THE VEGETATION OF THE COASTAL REGION OF SURINAME

Results of the Scientific Expedition to Suriname 1948—49

Botanical series No. 1

by

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The Great Swaying swamp seen from the North, in the distance some islands. "Here it is a garden in magnitude of scale of divine conception with infinite variation of design and detail; there a dreary waste, on which the sun beats or the wind revels—that storms and rain sweep over" (JENMAN)

GENERAL PART

CHAPTER I

Introduction.

The data on which this study is based, were gathered during a scientific expedition which lasted from September 1948 to May 1949. The author had accepted an invitation to join Prof. J. LANJOUW who on this expedition was entrusted with the botanical part of the investigations. They worked in close contact with the other staff members, the zoologists Dr D. C. GEIJSKES and P. H. CREUTZBERG, and the geo-morphologists Prof. J. P. BAKKER and Dr A. BROUWER. Especially the cooperation with the latter group proved to be of prime importance for the study of the vegetation. For more general information with regard to the aims and scope of this expedition the reader is referred to the preliminary report (26).

During the expedition various landscapes were visited and several vegetation types investigated. The present contribution describes the main vegetation types occurring in the coastal region of Suriname and discusses their development and their relations to each other and to the soil. The vegetation of the herbaceous swamps will be discussed in more detail and compared as far as possible with that of similar swamps outside Suriname.

The coastal region as it is understood here comprises the whole area formed by the sea in geologically recent times. According to our present knowledge it is roughly delimited by a line, running from Albina in the East over Moengo, Republiek ± 35 km South of Paramaribo, along the Wayombo River to a point near Oreala on the Corantine River. As our map I shows, it comprises not only all the alluvia that YZERMAN designates as fluviomarine but also a considerable part of his continental ones (BAKKER 25). As far as the ridges in the younger part of the coastal region are concerned, this map could be checked with the unpublished map which Dr ZONNEVELD of the C.B.L. had drawn of these ridges and which he kindly placed at my disposal.

The whole area, which covers some 18,000 square km, consists of alluvial clays and sands. The majority of the clay soils is permanently inundated and is covered by extensive swamp vegetations. The sand which is locally mixed with or replaced by shells, was deposited by the sea, but locally disturbed by the action of the wind and raised in the form of ridges, in Suriname called "ritsen". These ridges appear either singly or in groups, and may reach a considerable length. Along the present coast locally strandbars, ridges in statu nascendi, are found with a bare beach in the tidal zone and above the high-tide mark covered by strand vegetation. The ridges that are farther removed from the sea are covered by forest. The number of ridges is highest in the eastern part where the oldest ones rise to a height of 10 m above sea level. Westwards their number decreases while the depth of the coastal flats increases (map I). In the district Nickerie the ridges are reduced to small isolated patches that disappear in the immensity of the swamps.

The eastern ridges are all completely sandy, the deposits of shells being restricted to the western part, where they occur e.g. in the surroundings of Paramaribo and further westwards up to Coronie. Near Groningen and along the road between the mouth of the Coppename River and Coronie we find examples of shell beds, which are several meters thick and consist exclusively of layers of shells and shell fragments. A large part of the ridges, however, consists of sand with but a slight admixture of shells.

The time we spent in the coastal region amounted to three months divided over three trips to different parts of the area. On September 29th 1948 we entered the coastal belt in the eastern part of Suriname about 6 km north of Moengo tapoe.

It required two months to complete the distance of not quite 35 km, which separated this place from the ocean. In the second half of December we reached a place halfway between Coronie and the mouth of the Coppename River and had ten days to investigate the vegetation some distance North and South of the Coronie road.

After the program of the expedition had been completed, the author had the opportunity to visit the northwestern tip of the coastal region in the district Nickerie.

Literature.

Additional information was obtained from papers by LANJOUW (35) and GEIJSKES (30, 31) and some data were derived from the labels of the older collections that are preserved in the Utrecht herbarium. The literature contains but little information with regard to the swamp vegetation in the neighbouring countries, as most travellers, not only in South America but everywhere else in the tropics, appear to have confined their attention to the higher parts of the interior and to have avoided the swampy places. However with the increased interest for ecological studies in recent years there seems to come a change in this aversion of the swamps, which in my opinion was entirely unjustified.

The swamp vegetation presents not only in itself many interesting problems, but a sound knowledge of the coastal area is indispensable when one wishes to understand the geomorphology and the development of the vegetation of the country as a whole. Its study moreover is of direct economic importance as the soil of the swamps and ridges may be and in fact is being transformed into arable land, and as the virgin vegetation may give valuable indications with regard to the properties of the soil and its possible use. Lastly I should like to bring forward a subjective argument. Many swamps are said to be monotonous; those of the N. American coastal plain are even called "dreary marshes". The Suriname coastal belt on the contrary shows a good deal of diversity. At first view one already notices the alternation between tree-less and forested parts, and a closer inspection reveals that very often one dominant interchanges with another one and that the accompanying species vary locally. In my eyes the region offers much fine scenery, of which the photographs may give some idea, even though they do not show us anything of the often very fine colour scheme.

