this structure, but certainly erosion by superficially draining rain-water plays a part in it. The vegetation occupies mainly or, with strong dissection, exclusively the hillocks and thus the roots help in their consolidation. The soil fauna is also concentrated in them and promotes the permeability (earth worms).

The soil in the old coastal plain, where the forest type occurs frequently, consists of badly draining silt loams of the Coropina formation; elsewhere marsh forest grows on sand, loam and clay soils.

The decomposition of litter is good and usually the profile is rich in humus to a fair depth.

The upper storey forms a not fully closed, irregular canopy between 15 and 25—30 m with occasional taller trees; the lower storey, on the contrary, between 5 and 15 m is in general fairly dense.

The herb stratum is usually well developed and relatively rich with *Ischnosiphon* spp. (*warimbo*), *Geonoma* sp. (*tas*), *Heliconia* spp. (*kleine paloeloe*), *Ravenala guianensis* (*paloeloe*), *Diplasia karataefolia* (*kaaimangrassie*), *Olyra latifolia* (*kleine bamboe*) and other grasses, and besides the parasite *Helosis cayennensis*.

Epiphytes, especially Araceae, are found in abundance on the tree trunks and lianes also are numerous.

Buttresses are conspicuous in this forest type but stilt roots are not. Sometimes small adventitious roots 40—60 cm above the ground give the trunks of certain species like *Licania heteromorpha* (*anaura*) and *Licania macrophylla* (*sponshout*) a beardy appearance.

Palms are well represented but their numbers vary highly with the locality. *Maximiliana maripa* (*maripa*), *Euterpe oleracea* (*pina*), *Oenocarpus bacaba* (*koemboe*) and *Mauritia flexuosa* (*maurisie*) reach the canopy, whereas *Bactris* spp. (*kiskismakka* and *nanaimakka*), *Geonoma* sp. (*tas*), *Astrocaryum paramaca* (*paramakka*) and the locally present *Astrocaryum sciophilum* (*boegroemakka*) belong to the undergrowth. Moreover in the western

half of Suriname *Manicaria saccifera* (*troelie*) is found locally and then in abundance.

The gregarious habit in several localities appears to have been fatal to this palm from which a high tribute has been and is still being taken by the natives for roof thatching. The leaves of this palm are esteemed highest of all thatching material and a well laid roof is said to last for 20 years.

In general this formation is fairly rich in species. Important trees are: *krappa (Carapa procera* and *guianensis*), *Alexa wachenheimii* (*nekoehoedoe*), *Copaifera guianensis* (*hoepel*), *Eschweilera subglandulosa* (*manbarklak*), *Eschweilera corrugata* (*oemanbarklak*), *Trichilia* spp. (*sorosalie*), *Lonchocarpus hedyosmus* (*Nickerie basralokus*), *Hura crepitans* (*possentrie*), *Ceiba pentandra* (*kankantrie*), *Simarouba amara* (*soemaroepa*), *Jacaranda copaia* (*goebaja*), *Tabebuia serratifolia* (*groenhart*), *Parinari campestris* (*foengoe*), *Mora excelsa* (*mora*) and *Schefflera paraënsis* (*morototo*). A few species of the lower storey are: *lèlè* (*Rinorea* vs. *pubiflora*), *Talisia megaphylla* (*kraskrastikie*), *Gustavia augusta* (*watramabobbie*) and *Jacaranda rhombifolia* (*jaifie*).

On account of the wide differences in habitat of this forest type we may expect a considerable differentiation of which we will mention the following forms:

1. Riverbank forest with *Pentaclethra macroloba* (*kroebara*), *Zygia cauliflora* (*moeserkie*), *Hymenaea courbaril* (*rode lokus*) and *Eperua rubiginosa* (*oeverwallaba*) as differentiating species. Also *Tabebuia serratifolia* and *Ceiba pentandra* are often conspicuous elements in it. Locally over fairly long stretches palms like *Mauritia*, *Euterpe* and *Maximiliana may dominate* the canopy to such an extent that we can speak of a palm forest. As so far little research has been done in these forests we have as yet no indications about the cause of these quantative shifts in composition.

2. Creek forest in the hill country which is strongly influenced by the surrounding dry-land forest and therefore richer in species. Often we find a marked abundance of *Eperua falcata* (*wallaba*) in these valleys as well as on the adjoining slopes.

As special forms of marsh forest dominated by one species we name here the economically important *Mora* forest, *Hura* forest and *Carapa* forest. *Mora forest* is a magnificent forest attaining a height of 35—40 m. Mature *mora* trees have heavy boles with broad and up to 4 m high buttresses, but old trees are often rotten or hollow.

It can be regarded as a variant of the riverbank forest where *Mora excelsa* has gained absolute dominance in all storeys and even in the herb layer which consists mainly of seedlings of *mora*. Besides *mora* has formed an upper storey with its broad crowns giving a closed and even canopy instead of an occasional emergent. Thus the structure is that of rain forest. It occurs in the western half of Suriname on levees of the rivers outside the salt regime and upstreams locally even beyond the first rapids. The eastern limit of the *Mora* area is the Saramacca river basin.

Hura or *possentrie forest* has a very local distribution in Suriname on the flanks of ridges in the coastal area and is absent both at the eastern and western end.

Apparently *Hura crepitans* prefers the periodically wet areas and for this reason we placed this variant here. Under these circumstances *possentrie* shows a good rejuvenation; on dry and permanently wet places, however, reproduction is poor. From the marshy marginal ridge zones the *Hura* stands spread over the ridges where we encounter fewer but bigger trees, and into the swamps where we find rather many, but small trees. *Possentrie* belongs among the biggest trees of Suriname; stem diameters of 1.50 m at breast height are not exceptional while boles of 2.50 m strong and over 20 m long were observed. In a good *Hura* forest one may figure 100—150 cubic m round wood per ha of boles over 25 cm in diameter. At its optimum this variant, too, approximates rain forest in structure.

Carapa forest is a less marked variant compared to the foregoing, though *krappa* takes a very important part in it and shows an excellent rejuvenation. This variant is most typically represented in the western part of the coastal area. *Carapa* forms fair boles which reach but rarely big dimensions.

At the end of this review of marsh forest we can illustrate two variants with some figures calculated from the exploration-data.

To get an impression of the distribution of the species the frequency of every species was calculated from the transect survey. For this purpose the presence of a species in strip sections of 100 by 10 m was counted and expressed in percents of the total number of sections.

1. Marsh forest near the Wayombo river on silt clay of the old coastal plain. In this area 10 m wide strips were surveyed to a total length of 27.4 km, covering together 27.4 ha. Together 126 kinds of trees with a diameter of 25 cm or more were observed. When we speak here and in following examples of kinds instead of species the remark must be made that we wish to indicate kinds of trees recognized according to the vernacular names used by the surveyors. Many of these names, however, cover more than one botanical species and often do so in one locality. Where the species could be identified the botanical name is given first, where no choice could be made or more than one species was represented the vernacular name goes ahead. The number of true species therefore is higher than the available figures show and more so when we approach optimal growth conditions. Thus the given data have no absolute value, but the general pattern is not disturbed by this imperfection. With the swamp forest we have not yet mentioned this discrepancy, as it is negligeable there.

When we estimate the frequency of these 126 kinds in the way sketched above, it appears that only 9 kinds occur in 20 or more percent of the sections of 0.1 ha. The highest frequency of over 50 % was reached by *salie* (*Tetragastris* spp.) and *Goupia glabra* (*kopie*), followed in this order by

Parinari campestris (*foengoe*), *zwart riemhout* (*Micropholis* sp. nov. or *Pouteria engleri*), *Eschweilera subglandulosa* (*manbarklak*), *Antonia ovata* (*likahoedoe*), *Swartzia tomentosa* (*gandoe*), *Copaifera guianensis* (*hoepel*) *and Jacaranda copaia* (*goebaja*).

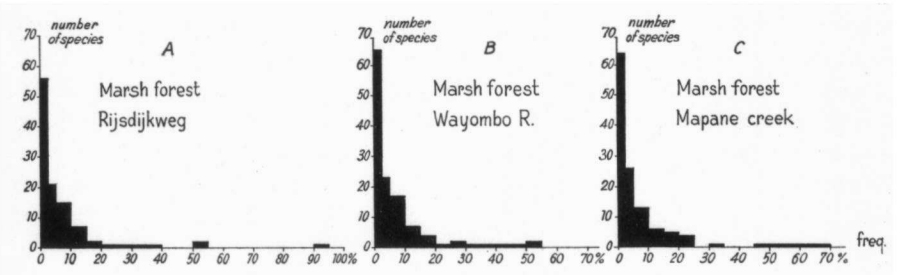

Fig. 1 Frequency distribution of trees of ≥ 25 cm diam. in marsh forest.

Figure 1a shows the distribution in frequency classes of 5 %. The lowest class of 0—5 % is divided in two to display the fact that one half of the total number of species has a frequency below 2½ %.

2. Marsh forest at the Rijksdijkweg, about 25 km South of Paramaribo, on silt clay of the old coastal plain. Here on 22.4 ha of strip sections 108 tree kinds were recorded including 56 with a frequency below 2½ %. Out of the 7 species over 20 % *Eschweilera corrugata* (*oemanbarklak*), reached a frequency of 92 %, *Parinari campestris* (*foengoe*) of 54 %, *Eschweilera subglandulosa* (*manbarklak*) of 51 %.
After these followed *Carapa procera* (*krappa*), *Copaifera guianensis* (*hoepel*), *Qualea coerulea* (*gronfoeloe*) and *Pithecellobium jupunba* (*sopohoedoe*), while *Swartzia tomentosa* (*gandoe*) came next with well under 20 % (fig. 1b).