As the literature wil be taken into account in the various chapters I can confine myself here to a short review. Some general information can be found in VERDOORN's Plants and Plant science in Latin America (123). Notes with regard to the distribution and habitat of species were gathered from floras and enumerations. After the Flora of Suriname (37), the Manual of the S.E. Flora by SMALL (111), proved to be the most valuable source.

The swamps of the N. American coastal plain were thoroughly studied by PENFOUND and HATHAWAY in S.E. Louisiana (103) and by WELLS in N. Carolina (127), but these swamps are outside the tropics and their vegetation is totally different from that found in the Suriname ones. S. Florida on the other hand is tropical and shows in its mangrove and beach vegetation a strong resemblance to the rest of tropical America; this can be gathered from the description of the Florida Keys given by MILLSPAUGH (97) in 1907 and from recent studies of DAVIS (66, 68). The well-known Everglades are a typical feature of Florida. EGLER (73) very recently published an important article on the changes which must have taken place in the past and are still taking place at present in the S.E. saline everglades. He developes the view that the Everglades are a semi-natural landscape that maintained itself during a long period owing to the fact that its further development was opposed by climatic disasters like hurricanes and hurricane floods and by the periodical burning practised by aborigines, but that it is now doomed to disappear as a result of the interference of white man.

In the Caribbean islands the vegetation was studied long ago in the Danish Antilles by BØRGESEN and PAULSEN (54, 55) and by RAUNKIAER (104) and more recently in Porto Rico by GLEASON and COOK 1926 (77), in Cuba by VICTORIN and LEON 1942 and 1944 (124), in Guadeloupe 1935 and Martinique by STEHLÉ 1937 (116, 117). BEARD published a comparative study of the vegetation of the Lesser Antilles 1948 (50), while CHAPMAN described the mangrove and beach vegetation in Jamaica

1944 (59) and GOODING that of the dunes of Barbados 1947 (78). A description of the vegetation types of Trinidad and Tobago given by MARSHALL 1934 (93) and BEARD 1946 (48) proves that many of them are very similar to those of Guiana. The tree-less swamps unfortunately received but little attention.

For the S. American continent I must mention the papers published round 1900 by HUBER on the Amazone delta and the isle of Marajo (83, 84) and by ULE (120, 121). DANSEREAU investigated in 1947 the sandy coast and the lagoons near Rio de Janeiro (63, 65).

A first attempt to arrive at a division of the vegetation found in French Guiana was made by COUDREAU in 1833 (60) and a better division was given by BENOIST in 1924 (53).

For Suriname the papers of LANJOUW (35) on savannas and swamps and by GEIJSKES (30, 31) on swamps have already been cited. The report of EYSVOOGEL a.o. (28) on the Nickerie district deals mainly with soil types and pays but little attention to the vegetation.

GONGGRIJP and BURGER (34) applied BEARD's division in formations to Suriname and discussed the occurence and the properties of a number of common tree species.

ANDERSON (45) described the forests in the north-western district of British Guiana. They comprise several examples of what Beard calls marsh and swamp forest. MARTYN (96) wrote a note on the foreshore vegetation near Georgetown and the way it changed after the building of a seawall and groins. CASE (58) discussed the value of the natural vegetation of strandbars as protection of the coast.

In 1888 JENMAN (87) published in a newspaper an interesting article which gives not only a vivid picture of the coastal region but also expressed his views on the development of an arable soil out of sediments deposited by the ocean, i.e. the colonisation of the latter by plants and the subsequent changes in the vegetation. In the following I will show how well his views agree with our present ideas.

MYERS (98, 100) in his papers on the savannas of the Guiana plateau and on the Venezuelan llanos makes some remarks on the swamps and on the marshy borders of waterbodies found in the savannas.

KENOYER (88) gave a short description of a hydrosere in Gatun Lake, Panama, some stages of which show some resemblance with Suriname swamp communities. STANDLEY (112-115) sums up the principal species of mangrove, swamp and strand vegetation in Panama, Costa Rica and British Honduras.

The vegetation in Lake Zotz in the mountain region of Petén, described by LUNDELL (91), deserves our attention as it shows a strong resemblance with that of some swamps in the coastal region of Suriname.

Valuable information on swamps in the Old World tropics was found in papers by HOPE (136), MIGAHID (139) and EGGELING (133), which deal with Africa's extensive papyrus swamps and in a paper by CHIPP (129) on mangrove, beach and lagoon vegetation on the Gold Coast.

SCHIMPER (107) made a study of the Indo-Malayan littoral flora and compared it as far as possible with the flora of the littoral zone in other tropical countries.

Methods.

Certainty with regard to the identity of the observed species must form the base for every study of vegetation. The way in which our identifications were carried out therefore deserves our special attention.

Although Prof. LANJOUW had visited Suriname before, and had revised some of the families and although I myself too had studied in the herbarium part of the Suriname plants, our knowledge of the latter was in most cases insufficient to enable us to name the plants in the field. A really sufficient knowledge of this kind can of course be obtained only after a long acquaintance with plants in the field. An other drawback was that we had hardly time during our sejourn for a careful identification by the aid of books. For this reason we were obliged to collect in each sample plot all the species that were present. Where the vegetation consisted of herbs and/or shrubs only this procedure offered no difficulties.