3. Creek forest in the low hill country East of the Suriname river between Jodensavanne and the Mapane creek, to be called the Mapane creek area, on the transition towards the Zanderij formation. In this area about 4000 ha of creek forest were covered by the 2-percent sampling and from the exploration data we could use a number of mostly short strips with a total coverage of 26.1 ha. Here 124 tree kinds were observed of which 10 had a frequency above 20 %: i.e. *Eperua falcata* (*wallaba*) with 67 %, followed by *Eschweilera corrugata* (*oemanbarklak*), *Pterocarpus officinalis* (*watrabébé*), *Carapa procera* (*krappa*), *swietiboontje* (*Inga* spp.), *Symphonia globulifera* (*matakki*), *Virola surinamensis* (*baboen*), *Copaifera guianensis* (*hoepel*), *anaura* (*Licania* cf. *heteromorpha*) and *Eschweilera longipes* (*manbarklak*). Here again we see that one half of all kinds stays below 2½ % in frequency (fig. 1c).

For the same area the stem number per ha and the total bole volume per diameter class of 10 cm were calculated. The class-symbols are taken from the mean diameters, class 3 ranging from 25—34 cm, etc., while in class 10 all trees from 95 cm upwards are included. The results are compiled in table I and figure 2.

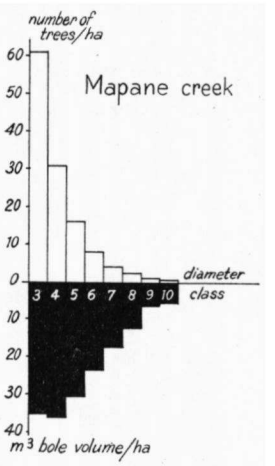

Fig. 2 Distribution of stem number and bole volume per ha in diameter classes of 10 cm for marsh forest in the Mapane Creek area.

TABLE I

Creek forest Mapane creek area

diameter class	number of trees p. ha	bole volume per ha
3	61.1	35.2
4	31.6	36.2
5	16.2	30.7
6	8.0	23.5
7	4.2	17.6
8	2.2	12.6
9	1.0	6.5
10	0.6	5.7

Mean number of trees $\geq$ 25 cm diam. per ha: 125.

Mean bole volume per ha: 168.5 m^3.

Mean basal area per ha: 17.7 m^2.

At the end of this chapter we have to mention communities which could not well be placed elsewhere. They belong to BEARD's *Mauritia-Chrysobalanus* association which inhabits parts of the older coastal plain in the form of belts along open swamp, mainly under pure swamp conditions. The *maurisie* palm forms an upper storey which is fairly closed at full development and reaches well up to 20 m. Under these palms we find an often dense thicket of *Chrysobalanus* with a few small trees of *Pterocarpus*, *Tabebuia*, *Genipa* and sometimes much *Clusia nemorosa* (*sabana mangro*).

A variant of this type with a distinct herb layer of mainly Cyperaceae inhabits the savanna areas in the form of galleries along small creeks draining the open savanna. In both cases a layer of pegasse is well developed, but in the latter marsh conditions are reigning with seasonal water-logging of the soil, normally, however, without serious dessiccation on account of the topography and the water capacity of the pegasse.

CHAPTER III

DRY VEGETATION TYPES

General remarks.

Under this head all those vegetations are brought together which in Suriname fall under the concept "savanna". They have in common that they periodically must withstand a more or less severe shortage of moisture, because the soil is either so permeable or has such a small capacity for water retention that during part of the year practically no free water is available to the roots. This is possible under the tropical climate of Suriname as the periodicity in rainfall is sufficiently marked that in the dry seasons the evaporation considerably exceeds precipitation.

The aspect of the vegetation is determined by the length of the periods of water shortage and for these three factors are important:
the water capacity of the soil, the volume of the rooted layer and the topography. These variables give rise to several seres of savanna vegetations correlated to the following three types of soil:

a. quartz sands in which the depth of a hardpan and the slope of the terrain are determining factors.
b. silt clays on impermeable kaolin.
c. stony soils with a strongly reduced rooting space.

Where the topography is very flat and drainage much impeded the soil types a and b will become waterlogged and even periodically inundated in the rainy season resulting in a further adversity of the habitat. Then BEARD's typical marsh conditions are realized.

Along the given lines we can expose the savanna vegetations in the following scheme:

	highly permeable, deep sands	drainage impeded by impermeable layers	stony soils with strongly reduced earth volume
short period of water shortage, soil with relatively high water capacity	savanna forest on slight slopes with lateral water supply	marshy savanna forest	mountain savanna forest
moderate period of water shortage	savanna wood on shallow watersheds and plateau borders	marshy savanna wood on plateaus with bad drainage, periodically waterlogged	mountain savanna wood
long period of water shortage, soil with small water capacity	scrub savanna on high watersheds with excessive drainage	wet scrub savanna, hogwallowed, periodically inundated	rock scrub; no soil, only a litter and root mat upon the solid rock
	dry open savanna	wet open savanna	rock savanna on exposed rock
		fens and savanna creekbeds, dry for only short periods	

The vegetation types in the first and second column are floristically so closely related that they will be treated together. The types in the third column haven physiognomical resemblance to the equivalents in the other seres, but differ in many other respects and are therefore discussed separately.

Savanna forest

This type of forest shows two storeys, the upper storey is closed, fairly dense and regular and reaches up to 25—30 m, as the tallest trees rise above the general level with broad round crowns without becoming emergents. The lower storey consists in general of many slender trees with very narrow crowns which give the forest a staky appearance. A herb stratum is sometimes practically absent, in other cases it is dense and usually dominated by *Bromelia alta* L. B. SMITH (*bosananas*). Curiously enough this species, common and well known in Suriname, recently appeared to be new to science. Typical in the herb stratum are seedlings of *Myrcia sylvatica* (*kleinbladige gujave*) and *Inga heterophylla* (*kleinbladig swietiboontje*).

The high savanna forest is rich in species due to the presence of many species from the adjacent rain forest. These species shared by the two types occur especially in the upper storey, whereas the characteristic trees of savanna forest are mainly restricted to the lower storey and therefore are recorded but rarely in the exploration surveys.

Clusia fockeana (*sabana mangro*), where present, is striking by its arched stilt roots from which it derives its vernacular name; buttresses play in general a small part in the aspect. Lianes are not frequent and epiphytes scarce except Araceae against the trunks.

Litter decomposition is usually good leaving the upper layers of the soil rich in brown humus. The soil itself consists of white sand with a water table several meters below groundlevel and drainage is eventually impeded only several meters down, which allows for a deep rooting of the trees.

Palms are not frequent and are represented mostly by small and immature specimens of *Astrocaryum paramaca* (*paramakka*), *Oenocarpus bacaba* (*koemboe*) *and nanaimakka* (*Bactris* spp.).

It is difficult to find species characteristic for the upper storey of this forest type as the frequent tall species grow also in rain forest. Probably *purperhart* (*Peltogyne pubescens* or *venosa*), *Loxopterygium sagotii* (*slangenhout*) and *Platonia insignis* (*pakoelie*) prefer drier sites and are for that reason more numerous in savanna forest.

Other frequent species are *kwarie* (*Vochysia* spp.), *tiengimonie* (*Protium* spp.), *Aspidosperma marcgravianum* (*wit parelhout*) and *Andira surinamensis* (*rode kabbes*); in the transition towards rain forest also *Dicorynia guianensis* (*basralokus*), *Ocotea rubra* (*wana*) and *Goupia glabra* (*kopie*).

Sometimes a single species can gain dominance and press its stamp on the aspect of the forest, so we can speak of:

1. *Eperua* or *wallaba forest* with an abundance of *Eperua falcata* in all size classes. Attention should be called to the fact that *wallaba* can also take a preponderant part in other forest types and certainly not on sandy soils alone. It is still an open question, however, which conditions of habitat *wallaba* prefers.

2. *Dimorphandra conjugata* or *dakama forest*. In optimal development this is a lofty forest with big trees, but it occurs also in many degraded forms down to a low scrub. The litter of *dakama* decays very slowly so that in time a thick springy layer of forest peat is formed which can accumulate in high *dakama* forest to a few meters depth. In this case around the big trunks additional heaps of litter up to 2½ m high are found. The undergrowth in this forest is very scanty and a herb layer is absent. The number of species is small and *Dimorphandra* is absolutely dominant. In the dry season the masses of dead leaf present great fire hazard and for this reason fine *dakama* forest is rare. After a fire the type shows a fast regeneration, however in poorer form, by the growth of coppice from the stumps and of root suckers.

3. Besides the pure *dakama* forest locally mixed *dakama-wallaba forest* and *Dimorphandra conjugata-Swartzia bannia forest* occurs whereas *Swartzia bannia* (*sabana ijzerhart*) can also locally dominate alone. Where the latter dominates its heavy, deeply fluted trunks are striking.

As equivalent of the dry savanna forest we have met in the marsh series only a. a marsh variant of *dakama* forest which is less poor in species and

has an undergrowth of palms: *Elaeis melanococca* (*obé*), *Attalea* sp. (*bergimaripa*), *Euterpe oleracea* (*pina*) and *Mauritia flexuosa* (*maurisie*).

b. a *wallaba* variant with *Ischnosiphon* spp. (*warimbo*) and *Ravenala guianensis* (*paloeloe*).

These variants occur in valleys on white sand covered by pegasse which is saturated with water for long periods. This marsh savanna forest has not yet been studied and has been reported at present only West of the Coppename River.

We may mention here that the high savanna forest is intermediate between typical savanna forest which is always rather low and rain forest and occupies a transition-belt between the two. As said before, the upper storey in the mixed savanna forest consists almost exclusively of species which occur in the rain forest as well. Still the limit between them can often be indicated exactly within 10 m with regard to the undergrowth, while the change in the soil profile is as rapid. This phenomenon has to be explained by further investigations.

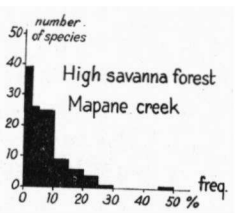

Fig. 3 Frequency distribution of trees of ≧ 25 cm diam. in savanna forest.

To conclude we give the frequency distribution of the mixed savanna forest in the Mapane Creek area (fig. 3). On 13.1 ha strip sections 111 kinds were recorded and from these 6 reached a frequency of over 20 %: i.e. *tiengimonie* (*Protium* spp.) 47 %, followed by *boskatoen* (*Bombax* sp.), *zwarte pisie* (*Ocotea* spp.), *Eschweilera corrugata* (*oemanbarklak*), *Parinari campestris* (*foengoe*) and *hoogland anaura* (*Couepia versicolor* and *caryophylloides*). 39 kinds fell below the 2½ % limit whereas in the examples of other forest types this class always contained about half of the total number of species. This difference is fictitious, however, as in this case the sampled area was much smaller. Had it been of about the same size, this class would have been larger because almost all additional species would come into it.

Savanna wood, scrub- and open savanna.

Savanna wood is much poorer in species and more homogeneous than the high savanna forest as the rain forest species are excluded by the more severe desiccation in the dry season. It consists of characteristic xeromorphic savanna species with small coriaceous leaves like *Clusia fockeana* (*sabana mangro*), *Licania incana* (*sabana foengoe*), *Bombax flaviflorum* (*sabana katoen*), *Swartzia bannia* (*sabana ijzerhart*), *Ocotea schomburgkiana* (*sabana pisie*)

and *Trattinickia burserifolia* (*sabana tiengimonie*), all of them species which occur in high savanna forest mainly in the lower storey.

Savanna wood is not differentiated in storeys and the height varies from 8 to 15 or 20 m. It is very dense and slender-stemmed with a very regular closed canopy of small crowns. Lianes are scarce and as epiphytes only mosses are abundant.

Towards the open savanna the savanna wood changes gradually into a dense scrub with almost the same floristic composition. Only *Bombax flaviflorum* preserves the tree habit with one straight stemlet.

Besides mosses orchids and ferns are often abundant around the shrub bases and ferns, especially *Schizaea incurvata* and *Actinostachys pennula*, may flourish in the sand between the shrubs.

At the end of this sere stands the open dry savanna. Scattered groups of shrubs do still occur in it, but a large portion of the white sand surface bears only a thin and poor vegetation of herbs and subshrubs, especially Cyperaceae (a.o. *Lagenocarpus weigelti*, *Bulbostylis conifera* and *junciformis*), grasses like *Axonopus attenuatus* and *Trachypogon plumosus*, a few Eriocaulaceae and *Cassia tetraphylla*.

Marshy savanna wood is in aspect very similar to dry savanna wood, but contains besides the species of the dry type as typical elements *Clusia nemorosa* (*sabana mangro*) and *Humiria balsamifera* (*blakaberie*); at the same time we find often a herb stratum with *Monotagma pluri-spicatum* (*kleine warimbo*), *Rapatea paludosa* (*kleine ananswawai*) and *Ravenala guianensis* (*paloeloe*).

The wet open savanna has a rich, but usually fairly thin vegetation of herbs and subshrubs which is characterized by the numerous Cyperaceae (*Lagenocarpus tremulus*, *Rhynchospora* species, a.o.), many Eriocaulaceae, *Utricularia* spp., *Drosera* and *Lycopodium*. Grasses play a very subordinate role. *Mauritia flexuosa* occurs on these savannas along watercourses and creek borders where the roots find moisture in the dry season. On the transition from the flat parts towards the watercourses we find usually a wide hogwallowed belt, which is most pronounced on the low side.

This sere finds its continuation in the small fens on the savanna and in the savanna-creek valleys with a usually strong layer of pegasse. The soil is waterlogged most of the time, but when the creeks run dry in the long dry season the pegasse layer can dry out for some time.

The vegetation consequently shows a double aspect; both swamp and savanna species take part in it, while coarse Cyperaceae like *Lagenocarpus guianensis*, *Becquerelia tuberculata* and the fern *Blechnum indicum* are often dominant in the dense herb stratum.

The savanna sere on rock.

Where on the bauxite hills and low mountains like the Nassau mountains a solid flat cap of ferrite or ferrobauxite is developed and where on the mountains in the interior only a very thin soil layer covers the parent rock,

we find a low forest or wood. On account of its thin-stemmed aspect with little stratification and a xeromorphic habit it is locally called savanna forest; in its floristic composition, however, it is completely different from typical savanna forest though most species have similar small coriaceous leaves. We have introduced therefore the designation *mountain savanna forest* for this type of vegetation. The preponderant families are Myrtaceae and Sapotaceae. Sometimes a dense herb stratum is present, consisting mainly of *Bromelia alta* (*bosananas*) or another Bromeliad (in the Nassau mountains *Vriesea splendens*).

Lianes are abundant as well as mosses and small epiphytes, especially near the ground and even on boulders. Older leaves are mostly covered with epiphyllous Bryophytes.

Similar to high mixed savanna forest on more favourable parts of the bauxite plateaus, where a reasonable amount of soil is present, a high mountain savanna forest is found which is intermediate between the typical form and rain forest. Here, too, occur *purperhart* (*Peltogyne pubescens* or *venosa*), *Loxopterygium sagotii* (*slangenhout*) and *Aspidosperma marcgravianum* (*wit parelhout*).

Rock savanna or rock pavement vegetation occurs locally on stretches of bare rock in the granite areas of the interior. Where the surface is not too steep and dust can accumulate in crevices and small depressions Algae and mosses prepare a foothold for some small herbs. When this is increased by their dying parts, they give way to taller species like some orchids, *Cassia tetraphylla* var. *saxatilis* and *Ernestia rubra*, all characteristic for these rock savannas. In their litter cushions in time scrubs can establish themselves and grow out into a scrub which further forms its own soil mainly out of litter. This scrub is often dominated by some *Clusia*; on and around the Voltzberg this is *Clusia nemorosa* or *Clusia pana-panari*. Cacti on the other hand are found in crevices.

CHAPTER IV

RAIN FOREST OR HIGH DRYLAND FOREST

As has been discussed in the introduction, the term rain forest is used here in the broad sense of RICHARDS, including BEARD'S evergreen seasonal forest, and we have combined under this heading the remaining forests on never inundated and well drained soil which together cover the major part of northern Suriname.

For the moment we do not feel justified in distinguishing types in this complex. Continued ecological and floristic investigation, however, will undoubtedly lead to a considerable subdivision in the dryland forests.

As a matter of fact, in the western part of the country, the aspect of the forest does no more correspond to the following description which applies

mainly to the forest area between Marowijne and Suriname Rivers. Where possible, differences are indicated.

In optimal form in dryland forest 3—4 storeys can be distinguished. The upper storey consists of more or less scattered emergents of 40—45 and some even 50 m tall, which expand their crowns freely above the fairly well closed canopy of the second storey with an average height between 25 and 30 m. Below the canopy we find an understorey of slender trees more or less separable from a layer of saplings and undergrowth species.

Long clean boles are numerous, whereas few trees with diameters over 25 cm are branched below 10 m. The exploration data show a tendency in the distribution of bole lenghts towards a two-topped curve with peaks at about 15 m and at 21—23 m while among the emergents occasional trees attain a bole length of around 30 m. The tallest one met and checqued was a *Helicostylis* with a bole of 39 m. The number of boles of 20 and more m tall varies with the site between 6 and 30 % of the recorded trees.

The shape of the crowns differs markedly in different storeys. The crowns of the emergents tend to be wider then deep, whereas the crowns of canopy trees on the average are about as wide as deep and those of understorey species long and narrow or tapering.

This stratification diminishes westwards. In the rain forest along the Coppename river the typical high emergents are lacking, reducing the number of storeys to 2—3 and the forest is less dense, especially in the lower storeys.

As a whole the forest is typically evergreen though in the upper layers occasional trees loose their leaves for a short period without strict relation to the seasons, for example several Mimosaceae like *Parkia*, *Pithecellobium* and *Piptadenia suaveolens*. Of these species one tree may stand leafless while others in the vicinity are still green or already covered with new foliage. In certain species the defoliated state coincides with the flowering and makes the latter the more spectacular as e.g. in *Tabebuia serratifolia* (*groenhart*), *Lecythis* spp. (*kwattapatoe*) and some *Couratari* spp. (*iengipipa*), more over the flowering of each species is simultaneous in one area.

Palms are usually numerous in this forest type: in the undergrowth *Astrocaryum paramaca* (*paramakka*), *A. sciophilum* (*boegroemakka*), *Attalea* sp. (*bergimaripa*) and *nanaimakka* (*Bactris* sp.), while *Oenocarpus bacaba* (*koemboe*) reaches the canopy. The first two are restricted for unknown reasons to fairly sharply limited areas which overlap in part. Within their area, however, both species are so little selective as to soil conditions and water excess that they are there at home also in the marsh forest. *Attalea* on the other hand has a marked preference for lighter sandy soils. Especially in the western part of the country locally the caulescent *boegroemakka* palms can form a closed understorey below which undergrowth is either almost absent or composed mainly of young palms.

The herb stratum is generally very open and contains broadleaved forest

grasses, small saprophytes and more or less shrubby Rubiaceae like *Cephaëlis* and *Psychotria* spp. (*bofroekasaba*).