To avoid the necessity of collecting common species again and again, we have introduced in several instances for easily recognizable species fancy names, based on characteristic features or on a similarity of some kind or an other with familiar plants. This method worked quite satisfactorily, but could be applied only in areas of a restricted size. In every doubtful case and also when a species was found after some time had elapsed, in a new area, samples were collected in order to enable us to check our identification.

In the forest it was not possible to collect samples from every species, but here we had much help from natives who were well acquainted with the flora and who could give us the vernacular names of a comparatively large number of trees. Here we were forced to a compromise between the time spent on the analysis of each plot and the reliability of the collected data. This we did by first surveying a part of the transect cut through the forest. Then we collected first of all flowering or fruiting species and took from each tree shoots for the herbarium and wood samples; the latter were taken from the trunk. Then sample plots were chosen and analysed. The height and diameter of every tree or treelet over 2 m high was registered either under vernacular names of the tree or under the number given to the samples that we had taken from it.

The scientific names in this paper are as far as possible those used in the Flora of Suriname. Species that are not yet dealt with in the Flora are cited under up-to-date names. In chapter XI most species mentioned in this paper are listed with the author indication and the synonyms found in the literature (In the text the species are always referred to under the names in this list). Remarks on the importance, distribution and ecology of the species and those vernacular names that were used in our field notes are also given. Species that were of little importance for our purpose are given in the text with author indication, they are not included in the list. An alphabetical list of the more important vernacular names is added. It is intended to publish separately an enumeration of all the species collected during the expedition. This will also contain critical remarks on the species.

In the description of the vegetation sometimes paced quadrats were analysed, at other times species were noted in passing. In herbaceous swamps and savannas the scales of BRAUN-BLANQUET for total estimate (abundance and cover combined) and for gregariousness were used.

In the forests the degree of cover could not be estimated, and we confined ourselves therefore to abundance and in that case I have applied the indications generally used in Anglo-American literature: *va*-very abundant, *a*-abundant, *f*-frequent. Where presence alone was recorded, the sign × is used; the sign + means scarce. We have made no difference between occasional and rare.

The records made in this way are put together in the tables found in the back flap. The figures for species found outside the sample plots are placed in parentheses.

To obtain some idea of the frequency of the species and of the homogeneity of the vegetation in the forest we used quadrats 10 m square and usually 4 of them in the same sample plot. Our forest employee HELSTONE, moreover, made a strip survey of all our transects in the way usually applied in the explorations that are carried out by the Forest Service. In a strip of 5 m width on each side of the path or line the Surinam name, the bole height and the diameter (either at breast height or above the buttresses) were registered of all trees that were over 20 cm in diameter. Furthermore every 100 m a short note was made on the occurrence of rejuvenation and on the undergrowth.

The descriptions of the communities, apart from those of the forest, were made according to the methods elaborated by the school of BRAUN BLANQUET. Although these methods were developed in the temperate zone of Europe, they were found applicable in tropical areas too. In Central Africa, for example, they are at present widely used, and many associations and higher units have already been described. Recently LÉONARD (137) has published a list of the communities found in the Belgian Congo. In the forest we could register the trees only in plots, that were much smaller than the minimum area. The method is universally applicable, but the size of the sample areas used by the investigators varies largely. Standardization therefore is very desirable to facilitate comparison. I regard the determination of the minimum area as practically of little importance for the study of forest communities. It will require very much time, as it necessitates the investigation of large areas. MEYER DREES (8) suggests that its size might be estimated by going in a spiral round the initial sample plot until no further new species are noted on first view. I deny the applicability of this method for the South American rain forest. It is possible to add in this way a number of trees to the list, but without scrutinizing each tree, we will never be certain that not several species are overlooked.

Our records intend to be the first step on the way towards recognition and registration of the communities occurring in Suriname. In the following chapters several types of the vegetation are distinguished. In general, however, I thought that it would be premature to establish and name associations. For this purpose the number of our records is too small, and our knowledge of the coastal region of Guiana much too restricted. I disagree with MEYER DREES (8, 9) that it is the historical and also the right way to begin with the delimitation of associations as soon as the vegetation of a small area has been studied, and then to compare these associations with those found in other areas in order to combine them into higher units. To delimit an association more is needed than a list of the partaking species. Every vegetation is the expression of the interaction of plants and environment, at present and in the past. It is absolutely necessary to take all these factors into account, and for this reason I see the intuition, which is always referred to as an essential quality of the true plant sociologist, as the result of a more or less unconscious synthesis of our experience with these factors, of which there must be a store at the back of our mind. The larger this store is, the more efficient will be the synthesis of the data met with in a special field.

In my opinion one should not base associations on the data obtained in a single area of restricted size and without comparison with similar communities in neighbouring areas. Where, as in Suriname, this is not yet possible, we should state the available facts as clear as possible, but be cautious not to make a host of new names which in the future may prove to be mere ballast. To avoid the accumulation of this ballast is the more urgent in the light of the proposals made by some sociologists to establish priority rules in plant-sociological nomenclature.