Lianes are represented by many species but not abundant, sometimes, however, they reach considerable thickness. Epiphytes are found mainly in the crowns of high trees together with hemi-epiphytic trees like *Clusia* spp. and strangler figs which are called in Suriname *abrasa*, as the aerial roots embrace the host tree. Stiltroots are scarce, but buttresses, including very spectacular ones of e.g., *Couratari*, *Terminalia* and *Andira* spp., are a common feature.

The decomposition of litter is good, the soil varies from loamy sand to clay with good to fair drainage. As a rule rain forest is so mixed by the wealth of species that dominance of one or two species does not occur, but considerable variation in mutual proportions is found. Thus more eastward *Dicorynia guianensis* (*basralokus*), *Eschweilera longipes* (*manbarklak*) and *Qualea* spp. (*gronfoeloe*) are more frequent whereas *Eperua falcata* (*wallaba*) increases to the Southwest and *Mora gonggrijpii* westward West of the Coppename River. *Ocotea rodiaei* is said to occur locally only in the extreme West of Suriname. These differences have probably to be accounted for by peculiarities in the geographical distribution of the species. Trees like *Goupia glabra* (*kopie*) and *Ocotea rubra* (*wana*), on the contrary, prefer apparently lighter soils and are therefore locally more important.

However, how careful one must be with conclusions is illustrated by the earlier mentioned example of the marsh forest where *Goupia* reached the highest frequency on the silt clay of the Coropina formation. Here the more open character of the forest may play an important part as *Goupia* requires much light for its germination. Between the storeys exist considerable differences in floristic composition as some species are always restricted to the undergrowth while others reach maturity in the canopy layer and but a fairly small number belongs to the true emergents. The first group contains species like *Paypayrola guianensis* (*tajahoedoe*), *Bonafousia undulata* (*mirkietikie*), *Rinorea* spp. (*lèlè*), *Gustavia hexapetala* (*hoogland watramabobbie*) and *Talisia megaphylla* (*kraskrastikie*), the second group a.o. *Eschweilera* species and the last group e.g. *Couratari*, *Vochysia* and *Lecythis* spp. Furthermore the disparity of light requirements for germination and seedling life adds to this differentiation as those species with a low requirement rejuvenate regularly, whereas the others get only an occasional chance where holes have been torn in the canopy by fallen trees. Consequently we often see a profuse seedling crop of *Goupia*, *Cecropia* and *Jacaranda* or other light demanding species in openings, while we may search in vain for saplings of these species in the shady forest. Nevertheless these crowds of seedlings do produce but a few survivors as mature trees of these species are rarely gregarious.

As mentioned before, it is impossible to arrive in a short time at a subdivision of the rain forest, as this wil have to be done for a good part on the basis of the floristic composition. To give an impression of the richness in species the following comparison of the rise in species number with increasing area is presented starting with various minimum tree sizes. The resulting

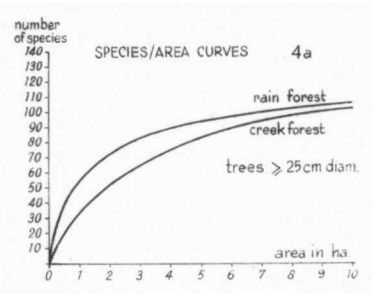

Fig. 4a Species/area curves for trees of rain forest and creek marsh forest in the Mapane Creek area, taking into account only trees of 25 cm diam. and over. Data taken from the transect surveys of the Forest Service.

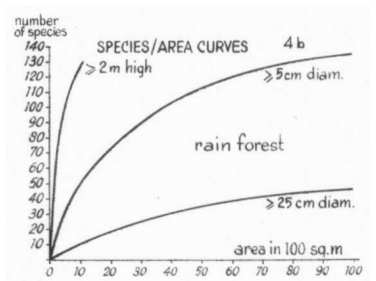

Fig. 4b Species/area curves of rain forest in the Mapane Creek area for trees in 3 size classes, viz. with minimum diameters of 25, 5 and 1 cm. Data taken from a sample plot survey of 1 ha.

species/area curves are shown in fig. 4. Starting with a minimum diameter of 25 cm, data taken from the exploration surveys show that about 50 kinds are recorded on 1 ha., while this number keeps growing steadily with increasing area up to around 90 kinds on 4 ha. Only beyond this point the curve levels off gradually. When we take into account all trees from 5 cm diam. upwards, it appears that a number of 50 species is reached already on 0.1 ha and the break of the curve lies between 0.5 and 0.6 ha, already far above 100 species. Starting with a tree height of 2 m, approximately corresponding with a minimum diameter of 1 cm, the curve rises still steeper and a number of 100 species is found already on 0.1 ha.

We must remark here that for the first and last curve the data were taken from strip surveys resulting in an increase of the area in one direction while for the second one an extension of the area in two directions up to a square plot of 1 ha was used. We may expect for this reason a slightly more rapid rise of the curves in the first case together with a small shift of the breakpoint towards a smaller area. In addition fig. 4a shows the position of the species/area curve of the marsh forest along creeks which drain the rainforest area. In the same way as was done for the marsh forest, for a few areas the frequency distribution of tree species in the rain forest was calculated. We may recall here that the frequency percentage gives information only on the distribution of the species and should not be confounded with density.

Therefore no conclusions about the volume per ha can be drawn from it. On the one hand species with a high frequency are necessarily abundant and those with a low frequency rare as no tree occurs in widely scattered dense groups; on the other hand there are indications that the distribution of some species differs markedly from a chance pattern.

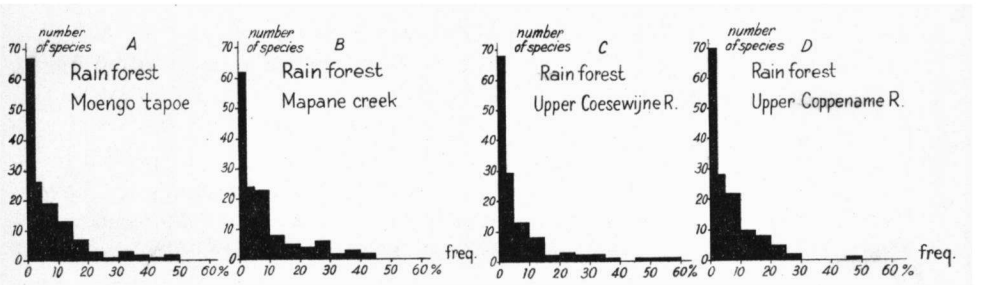

Fig. 5 Frequency distribution of trees of ≧ 25 cm diam. in rain forest in 4 areas.

Frcquencies of the tree species were calculated for 4 areas (fig. 5).

A. In the rain forest South of Moengo tapoe on a total area of 38.3 ha of strip sections 13 out of a total of 144 kinds reached a frequency of over 20 %; i.e. *oemanbarklak* (*Eschweilera* spp.) 43 % followed by *gronfoeloe* (*Qualea rosea* and *albiflora*), *tiengimonie* (*Protium* spp.), *manbarklak* (*Eschweilera* vs. *longipes*), *riemhout* (*wit: Micropholis guyanensis* and *zwart*: *Micropholis* sp. nov. and *Pouteria engleri*), *Dicorynia guianensis* (*basralokus*), *salie* (*Tetragastris* spp.), *swietanini* (*Pouteria* sp.), *Vouacapoua americana* (*bruinhart*), *Piptadenia suaveolens* (*pikienmisikie*), *jakanta* (*Poraqueiba guianensis* and *Dendrobangia boliviana*), *kiemboto* (*Pouteria* spp.) and *Parinari campestris* (*foengoe*); 74 species or one half had a frequency below 2½ %.

B. In the area between Suriname River and Mapane Creek on 25.6 ha 17 kinds out of a total of 139 appeared to have a frequency above 20 %, i.e. *salie* (*Tetragastris* spp. and *Trichilia* spp.) 43 %, followed by *Carapa procera* (*krappa*), *tiengimonie* (*Protium* spp.), *manbarklak* (*Eschweilera longipes* and *odora*), *Eperua falcata* (*wallaba*), *oemanbarklak* (*Eschweilera* spp., mainly *E. corrugata*), *Chaetocarpus schomburgkianus* (*fomang*), *hoogland anaura* (*Couepia caryophylloides* and *versicolor*), *swietiboontje* (*Inga* spp.), *jakanta* (*Poraqueiba guianensis* and *Dendrobangia boliviana*), *Goupia glabra* (*kopie*), *iengipipa* (*Couratari* spp.), *jamboka* (*Pouteria guianensis* a.o.), *zwart riemhout* (*Micropholis* sp. nov. and *Pouteria engleri*), *broedoehoedoe* (*Iryanthera sagotiana*), *pisie* (Laur. div. sp.) and *Parinari campestris* (*foengoe*), while *Ocotea rubra* (*wana*) fell just below 20 %; 62 species stayed below 2½ %.

C. In an area between the Saramacca and Upper Coesewijne Rivers on 43.4 ha a total of 131 kinds was recorded including 11 with a frequency over 20 %, i.e. *Dicorynia guianensis* (*basralokus*) 56 %, *Ocotea rubra* (*wana*) 52 %, *Micropholis guyanensis* (*wit riemhout*) 47 % and further *Parinari campestris* (*foengoe*), *Goupia glabra* (*kopie*), *Chaetocarpus schomburgkianus* (*fomang*), *gronfoeloe* (*Qualea* spp.), *Eperua falcata* (*wallaba*), *anaura* (*Licania spp.*), *jakanta* (*Poraqueiba guianensis* and *Dendrobangia boliviana*)

and *zwart riemhout* (*Micropholis* sp. nov. and *Pouteria* sp.); 69 species had a frequency below 2½ %. In this area we see a limited number of species dominating the upper storeys.

D. In the open rain forest at the Upper Coppename River near Bitagron on 21 ha 146 kinds were recorded of which 70 had a frequency below 2½ % and only 8 appeared to come over 20 %, i.e. *Eperua falcata* (*wallaba*) with 46 %, *tiengimonie* (*Protium* spp.) with 27 %, followed by *Micropholis guyanensis* (*wit riemhout*), *hoogland anaura* (*Couepia caryophylloides* and *versicolor*), *Parinari campestris* (*foengoe*), *oemanbarklak* (*Eschweilera corrugata* a.o.), *jakanta* (*Poraqueiba guianensis* and *Dendrobangia boliviana*) and *Virola melinonii* (*hooglandbaboen*). *Goupia*, *zwart riemhout*, *Swartzia benthamiana* (*bergibébé*), and *Dicorynia guianensis* (*basralokus*) fell not far short of 20 %, partly as a consequence of the small number of trees per ha in this area.

When we pay attention to the families instead of to the species we get the following picture of the composition for the areas A and B:

Moengo tapoe		*Mapane creek area*	
Sapotaceae	17 %	Papilionaceae	18 %
Papilionaceae	14 %	Lecythidaceae	12 %
Lecythidaceae	11 %	Rosaceae	7 %
Burseraceae	8 %	Meliaceae	7 %
Mimosaceae	7 %	Sapotaceae	7 %
Vochysiaceae	6 %	Burseraceae	6 %
Rosaceae	4 %	Mimosaceae	6 %
Moraceae	3 %	Euphorbiaceae	4 %
Myristicaceae	3 %	Lauraceae	4 %
Lauraceae	2.6 %	Myristicaceae	4 %
Remaining 28 families	± 24 %	Celastraceae	3 %
		Icacinaceae	3 %
		Vochysiaceae	2.6 %
		Remaining 22 families	± 16 %

For the same areas the stem numbers and the stem volume per ha and per diameter class were calculated from the exploration data. The results are shown in fig. 6 and table II.

The distribution of the stem numbers per diameter class follows a simple mathematical relation as the logarithms of the class totals appear to fall extremely close to a straight line (see fig. 7). Supposing that this logarithmic relation holds also true for diameters smaller than 25 cm, we can estimate

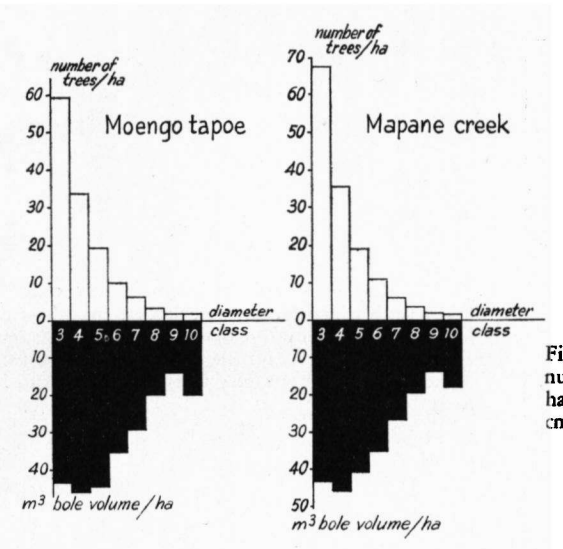

Fig. 6 Distribution of stem number and bole volume per ha in diameter classes of 10 cm for rain forest.

TABLE II

Rain forest Moengo tapoe area			Rain forest Mapane creek area		
diameter class	number of trees p. ha	bole volume per ha	diameter class	number of trees p. ha	bole volume per ha
3	59.7	43.2	3	67.8	43.1
4	33.9	46.0	4	35.4	45.4
5	19.4	44.6	5	19.0	40.6
6	10.2	35.2	6	10.9	35.1
7	6.2	29.0	7	6.0	26.5
8	3.2	19.8	8	3.4	19.6
9	1.8	14.1	9	1.8	13.7
10	1.8	19.9	10	1.7	17.9
Mean number of trees $\geq$ 25 cm diam. per ha: 137.			Mean number of trees $\geq$ 25 cm diam. per ha: 146.		
Mean bole volume per ha: 252.4 m^3.			Mean bole volume p. ha: 242.5 m^3.		
Mean basal area per ha: 22.2 m^2.			Mean basal area per ha: 23.0 m^2.		

by extrapolation the size of class 1 and 2. These would then amount to 115 and 230 respectively, which is in good agreement with the data of a few detailed surveys of 0.1 ha.

The position of this line is an expression of the quality of the forest, while its inclination is correlated with the forest type. This appears when similar lines are constructed, e.g. for savanna forest and creek forest. These lines are steeper than those for rain forest showing that the higher classes are less and the lower classes absolutely or relatively better represented.

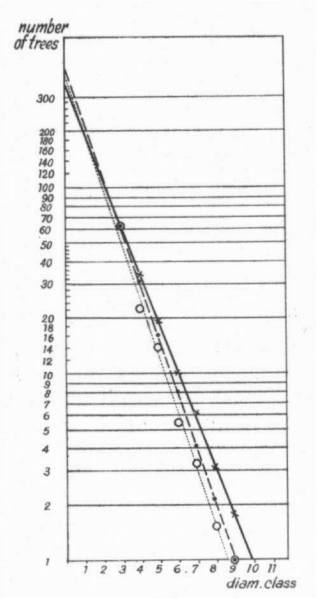

Fig. 7 Diameter-class distribution of trees in 3 forest types in the Mapane Creek area; drawn with logarithmic ordinate. Numbers of trees per ha in rain forest (crosses; full line), marsh forest (dots; broken line), and savanna forest (circles; dotted line).

An analysis of the diameter-class distribution for single species falls outside the scope of this review, but we may expect wide variation for them. Experience has shown for instance, that light-demanding species are very badly represented in the lower classes, while several species from the lower storeys grow only exceptionally beyond the 15 cm limit into the second class.

The average basal area per ha for trees of 25 cm diameter and over, calculated from the diameters at breast height, is 22.2 and 23.0 sq.m. respectively for the two explored areas. For creek marsh forest the figure is 17 sq.m and for swamp forest 13 sq. m. This comparison demonstrates the much better quality of rain forest. When we account for small diameters by extrapolation, we arrive at an estimate of an addition of about 5 sq. m. per ha or a total basal area of around 28 sq. m. per ha for rain forest.

Ridge forest.

The forest on the older ridges in the coastal plain we regard as a poor form of rain forest. The ridge forest shows 2 tree storeys; the upper storey forms a closed canopy and in the better parts tall trees reach over 30 m height without becoming true emergents. The undergrowth is dense and rich in palms like *Astrocaryum paramaca* (*paramakka*), *Oenocarpus bacaba* (*koemboe*) and *Maximiliana maripa* (*maripa*). The herb stratum is generally well developed with grasses, *Cephaëlis* spp. (*bofroekasaba*), *Heliconia* spp. (*popokaitongo*) and locally facies-forming *Bromelia alta* (*bosananas*). Lianes and epiphytic Araceae upon the trunks are numerous. Frequent canopy trees are *Hymenaea courbaril* (*rode lokus*), *Cedrela odorata* (*ceder*), *Simarouba amara*

(*soemaroeba*) and *Parinari campestris* (*foengoe*). The last species is even dominant on the older ridges in the East of the country.

On the older and higher ridges the forest is still fairly rich, but on the younger ridges the number of species and the height of the forest decrease considerably seaward, while the canopy becomes very irregular and broken. In a narrow coastal belt of 1 or 2 km wide we find as differentiating species the *awarra* palm (*Astrocaryum segregatum*), gigantic cacti (*Cereus* sp.), *Ximenia americana* and *Eugenia wullschlaegeliana*. Frequent trees are here *Protium heptaphyllum* (*tiengimonie*), *swietiboontje* (*Inga* spp.), *Hymenaea courbaril* (*rode lokus*) and *Himatanthus articulatus* (*mabwa*). The bad quality of this forest is probably due in part to occasional fires which in exceptionally dry years have damaged most of the young coastal area. Mainly, however, it may be ascribed to the influence of seawinds and the drier climate of the coastal belt; therefore this low forest may be classified as littoral woodland as has been discussed in chapter I.

CHAPTER V

Liane forest.

In aspect the liane forest is an outstanding type characterized by the absence of storeys. Locally larger trees stand so far apart that it is even impossible to speak of a canopy layer. Tall trees do still occur in this very degraded forest, but they are draped with lianes which also fill the gaps between the trees with an impenetrable tangle. Lightwood species are relatively important. In total a considerable number of tree species is represented, but most of them have a very low frequency. This may be illustrated by some figures from an area between Upper Coppename and Upper Tibiti Rivers, where this type is common in the strongly dissected hilly country. On 12 ha strip sections 99 kinds were recorded but 80 of these had a frequency under 5 %. Only four kinds came above 20 %, i.e. *oemanbarklak* (*Eschweilera corrugata* a.o.) and *bospapaja* (*Cecropia* spp.) but a little, whereas *swietiboontje* (*Inga* spp.) and *salie* (*Tetragastris* spp.) even came above 50 %.

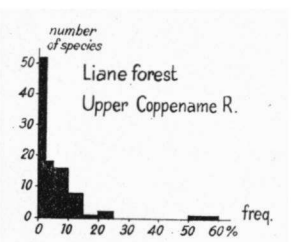

Fig. 8 Frequency distribution of trees of ≧ 25 cm diam. in liane forest.