Terminology.

A number of terms will be defined here as they are used either in a slightly deviating or in a restricted sense. Following BEARD (47, 48) I make a difference between forest and wood, and between swamp and marsh.

Forest, a vegetation usually more than 20 m high, the trees showing a more or less distinct stratification in 2—4 layers.

Wood, a 10—15 m high vegetation without distinct stratification of the trees. The term "scrub wood" is used for woods in which the trees for a large part have become shrubby.

Swamp, an area which is inundated either permanently or at least during the greater part of the year but in the latter case with a permanently soaked soil. The vegetation consists of herbs, shrubs and (or) trees.

Marsh conditions occur in an area which is flooded in the rainy season but dries up in the dry season. The term marsh is used only in the combination marsh forest. A vegetation consisting of herbs and shrubs may grow under marsh conditions, but in account of its physiognomy it is regarded as savanna and indicated by that name.

Savanna is used for plains that become very dry in the dry season and are covered by a vegetation consisting of herbs, shrubs and a few often stunted trees. This is another wording of the savanna concept developed by LANJOUW (35), who gave the following definition: "Savannahs are plains in the West Indian Islands and Northern South America covered with more or less xeromorph herbs and small shrubs and with few trees or larger shrubs". LANJOUW still adds an h at the end of the word although he remarks that he does not know why this h is added in modern English, the word savanna being derived from the Caraib word *sabana.* More recently we see that this h is omitted. I have stressed the seasonal dryness of the savanna as the Indian word sabana has a much wider sense. It is used for all plains, either wet or dry, which are not covered by forest; sometimes savanna forest too is included. The wet sabanas, our swamps, may be fresh or saline.

The forests on dry ground are divided into two types:

Evergreen seasonal forest is a form of the tropical rain forest in the wide, general sense. It is a high forest with three stories of trees, a highly discontinuous stratum of emergent trees reaching 30 m and more, an almost continuous canopy layer and a continuous lower story. The term is introduced by BEARD to distinguish it from the equatorial rain forest which grows in a climate without a well-marked dry season and which should contain four stories of trees. In this forest most tall trees have straight branchless stems over 20 m high. These give the forest the famous cathedral aspect which we miss in the evergreen seasonal forest.

Savanna forest is the woody vegetation on soils that are exposed to severe desiccation in the dry season. In its optimal form it is a forest with a continuous canopy layer at 10—18 m consisting of a remarkably large number of thin trees overtopped by a few bigger ones. A lower story is very indistinct. Most trees have small leathery leaves. In physiognomy it comes close to BEARD's dry evergreen forest.

The term *subgrowth* is used to indicate the layer of herbs and shrubs up to a height of 2.5 m.

The *salinity* of swamp and ground water is given in mg Cl/l; it was determined by titration with silver nitrate. As a general scale for the expression of the degree of salinity the classes of REDEKE have been adopted, but the name of the last class has been modified from ultra- in hyper-halinous to avoid the use of one Latin root in the midst of a series of Greek ones.

fresh water	less than 100	mg	Cl/l
oligohalinous	100 — 1000	,,	,,
mesohalinous	1000 —10,000	,,	,,
polyhalinous	10,000—17,000	,,	,,
hyperhalinous	more than 17,000	,,	,,

For sea water (± 17,000 mg Cl/l) with OLSEN (11) the term euhalinous may be used.

The *acidity*, pH, of soils and waters was determined in the field with a Hellige tile; the whole numbers can be read, but decimals must be estimated with this method.

Vernacular names.

In the older collections of the Utrecht herbarium already a large number of specimens were present of which the labels mentioned vernacular names. These specimens have mainly been brought together by the former Forest Service in Suriname, "Het Boschwezen", currently cited as B.W.. This Service did excellent work during the years 1904—1925, when it stood under the direction of the forester J. W. GONGGRIJP, but was unfortunately abolished as a result of the advancing world crisis.

We also owe a large number of names to Prof. G. STAHEL, who collected during the second world war herbarium material and wood samples of 380 Suriname trees.

A new Forest Service, "'s Lands Bosbeheer", abridged B.B.S., was instituted in 1946 and started its work in the following year under the leading forester Ir I. A. DE HULSTER. From the very beginning it tried to attract native employees with a serviceable knowledge of the forest trees. As a result of the generous cooperation of this Forest Service we were accompanied on all our trips with the exception of the short one to Coronie, by the very able creole forest employee MAX HELSTONE, to whom we owe nearly all our Surinam tree names. Under Surinam names I understand those that are used mainly by the creoles and that are indicated in the Flora of Suriname with (N.E.) or (S.D.), abbreviations for Negro-english and Surinam-dutch. I prefer the name Surinam to Negro-english as it can not be regarded as the language of the negroes alone, nor is it for the greater part derived from English. The language is a mixture of words of Dutch, English, French, Portuguese and African origin. It is spoken as mother tongue by only a part of the creole population, but it is used everywhere in Suriname as a means of communication between the various groups of the very heterogeneous population.

The bush negroes on the other hand are divided into several tribes which are descended from different African peoples. The members of these tribes have refound each other notwithstanding the time spent in slavery. Each tribe has succeeded in preserving part of its ancestral way of life and tongue and thus speaks its own dialect, which differs as a rule in many respects from the common Surinam language. HELSTONE told me that these differences are sometimes so considerable that even a creole may find it difficult to understand these people. He had experienced it several times himself.

In plant names I have not separated Surinam names from Surinam-dutch names because the last ones are always mere translations of the first and in fact no clear division is possible. If a name consists of more than one word, which is the rule, one of them may have the Dutch form and the other one the Surinam form. It also happens that the Dutch and Surinam form are used alternatively by the same person. Moreover, only the names of the best known trees have been remodelled into a Dutch form, and it are these species that are known to the Indians under the Surinam name as well as under the names they bear in their own language. For example the three forms *witti hoedoe, witte hoedoe* and *wit hout* are used alternatively and besides *foengoe* (Sur.) which in Dutch is *vonk-hout,* both *blaka foengoe* and *zwarte foengoe* are used for a related species. Part of the Surinam names are formed from some distinctive character, another part are derived from Indian names. If they fitted in the phonetic pattern they are sometimes borrowed without change but most of them are more or less transformed. The origin of a third part of the names is not yet known.

Some words may be said here about the spelling of the vernacular names. All names cited in this work are phonetic transcriptions made as close as possible of the words as we heard them from our assistants. This is often so difficult that in my field notes I have written many times the same name in different ways. Here I have aimed at uniformity in the spelling of the names. A really justified spelling, however, can not be established without a thorough study of the different languages.

The Surinam language has not yet an official orthography; therefore many differences occur in the spelling of the words, but in general the same sound values are attached to the letters as in Dutch. In accordance the Surinam names are written in the Dutch way with a few exceptions. The word for *small* forming a part of several names is usually written *pikien* whereas it is pronounced *pikjien* or even *pitjien.* The word for *Indian* is written *ingi* or *iengi,* but pronounced *ienji.* Besides normal *l* and *r* an intermediate consonant occurs for which in every instance one of the two characters *l* and *r* must be chosen, e.g. one will write the name for *Eschweilera* at one time *barklak* and at another *barkrak.* In this case I have chosen the first notation. The character *g* is not the Dutch *g,* but the voiced guttural stop of the English *get,* except in the combination *ng* where it indicates the nasalisation of the *n.*

For the Indian names which are not restricted in their use to Suriname, I have followed a more generally understandable transcription as there does not exist an international system of phonetic signs. In other words the names should be pronounced in what the English call 'the continental way'. The main differences with Dutch usage are: *u* for Dutch *oe,* the vowel in English *foot, y* in English *yes* for Dutch *j.* Where necessary a voiceless *e* is indicated by *ĕ.* Softened stops are marked by ˙, e.g. *k˙* is Dutch *kj, t˙* Dutch *tj.*

Examples of Surinam names derived from Indian ones (Caraib or Arawak):

pakoelie Sur. is *pakuli* Car.

dakama Sur. is *dakama* Araw.
kopie Sur. from *kopi-i* Car.
zwarte koenami Sur. for *kunami* Car. and
witte koenami Sur. for *kunamirang* Car. (the suffix-*rang* means resembling)
taproepa Sur. from *tapurupo* Car.
laksirie via *alakasirie* Sur. from *alakusèrĭ* Araw.

A fact which has been never properly stressed is the great diversity occurring in the tree names that are used by the bush negroes. Each tribe uses but a part of the ordinary Surinam names and these often in a dialect variant, and has for many other species its own and completely different names. The fact that the same name is sometimes used by two tribes for completely unrelated species is very confusing. Some tribes have a specific name for nearly every plant as the collections made by FLORSCHÜTZ in 1950—51 showed. When travelling along the Saramacca River he had some Matoearis as boatsmen, from whom he obtained several vernacular names, none of which appeared to be present in the card index at Utrecht. When he looked over the dried specimens before packing them in the cases, he experienced how certain the boatsmen were of their knowledge, for to his surprise they repeated without hesitation for each plant the names, they had given to it in the field. As we had no bush negroes with us, we obtained only incidentally a few of the names that are in use with them.

Indian names we obtained from several persons because the composition of our gang underwent considerable change between the trips. However most of the Caraib names we owe to HENDRIK TEMPICO, our foreman, who unfortunately could assist the botanists but occasionnally, and to his brother EGBERT, who accompanied us during the 3d and 4th trip. The Arawak CLEMENS from Albina gave us much information during the first half of the first trip, but he fell ill and so we lost a very valuable hand for which we could find no suitable substitute.

To illustrate a common development we will describe here how we came to enlist CLEMENS a member of our special crew. For the first trip four Arawaks were enlisted, and when we asked them who had the best knowledge of plants, three of them pointed without hesitation to the fourth and said: "He is much older than we are, he knows most." Why his being older should be a guarantee for a better knowledge of the flora was explained to me by one of the younger men. The children in the villages play all day until they are six years old; then they go to school and only after they have left school at about the age of twelve they start to learn the ancestral knowledge. As they soon are obliged to earn a living for themselves, they have no time to assimilate the whole stock of knowledge of their parents. At the moment most of the younger Arawaks know only the more common trees and those plants that are in one way or another of use to them. CLEMENS on the other hand appeared to know the names of a large number of trees and shrubs and also of some herbs, though like so many others, he confessed that his father knew a much larger number of them. In the Arawak tribe this decline proceeds fairly rapidly, they have lost several old handicrafts and are already losing their own language. In other tribes however the same trend is found.