This forest type is apparently restricted to areas with adverse edaphic conditions, like stony lateritic soils in which rooting is bad as a result of massed ferritic concretions and the foothold of the trees insecure, as is indi-

cated by the very numerous fallen trees. Possibly this type has to be regarded as a peculiar transition between rain forest and mountain savanna forest, but detailed study will be necessary to clarify its position. At present we can only add that the taller trees all belong to species present in rain forest.

CHAPTER VI

Vegetation map of northern Suriname.

As a basis for this survey map three maps produced by the Central Bureau for Aerial Surveys (C.B.L.) were available. On each of these maps one element of the landscape is indicated, i.e. the ridges in the young coastal plain, the flats of the old coastal plain and the savannas. These three elements were brought together in one map and then the vegetation types were sketched in following the aerial photographs. Besides, especially for the eastern half, we could rely upon the sketch maps prepared by the C.B.L. and upon our own knowledge of the terrain.

In general the resulting map requires no explanation; we may mention, however, that the ridges in the young coastal plain are drawn as such, as their shape did not allow the use of a signature. For the greater part they are covered by the described poor forms of rain forest, whereas the flanks and the low parts bear marsh forest.

In the old coastal plain only the high ridges which bear savanna forest and in the East even savannas, are indicated with the concerning signature. For the rest the not or slightly eroded part of the old coastal plain, the flats, is mapped as marsh forest because this type forms the main element but includes scattered patches of rain forest and swamp forest type C. On the other hand, also the levees of the large rivers and their old courses bear the marsh forest symbol.

In the savanna belt the distribution of savannas and savanna forest runs in general parallel to the occurrence of the white quartz sands of the Zanderij formation. Extensive silt clay savannas are found only in the Northeast, in the old coastal plain, whereas the soil of the savanna along the southern part of the railway consists of weathered material of the Rosebel sere.

A broken line indicates the southern limit of the forest belt South of the savannas where the exploration by the Forest Service is going on since 1949. South of this line the strongly dissected and therefore inaccessible hill country begins. For the major part this is covered by rain forest.

CHAPTER VII

FOREST PROFILES

These diagrams were compiled from plot surveys in strips 10 m wide and subdivided in squares of 10 by 10 m. In each square all trees and saplings of at least 2 m high were recorded. In the adjacent 10 m strip all trees of 5 cm

diameter and over were enumerated. The height of the smaller trees was estimated against a rod of 5 m, while tall trees were measured with an altimeter of Blume-Leiss. Subsequently sketches were made of all trees of at least 5 m high in a strip 5 m wide being one half of the first 10 m strip, representing the front of the profile. In the second half of this strip all trees over 10 m high were drawn and in the second 10 m strip representing the background of the profile only the trees of at least 20 m high. Every sketched tree was marked in an outlay, and upon this outlay the forest profile was built up from the separate sketches. To strike a note of perspectivity in the profile drawings 3 different widths of contour lines were used, the heaviest for the trees in front. The tall trees in the second 10 m strip were drawn in as background with broken contour to give a better idea of the coverage in the upper storeys.

For each of the 6 profile sketches contained in the back flap a short description follows. All species present in the drawings are marked by a number or letter according to the list on p. 38 where behind each species the number of specimens in each profile is indicated.

Profile I shows a fairly young stand of *Triplaris* forest in a shallow swamp fringing the ridge over which the road called Garnizoenspad, West of Paramaribo, is built.

The soil consists of very heavy, blue-grey marine clay. In the long rainy season the soil is covered by at least ½ m of water and it falls dry for some time in very dry years. In such cases fires can destroy the forest. According to tree-expert Helstone this happened in this area in 1944, but during the survey in 1954 no traces of fire were found any more.

The plot contains but 6 species and of these *Triplaris* and *Pterocarpus* together make up 80 % of the stand. But for an occasional gap, the canopy is closed and consists of fairly even aged trees of up to 30 cm diameter and so densely stocked that a strip of only 5 m wide could be drawn.

Profile II illustrates a swamp forest of type B, surveyed in the vicinity of Doksie Creek (near the confluence of the Coppename and Tibiti Rivers) and close to a small flat of the old coastal plain. Under natural conditions the layer of pegasse comes above water in the long dry season, but is submerged 1 m or maybe more in the rainy season. The soil below the pegasse consists of grey-brown and, deeper, pale grey silty clay. Very striking in the forest are the numerous clumps of *pina* palms (*Euterpe oleracea*) on high root cushions. The principal trees are: *baboen*, *matakki* and *watrabébé* with large buttresses or stiltroots and the usually small *blakaoema* (*Diospyros guianensis*). Next to these 6 other tree species are present in the profile.

Profile III represents a plot of *Mora* forest on the broad levee of the Coppename River at the Andresa point (South of the mouth of the Wayombo River) and perpendicular to the riverbank. This marsh forest is inundated

at its highest point about spring tide for a short time around high water and in its lower parts with every tidal flood. As a result of the rapid changes of the water level the aeration of the top soil is good as is evident from the profile. This consists of heavy silty clay which is brown to a depth of 20 cm and below 20 cm grey with brown and yellow-brown spots.

Though *Mora* provides most of the tall trees, it accounts for no more than 43 % of all counted specimens and *Eperua rubiginosa* (*oeverwallaba*) and *Carapa guianensis* (*krappa*) make up for another 22 %. The rest includes 20 tree species besides *maripa*, *pina* and *paloeloe*. In the herb stratum the seedlings of *Mora* are dominant.

Profile IV gives a picture of another variant of marsh forest, i.e., *possentrie* or *Hura crepitans* forest, in a seasonal swamp between two low ridges West of the Coppename estuary. The left end of the strip lies on the sandy slope of a ridge, the remainder on heavy clay which is rich in humus in the upper layers, then pale grey and below 70 cm pale blue with yellow and light brown spots.

The scattered large *possentries* form a special, strongly broken upper storey, but as *Hura* rejuvenates poorly, the species comes at only 9 % of all sampled trees. The most abundant species is *krappa* with 27 %, followed by Triplaris with 15 %. The latter, however, shows preference for the lighter spots and is restricted to the second storey. Next in number follow *Crudia glaberrima* (*watrabirie*) and *Pterocarpus officinalis* (*watrabébé*) not counting the palms *pina* and *kiskismakka* which are both numerous. The remaining 24 species are present in small numbers only.

Profile V shows a transition of creek forest towards rain forest in the area between the Suriname River and Mapane Creek. The transition belt of square 3 to 5 is relatively broad here as it contains a spring level caused by a layer of iron concretions at a depth of 70—100 cm under silty colluvial loam. This spring keeps the soil wet for the greater part of the year. In the creek valley loams and coarse sands are intermingled without order, while the slope above square 5 consists of a sandy loam with small iron concretions at the surface. This loam is brown at the top and changes downward to yellow and orange.

Along the creek grow many *Pterocarpus* trees with strongly straggling buttresses towards the side of the current. Other species in the creek forest are *Eperua falcata* (*wallaba*), *Iryanthera paraënsis* (*srébébé*), *Symphonia globulifera* (*matakki*), *Licania macrophylla* (*sponshout*) and *Tabebuia insignis* (*zwamppanta*). In the undergrowth *lèlè* (*Rinorea pubiflora*) is abundant, while on the slope this species gives way to the related *Paypayrola guianensis* (*tajahoedoe*). In the rain forest also *paramakka* takes an important part in the undergrowth; out of more than 60 species no one comes into the foreground.

Profile VI illustrates a transition of savanna forest into rain forest, also in the area between the Suriname River and Mapane Creek. The savanna forest occupies square 57—63 and stands on white Zanderij sand covered by a more or less thick layer of raw humus. The same coarse sand bears most of the rain forest, but there it is rich in humous to considerable depth. Just before square 50 the soil changes abruptly into orange sandy loam.

Restricted to the savanna forest and there numerous are *Clusia fockeana* (*sabana mangro*), *Octoea schomburgkiana* (*sabanapisie*), *Bombax flaviflorum* (*sabanakatoen*) and 3 *gujave* species (Myrtaceae), whereas a.o. *Carapa*, *Tetragastris* spp. (*salie*), *Qualea albiflora* (*hoogland gronfoeloe*), *pinpin* and *paramakka* occur only in the rainforest part of the plot. In total this profile counts over 80 species.

List of species occurring in the forest profiles.