Value of vernacular names.

The reliability of the vernacular names depends on several things. Once we had selected our assistants on the recommendation of their companions we had to take the reliability of their identifications for granted. We had told them in advance not to give us a name unless they felt certain about it, and not to be ashamed when they did not know a tree. We knew that a native does not like to disappoint his employer and that he is therefore inclined to invent a name if he does not know the right one. After checking the names obtained by us with those in the card index at Utrecht we feel sure that we were but rarely deceived by our assistants.

A second difficulty was the inclination of our assistants to give us at first simple names more or less comparable to the generic names of the taxonomist. Further questioning sometimes revealed that they also knew a differential name, but in many instances this was not so and then it was left to us to discover whether the name applied to one or to more than one species. As we see that the "Flora" gives, especially for the Caraib and Arawak tongues, many compound names, we must assume that a large number of the "specific" names have been lost in the transmission to a younger generation.

Sometimes our men could see a difference between allied species, but they lacked names for them. In a few instances we invented names to help ourselves; for instance with *sopohoedoe*, the Surinam name for two species of *Caryocar*, one with a smooth cortex the other with a rough one, we named after these characters.

However in many instances it was impossible to ascertain in the field whether a name was applied to one or to more than one species, and as time did not allow the collection of material from every tree we could but hope for the best. We tried to collect in each region we visited at least one specimen of every tree that was pointed out to us under one name and several specimens when the name sounded ambiguous.

In our records we have used Surinam names mostly and these are also in general use with the Forest Service. In British Guiana on the contrary the Forest Department mainly uses Arawak names but RICHARDS (14) mentions in his latest book that he experienced there the same difficulties as we did in Suriname. Our identifications show that of the ± 250 Surinam names listed by us 40—45% have been used for one species, and 30—35% for 2 or 3 species which were either closely related or resembled each other in habit or in some prominent character. Examples are: *boskatoen* = *Bombax globosum* and *nervosum.*
marmeldoosje = *Duroia eriopila* and *Amajoua guianensis,* both Rubiaceae with the same habit.
swampgujave = *Aulomyrcia pyrifolia,* a Myrtacea and the Euphorbiacea

Amanoa guyanensis, both low trees often with several trunks and with coriaceous, dark green leaves of a small size.
sopohoedoe = *Caryocar glabrum* and *microcarpum,* but in some cases *Pithecellobium jupunba,* a Mimosacea also containing saponins.

The rest of the names, 20—30%, cover several species sometimes belonging to one genus or family and at other times to taxonomically very different groups.

Examples are: *swietiboontje* = *Inga sp. div.* (This rule should not be reversed; not every *Inga* is called *swietiboontje,* e.g. *Inga alba* is called *prokonie*)
bradiliefie = *Coccoloba sp. div.,* a Polygonaceous genus, but also *Conceveiba guyanensis* and *Aparisthmium cordatum,* two Euphorbiaceae with broad leaves.
pisie = several Lauraceous species, mainly from the genera *Ocotea* and *Nectandra.*

Another point deserves to be mentioned here. When checking the vernacular names obtained by us with our card index we obtained the impression that some of the names used by the present Forest Service are applied nowadays to other species than formerly. Ir I. A. DE HULSTER, the present chief forester, told us that he shared this opinion, but a definite answer to the question can only be given after a larger number of specimens have been collected and after careful field observations by experts. The name *kassavehout* can be given as an example. Two B.B.S. specimens of *Didymopanax morototoni* are provided with this name, but on the labels of older collections the name *kassavehout* or *kasabahoedoe* was used for quite different trees, e.g. more than once for *Alchornea triplinervia* and for *Alchorneopsis trimera.*

When the frequence of our three classes is determined in belt transects for trees that are over 20 cm in diameter, we find similar figures. In the forest situated on a bauxite hill North of Moengo tapoe (between km 0.6 and 1.6) 125 trees were noted and of these 43% appeared to have a name which is applied to one species only, 28% to 2 or 3 species, whereas of 29% the name gave no clue to the identity of the trees or no name was added at all. In the marsh forest between the hills from km 1.9 to 2.9 the results are the names of 132 trees listed, and resp. 49, 30 and 21% in the 3 classes.

Where one species dominates, we find, of course, a shift to the first class. In the forest on the oldest ridges between km 14.2 and 15.2, for example, the number of 141 trees were noted and the percentages in the three classes proved to be 64, 23.5 and 12.5, but here 50% of all the noted trees were *foengoe, Parinari campestris.* Thus for the other half the percentages are 28, 47 and 25.

In a few cases where the vernacular name leaves a choice, it is possible to identify the species with reasonable certainty if between the alternatives differences in the adaptation to edaphic or climatic conditions or to both exist. *Tafelhout* or *tafraboom* is applied to several species of *Cordia,* but

Cordia tetrandra is confined to the coastal region and prefers moderately to very humid habitats whereas the other species grow in the interior and/or prefer a dry soil.

The name *kokriki* is applied to *Ormosia*, but in savannas and savanna woods on at least periodically very dry sand *Ormosia costulata* is common whereas the other species prefer welldrained forest soils.

Sometimes a discrimination is shown in the vernacular names where botanically no difference is found, *matakki* and *hooglandmatakki* prove both to be *Symphonia globulifera*, an euryoecious species, which in future may prove to contain a number of varieties or ecotypes.

At last a small number of vernacular names are at present nomina nuda as either the material collected under such a name could not be identified or as there were no herbarium specimens after all.

The soil.

The survey of the soil was carried out by the geomorphological section. As a mean on every 100 m of the line transect a set of soil samples was taken by means of a soil auger and profile pits. The depth to which the borings were made varied, as time and terrain permitted, from 1 to 8 m, the depth of the profile pits from 0.7—2.5 m.

Where rapid changes occurred the samples were taken closer together; on uniform stretches they were taken further apart. Remarks on the soil are based on the field notes made by Prof. BAKKER and Dr BROUWER and for samples taken in the swamps on a series of granular analyses and on the determinations of their amount of several ions. The analyses that were made especially for this study, were carried out in the Laboratory for Agricultural Pedology at Oosterbeek. Lately Dr H. J. MÜLLER was so kind to determine pH and chloride content of a number of samples (in Prof. BAKKER's new laboratory).

Some general remarks on the soils found in the swamps and on the ridges are given here. They are based on the soil profiles and on analyses. In table III (at the back side of table II in the back flap) the analyses of part of the samples collected by our expedition are brought together with those of illustrative samples taken by EYSVOOGEL c.s. in the Nickerie district. The latter are divided by the authors in five groups and are presented here under the headings used by them.

In table III all figures represent percentages of the oven-dry soil.

In most samples the humus content is estimated by an elementary analysis, but in those with a high humus content the latter was calculated from the ignition loss. The latter values are marked by a*.

Silt and clay are combined in the table under the heading suspensable material. For most samples the upper limit of the particles is the conventional one of 20 μ. Where the figure is marked with a °, the samples were analysed in subfractions and the upper limit of the suspensable material in this case was taken to be 16 μ. In general the fraction of clay particles smaller than 2 μ, comprises about 2/3—3/4 of the total clay + silt fraction.

Phosphoric acid has been determined by extraction with 2% citric acid, as this concentration has generally been used at the Experiment Station in Paramaribo.

The pH was determined electrometrically both in water and in KCl-solution. For comparison, where possible, the pH of the swamp or soil water has been added; this was estimated in the field with a Hellige tile.

The description of a number of profiles is to be found in the additional notes to tables I and II (p. 120), and the relation of the main types to vegetation and topography is shown in fig. II.

From the clays found under the swamps in the coastal region a number of analyses have been made which show that they are with a few exceptions very heavy ones with 88 or more per cent of suspensable material. The humus content of the upper layer is usually 2—5%, of the deeper layers about 1—2%. Fine sand is present in 1—10%, while occasionally a small number of grains coarser than 200 μ are found.

For the Nickerie district Eysvoogel c.s. (28) have distinguished two profile types which throughout show the same grain-size frequency, but differ in pH and in the colour of the horizon found at a depth of 30 to 60 cm.

In type I the top-layer of 15 cm has a pH of 4.8—5.5; downwards the pH decreases slightly; and in the zone between 30 and 60 cm there appear red as well as yellow spots in the blue-grey clay. Below 60 cm the red spots decrease in number and the pH rises again to 5.0—7.2.

In type II the pH is 5.3—6.6 in the top-layer and increases gradually downwards to reach between 60 and 80 cm a value of 6.9—8.3. Here brown-yellow to yellow-brown spots are present, red spots are absent in the profile.

In both types the top-layer is greyish black, rich in humus and in sharp contrast to the grey clay below. The clay soil is usually covered by a layer of pegasse of varying thickness.

The swamp borings made by our expedition do not show these two profile types. As a rule there is no marked jump in the humus content; it generally decreases downwards, but there may be an accumulation at some deeper horizon. All analysed samples contain an appreciable amount of organic matter, whereas Eysvoogel c.s. considered the latter except in the top-layer so low that it was not determined.

Yellow spots may be present in the deeper layers, but red spots were found in one boring only, viz. in the fifth swamp in the Wiawia line. In another boring made in the same swamp they were absent (see addition to record 16, p. 121).

In the southern part of the Great Swaying swamp under the grey swamp clay sandy kaolin with red spots was found. The kaolin surface dips northwards and was soon out of reach of our boring outfit.

The pH shows a wide range of variation. A distinct positive correlation exists with the salinity of the soil; on the other hand the pH is also influenced by the vegetation and for this reason the first correlation is sometimes obscured.