Symbol surinam name	Botanical name	Number of specimens in profile					
		I	II	III	IV	V	VI
1 *krappa*	*Carapa procera* or *guianensis*			9	41	3	3
2 *watrabébé*	*Pterocarpus officinalis*	38	7	2	11	6	
3 *nekoehoedoe*	*Alexa wachenheimii*				3	4	
4 *wallaba*	*Eperua falcata*					15	
5 *manbarklak*	*Eschweilera subglandulosa*			5			
6 *swietiboontje*	*Inga* sp. div.	2		1	5	5	2
7 *baboen*	*Virola surinamensis*		13	1	5	1	
8 *kraskrastikie*	*Talisia megaphylla*				2		
9 *blakaoema*	*Diospyros guianensis*		7		1		
10 *mansalie*	*Conceveiba guianensis*					1	4
11 *bosamandel*	*Terminalia dichotoma*			4	5		
12 *salie*	*Tetragastris* spp.					2	4
13 *oemanbarklak*	*Eschweilera corrugata* and *amara*					12	16
14 *hoepelhout*	*Copaifera guianensis*		1			1	
15 *mirkietikie*	*Bonafousia undulata*					3	2
16 *tajahoedoe*	*Paypayrola guianensis*					30	
17 *pisie*	*Lauraceae* sp. div.		1	1	2	4	4
18 *tiengimonie*	*Protium* spp.				1	18	1
19 *spikrihoedoe*	*Mouriria* spp.					2	7
20 *watramabobbie*	*Gustavia augusta*			5			
21 *tiengimonie* (gr. bl.)	*Protium neglectum*					6	4
22 *doifisirie*	*Guarea guara*				2	4	
23 *pakoelie* (paars bast)	*Rheedia macrophylla*			1			1
24 *pinpin*	vs.*Mapouria chionantha*				1		10
25 *mankrappa*	*Talisia* sp.				1		
26 *lèlè*	*Rinorea pubiflora*					6	
27 *njamsihoedoe*	*Pisonia* sp.				1		
28 *boogland-baboen*	*Virola melinonii*						1
29 *boogland-gronfoeloe*	*Qualea albiflora*						4
30 *berggronfoeloe*	*Qualea rosea*						1
31 *hgl. watramabobbie*	*Gustavia hexapetala*					2	2
32 *tiengimonie* (kl. bl.)	*Protium heptaphyllum*				2		22
33 *iengipipa*	*Couratari* spp.					4	
34 *witte foengoe*	*Drypetes variabilis*					1	1
35 *boszuurzak*	*Annona montana*, resp. sp.				1	3	
36 *fomang*	*Chaetocarpus schomburgkianus*					4	2
37 *jamboka*	*Pouteria* sp.						4
38 *alasabo*	*Citharexylum macrophyllum*				3		
39 *bosmomouw*	*Bombax* sp.		2				
40 *kopie*	*Goupia glabra*					3	
41 *booglandbébé*	*Alchorneopsis trimera*		1			1	1
42 —	*Discophora guianensis*					2	
43 *pakoelie* (lichte bast)	*Rheedia Kappleri*				1		
44 *jakanta*	*Poraqueiba guianensis*					4	

Symbol surinam name	Botanical name	Number of specimens in profile					
		I	II	III	IV	V	VI
45 *bosmangro*	*Tovomita* sp.					1	
46 *witte gauetrie*	*Matayba* sp.						5
47 —	*Ficus* spp.	5			2		
48 *bradiliefie*	*Coccoloba latifolia*				1		
49 —	*Elvasia hostmannia*			1			
50 *tiengimonie* (getand)	*Hemicrepidospermum rhoifolium*					3	
51 *bospapaja*	*Cecropia* sp.					2	
52 *zoutoemetiehoedoe*	*Maytenus* sp.						3
53 *kwattabobbie*	*Chrysophyllum cuneifolium*						1
54 —	*Cheiloclinium cognatum*					1	
55 *sorosalie*	*Trichilia* spp.					7	
56 *zwart riembout*	*Micropholis* sp. nov.						1
57 *gandoe*	*Swartzia tomentosa*					1	
58 *kwassikwassihoedoe*	*Ampelocera edentula*					1	
59 *foengoe*	*Parinari campestris*					3	2
60 *zwarte kabbes*	*Diplotropis purpurea*					1	
61 *groenhart*	*Tabebuia serratifolia*					1	
62 *manletterhout*	*Piratinera* spp. or *Perebea laurifolia*					1	3
63 *djadidja*	*Sclerolobium melinonii*					1	
64 —	*Pouteria melanopoda*					2	1
65 *letterhout*	*Piratirena* sp.						2
66 *wana*	*Ocotea rubra*					1	
67 —	3790 vs. *Ogcodeia guianensis*					1	
68 —	Myrt. 4955?						19
69 *santihoedoe*	*Licania ovalifolia*						1
70 *njamsihoedoe*	*Pisonia* 4978						14
71 *koenatebie*	*Platymiscium ulei*						1
72 —	*Calyptranthes speciosa*						4
73 —	*Mapouria chlorantha*						4
74 *basra lokus*	*Dicorynia guianensis*						1
75 *mappa*	*Macoubea guianensis*		1				
76 *boogland anaura*	*Couepia versicolor* or *caryophylloides*					2	
77 *zwart riembout*	*Pouteria engleri*					1	
78 *blakaoema*	*Diospyros* sp.						4
79 *withoedoe*	*Tapirira guianensis*						2
80 *pientobolletrie*	*Pouteria cladantha*						2
81 *bofroehoedoe*	*Sacoglottis guianensis* var. *sphaerocarpa*					1	
82 *okrohoedoe*	*Sterculia excelsa*						1
83 —	*Aulomyrcia schaueriana*					3	
84 *manbarklak*	*Eschweilera* cf. *longipes*					3	
85 *swietiboontje* (kl. bl.)	*Inga heterophylla*						1
86 *wit parelhout*	*Aspidosperma marcgravianum*						1
87 *bosdruif*	*Heisteria cauliflora*						1
88 *gele kabbes*	*Vatairea guianensis*						2
89 *kalebashout*	*Terminalia* sp.						2

Symbol surinam name	Botanical name	Number of specimens in profile I	II	III	IV	V	VI
90 *sponshout*	*Licania macrophylla*					1	
91 —	*Eschweilera simiorum*					1	1
92 *djoebolletrie*	*Pouteria* sp.						1
93 *gujavekwarie*	*Qualea dinizii*						1
94 —	*Siparuna decipiens*					1	
95 *purperhart*	*Peltogyne venosa*						2
96 *panta*	Annonnacea						1
97 *prokonie*	*Inga alba*						1
98 *pikienmisikie*	*Piptadenia suaveolens*						1
99 —	5502 cf. *Endlicheria formosa*				1		
100 —	5503?				1		
101 *spikrimakka*	*Randia spinosa*				1		
102 *foengoe* soort	*Hirtella paniculata*				1		
103 —	*Casearia arguta*				1		
104 —	*Eugenia wullschlaegeliana*				1		
105 —	*Sacoglottis* gui. var. *dolichorcarpa*			1			10
106 *djedoe*	*Sclerolobium* sp.					1	1
107 *kankanhoedoe*	*Apeiba echinata*					1	
108 *raverienja*	*Sloanea dentata*					2	
109 *panta*	*Unonopsis guatterioides*			1			1
110 —	*Caraipa richardiana*			1			
111 *mispel*	*Bellucia grossularioides*			1			
112 *kalebashout*	*Vitex* sp.			1			
113 —	*Catinga* sp.			2			
114 —	3773 *Trymatococcus* cf. *paraënsis*					1	
115 *sabana foengoe*	*Licania incana*						1
116 *aprahoedoe*	*Pouteria sagotiana*						1
117 —	*Rudgea hostmanniana or cornigera*						1
118 *bergibébé*	*Swartzia benthamiana*						1
119 *koelarie*	*Calophyllum brasiliense*		2				
122 *spikrihoedoe*	*Mouriria princeps*			1			
149 *zwampanaura*	*Licania* sp.						1
150 *batamballi*	*Ecclinusa guianensis*						1
151 *mispel*	Melastomatacea						1
152 *pritijari*	*Zanthoxylum* 4981						1
153 *rode djedoe*	*Sclerolobium albiflorum*						1
154 *kromantiekopie* (kl. bl.)	*Agonandra* sp.						2
155 *kwasiba*	*Pouteria* sp.						1
	Locally frequent species						
A *mora*	*Mora excelsa*			44			
B *mierenhout*	*Triplaris surinamensis*	31			22		
C *possentrie*	*Hura crepitans*				13		
D *sabana-mangro*	*Clusia fockeana*						11
E *oeverwallaba*	*Eperua rubiginosa*			14			

Symbol surinam name	Botanical name	Number of specimens in profile					
		I	II	III	IV	V	VI
F *matakki*	*Symphonia globulifera*		9	1		1	
G *zwamppanta*	*Tabebuia insignis* + var. *monoph.*	9	3			1	
H *makraka*	*Cynometra hostmanniana*			3			
I *watrabririe*	*Crudia glaberrima*				16		
J *boskers*	*Eugenia* sp.						2
K *sabana-pisie*	*Ocotea schomburgkiana*						27
L *„tritri"*	*Trichilia trinitensis*				1		
M *rode gujave*	*Aulomyrcia hostmanniana*						3
N *sabana katoen*	*Bombax flaviflorum*						5
O —	*Pagamea guianensis*						9
R *srèbébé*	*Iryanthera paraënsis*					10	
S *anaura* (kl. bl.)	*Hirtella racemosa*						19
T *gauetrie*	*Cupania scrobiculata*					2	
U =	*Tapura guianensis*					2	2
V *broedoehoedoe*	*Iryanthera sagotiana*					1	1
W *zwarte gauetrie*	*Matayba* sp.						11
X —	unknown			1		3	1
Y *zwart parelhout*	*Aspidosperma oblongum*						9
Z *gujave* (grijze bast)	vs. *Calycopus revolutus*						14
	Palms and tall herbs						
a *paramakka*	*Astracaryum paramaca*					17	5
e *kiskismakka*	*Bactris* cf. *pallidispina*				29		
k *koemboe*	*Oenocarpus bacaba*		1				1
m *maripa*	*Maximiliana maripa*			2			
p *pina*	*Euterpe oleracea*	1	31	6	26		
r *paloeloe*	*Ravenala guianensis*			2			
+ *mokomoko*	*Montrichardia arborescens*				x		

RESUMEN

Desde el punto de vista geológico el norte de Surinam se divide en 4 zonas distintas, a saber:

1°. la parte del sur que pertenece, como también el resto de Surinam, a la capa precambriana de Guyana, que, a su vez, consiste principalmente en granitos, granitodioritas y esquistos, y que, por la mayor parte, lleva selva pluvial en terrenos corroídos muy profundos.

2°. Al norte de esta capa se encuentran depositaciones mucho más jóvenes: la capa de la formación Zanderij, constituída por arenas blanqueadas con vegetaciones de sabana y, además, arenas no blanqueadas y arcillas con arena gruesa.

3°. Luego hay la formación Coropina de la vieja llanura costera o sea un viejo terreno de bajiales compuestos de limos polvorosos y arcillas con formaciones de pantano y de lodazal. En la franja del norte se encuentran cordones litorales de arena fina (llamados en Surinam „ritsen").

4°. Finalmente, desde allí hasta la costa actual la joven llanura costera que consiste en arcilla pesada marina con formaciones de pantano y cordones costeros de arena o conchas, cubiertos de selva (véase el mapa).

Tipos de vegetación en lugares húmedos:

1. *Manglar*, que se divide en selva de *Avicennia nitida* (la *parwa*) en la costa y en los diques naturales de los ríos grandes, zonas de *Rhizophora* (*mangro:* 3 especies) en barro a lo largo de las orillas de los ríos, y el manglar mixto.

2. *Pantanos herbáceos*, que contienen muchas comunidades en agua salina y dulce, descritas en la parte primera de esta serie.

3. *Bosque de pantano*, que varía desde matorral abierto hasta bosque de un estrato de 10—15 m. de altura y que es muy pobre de especies. Matorral de *Machaerium lunatum* (*brantimakka*) y bosque de *Erythrina glauca* (*koffiemama*) en agua salobre, y en agua dulce bosque de *Pterocarpus* y *Tabebuia*.

4. *Selva de pantano* tiene un dosel de entre 18 y 30 m., es pobre de especies y, ordinariamente, tiene numerosas palmeras; dicha selva se distingue en 3 tipos:

El tipo A tieno mucho *Triplaris* (*mierenhout*) y ningún *Symphonia* (*matakki*) y es muy corriente en la joven llanura costera (perfil 1).

El tipo B no tiene *Triplaris*, pero mucho *Symphonia y Virola surinamensis* (*baboen*) y se encuentra en las partes de más edad de la joven llanura costera; la formación de turbera es muy intensa. (perfil 2).

El tipo C es como B, pero es más rico en especies en las partes más bajas de la vieja llanura costera, o sea en albercas detrás de los diques naturales de los ríos.

Selva de lodazal es bastante rica en especies, tiene 2 estratos y se da en terrenos periódicamente inundados, como p.e. los témpanos erosionados de la vieja llanura costera, las partes bajas de los „ritsen", los diques naturales de los ríos y en las aroyaderos en los terrenos accidentados. Característicos son los „kauwfoetoes", que son suelos desiguales y canalados; la capa herbácea está, casi siempre, bien desarrollada, las varias palmas se dan con un número muy cambiante. En la selva litoral éstas pueden hasta dominar en el dosel de copas.

Selva de Mora (perfil 3) es una variante alta de la litoral (de 35—40 m. de altura), en la que predomina *Mora excelsa* en todos los estratos y que se halla solamente en la parte occidental de Surinam.

La de *Hura crepitans* (perfil 4) predomina aquí y allí en las partes bajas de los „ritsen" y hacia el oeste de la llanura costera se aumenta el número de *Carapa* formando así la variante tercera: la de *Carapa.*

Formas xeromórficas de vegetación:

En Surinam se resumen las formas xeromórficas de vegetación bajo el concepto de „sabana". Dichas formas se dan en los sitios donde el suelo tiene tan poca capacidad retentiva del agua que en los períodos secos, cuando la evaporación supera con mucho la caída pluvial, aparece falta de agua y la vegetación se hace susceptible para incendios.

Según el tipo de suelo distinguimos 3 series en las que la duración del período de falta de agua determina el aspecto de la vegetación.

1. la serie seca en arena profunda de cuarzo blanco muy permeable que lleva varios tipos de selva, a saber:

Selva de sabana, de 25—30 m. de altura, dosel cerrado y un estrato inferior de árboles delgados; es rica en especies por el hecho de que hay muchas de la selva pluvial, al lado de las típicas de la de sabana, especialmente en el estrato inferior; las palmas que se den son pocas y pequeñas (perfil 6 p.p.). Aquí y allí se encuentra *selva de wallaba* con *Eperua falcata*, y *selva de dakama* con *Dimorphandra conjugata* como especie predominante. También se da el caso de 2 especies prevalecientes.

Bosque de sabana se compone solamente de especies xeromórficas de sabana y se convierte, en caso de persistente falta de agua, en matorral con más o menos las mismas especies, para pasar a ser luego *sabana abierta* con grupitos de arbustos y una vegetación ligera y pobre de hierbas y semiarbustos.

2. la serie húmeda en terrenos llanos con capas impermeables en el suelo, de mode que, por consiguiente, carencia de agua en el período seco alterna con inundaciones en el de lluvias. Las formas forestales de sabana húmeda

tienen en común muchas especies con las de la serie seca, aunque no dejan de tener algunas propias. Además tienen una subvegetación de hierbas grandes (Scitamineae). La *sabana abierta húmeda* lleva una vegetación rica, pero bastante cerrada, de especies propias.

3. la serie de piedra en suelos tenues que se encuentran sobre roca sin corroer en terreno accidentado y montañoso. Así hay p.e.:

Selva de sabana montañosa en capas de ferrita y ferrobauxita en los montes, que se parece a la de sabana corriente, pero se caracteriza por otras especies, sobre todo Myrtaceae y Sapotaceae, y muchas lianas, musgos, y epífitas pequeñas. *Sabana de roca* se halla en masas de roca desnuda en el interior del país, p.e. en la montaña de Voltz sobre la cual crecen algunas hierbas en cavidades y hendiduras, sucedidas por grupos de arbustos en los que predomina, muchas veces, una de las especies de *Clusia.*

En el sistema de BEARD la 1a y la 3a constituyen 2 series paralelas de las formaciones siempreverdes secas, mientras que la 2a entra en las formaciones de lodazal.

La selva de tierra firme o *la selva pluvial* comprende los tipos que cubren la parte mayor de la superficie; sin embargo, no se las puede subdividir a causa de su grande riqueza de especies y su complejidad. En su forma óptima en la parte oriental del terreno accidentado esta selva constituye una de 3 o 4 estratos: uno, superior, de „emergentes" esparcidos, de 40—45 m. de altura; otro con un dosel irregular, bastante cerrado de una altura entre los 25 y 30 m.; y debajo del segundo un tercer estrato de árboles delgados y una subvegetación vaga, pero con especies propias, al lado de ejemplares jóvenes de las de estratos superiores. Palmas, generalmente, son numerosas, y en particular en la subvegetación (perfiles 5 y 6).

Hacia el oeste y la costa el estrato superior desaparece poco a poco, quedándose más abiertos los inferiores, como pasa también en la selva veranera siempreverde de BEARD, lo cual, esto no obstante, no hemos distinguido, por haber una conformidad grande de especies.

También la selva de „rits" en la llanura costera pertenece, según nuestro modo de ver, a los tipos más pobres de la selva pluvial.

Sólo en una franja estrecha de 1—2 km esta selva se hace tan pobre e irregular, aunque tiene algunas especies propias como un cacto gigantesco (*Cereus* sp.), la espinosa *Ximenia americana*, la palma *Astrocaryum segregatum* y *Eugenia wullschlaegeliana*, que es mejor hablar de bosque costero.

Al este de la Coppename predomina, aquí y allí, la *Mora gonggrijpii* (*moraboekea*) en todos los estratos.

Completamente aparte está, a causa de su aspecto, la selva de lianas en la que faltan estratos y, no pocas veces, el dosel de copas por el hecho de que los árboles se encuentran muy dispersos. Bien es verdad que hay árboles altos, cubiertos de lianas que llenan también los espacios intermedios.

La selva susodicha se encuentra en suelos pedrosos que hace difícil la radicación. Por consiguiente son muy numerosos los árboles caídos a tierra. Dicha selva cuenta con muchas especies que se dan también en la selva pluvial.

Para los tipos de selva se suministran ejemplos de la fracción frecuentativa de las especies, y para la selva de arroyo y selva pluvial se la da también de masa y número de troncos por hectárea y clase diamétrica. En 6 perfiles fueron bosquejados los tipos principales forestales: en una franja de 5 m. de ancho se trazaron todos los árboles de 5 m. y más; en una segunda de igualmente 5 m., todos los de más de 10 m.; y en la tercera de 10 m. de ancho sólo los de 20 m. y más. En la lista de especies se da de todas las especies el nombre surinameño y el científico, y el número de ejemplares por perfil.

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OVERZICHTSKAART VAN DE BEGROEIINGSVORMEN IN NOORD SURINAME

SURVEY MAP OF THE MAIN VEGETATION TYPES IN NORTHERN SURINAME

SCH. 1:400 000

0 20 40 KM

LEGENDA

- MANGROVE BOS / MANGROVE FOREST
- OPEN WATER
- RITS / RIDGE OF SAND OR SHELLS
- KRUIDEN- EN STRUIKZWAMP / SWAMP WITH HERBS AND SHRUBS
- LAAG ZWAMPBOS / SWAMP WOOD
- HOOG ZWAMPBOS TYPE A / SWAMP FOREST TYPE A
- HOOG ZWAMPBOS TYPE B-C / SWAMP FOREST TYPE B-C
- DRASBOS / MARSH FOREST
- OPEN SAVANNEN EN STRUIKSAVANNEN / OPEN SAVANNAS AND SCRUB SAVANNAS
- SAVANNEBOS / SAVANNA FOREST
- HOOG DROOGLANDBOS / RAIN FOREST
- BERGSAVANNEBOS / MOUNTAIN SAVANNA FOREST
- ROTSSAVANNE / ROCK SAVANNA