Some plants tend to acidify their surroundings and can lower the pH considerably, even if the soil solution is brackish. In the 7th swamp in the Wiawia transect in one sample a pH of 3.3 was found (sample 1190) but at a distance of 50 m the pH was 5.3. When the distribution of the two profile types given by EYSVOOGEL c.s. is compared with my vegetation map, a correlation between the first type and mixed swamp wood is suggested. However, to obtain a good insight in the origin and the practical significance of the local differences in the clay soils detailed investigations of the soil profile, the vegetation and the habitat conditions will be necessary.

EYSVOOGEL c.s. point out that their first soil type will need a gift of lime before being brought into cultivation to raise the pH. The potash content of both types is the same 0.009—0.023%, but the average S-value, i.e. the sum of the exchangeable basic ions in milliaequivalents per 100 g soil, is in the first type somewhat lower (25) than it is in the second one (27), and in the latter it shows a correlation with the pH.

Our figures show that the potash content is also correlated with the salinity; towards the coast it increases several times.

The levees of the rivers are separated by EYSVOOGEL c.s. as a special type on account of their situation above the level of the swamp soils and of the concomitant difference in their water household. The texture of the levees is but rarely lighter than that of the swamp clays, because most rivers in Suriname transport but very little and only fine sediment and deposit the latter when the tidal wave is at its highest point and the current all over almost reduced to zero. The only rivers which have a higher transport capacity are the Corantine and the Marowijne, which are both rich in islands. The Marowijne, moreover, has sand flats near the mouth along the banks, and its water is blue instead of dark brown as in the other rivers.

According to EYSVOOGEL c.s. on the levees the top-layer is usually grey-brown and at a certain depth often red spots and iron-manganese concretions are found. They are apparently the result of fluctuations in the ground-water level. The pH is intermediate between that of the two types of swamp profiles.

The profiles of the ridges show considerable differences in connection with the age, the elevation and the composition of the ridges.

In the shell ridges the profile shows no other zonation than that of the different layers of shells and shell fragments which downwards may be cemented together into a hard breccia (GEIJSKES 32).

In the western half of the young coastal region, where these pure shell ridges occur, the majority of the ridges is sandy. The elevation is relatively small; the highest one North of Paramaribo rises 1.60 m above the surrounding clay; the lowest one only 0.20 m. The elevation of the ridge complex along our lines near Coronie varies from 0—1 m above mean sea level while the swamp bottom is 0.50—1 m below this level, and the few ridges near Nickerie are still lower. Most of these ridges consist of fine sand with a varying admixture of shell fragments, 4 or more % of silt, usually a fair amount of mica flakes and a few coarse particles (0—3%). The top-layer of 15—20 cm is yellow-brown and contains several percent humus. In the depressions the humus and silt content is higher than on the higher parts. Then follows yellow to grey sand often with red spots and iron concretions in the gley horizon. Below 1—2 m the sand often becomes blue-green.

At least in the Coronie ridges the top-soil is decalcinated by rain water to a depth of 40—80 cm, deepest on the highest parts. One might ask whether the absence of lime could not be partly primary. GEIJSKES reports that the pure sand on top of the highest parts of the Charlesburg ridge North of Paramaribo is very similar in granular composition to the sand of the small dunes found on the wide beach at the mouth of the Matappica canal. The samples of the higher parts of the Coronie ridges are not yet analysed; therefore we can only mention that no differences in the sands were observed in the field and that for this reason it is improbably that wind action has been of any importance for the formation of these low ridges. Wind-blown sand, on the other hand, needs not to be almost free of lime, but is much sooner decalcinated than layers with coarse shell fragments. The analysed samples show that in the lower parts the grain-size frequency is the same throughout the whole profile. The most common grain sizes are those varying from 75—150 μ.

The analyses of the samples of three small ridges near Nickerie reveal a high amount of coarse sand. This may point to a difference in the formation of these ridges with regard to the other and larger ones. In the ridge South of the Clara polder most of the sand grains measure 105—300 μ; the samples of the ridgelet opposite Nieuw Nickerie are coarser, but the subfractions were not determined. The last-named ridge is a deposit of coarse sand (mainly 150—600 μ) and shell fragments (25%) on top of the clay bank found at the abrasion coast in front of the sea dyke of Nickerie. Here a silt fraction is almost absent.

In the eastern part of the coastal region we have encountered a series of much higher ridges. Most of these rise 2 to 4 (or 5) m above the surrounding clay surface. The sand in the top-soil is fine, but it becomes generally coarser in the deeper layers. Especially in the higher parts the sand is very pure, and in the older ridges it forms an almost white A-horizon. Where the sand is less pure, also an ABC profile develops, but here the A-layer is grey-yellow or brownish. In the second ridge already a migration of iron could be observed, but a distinct iron pan was not found before the 8th ridge.

The higher parts of the ridges must have been formed by wind action and this will account for the pureness of their sand.

The soil samples of these ridges are not yet analysed; the composition of a pure ridge sand from an accidental sample taken on the plantation Katwijk along the Commewijne River is the only one that can be given.

Along the border of the ridges and in the depressions between them everywhere a mixture of sand and clay is found. EYSVOOGEL c.s. bring these zones to their soil type V, but they show considerable variation. In one place sand and clay layers alternate; in another sandy clays or clayey sands occur.

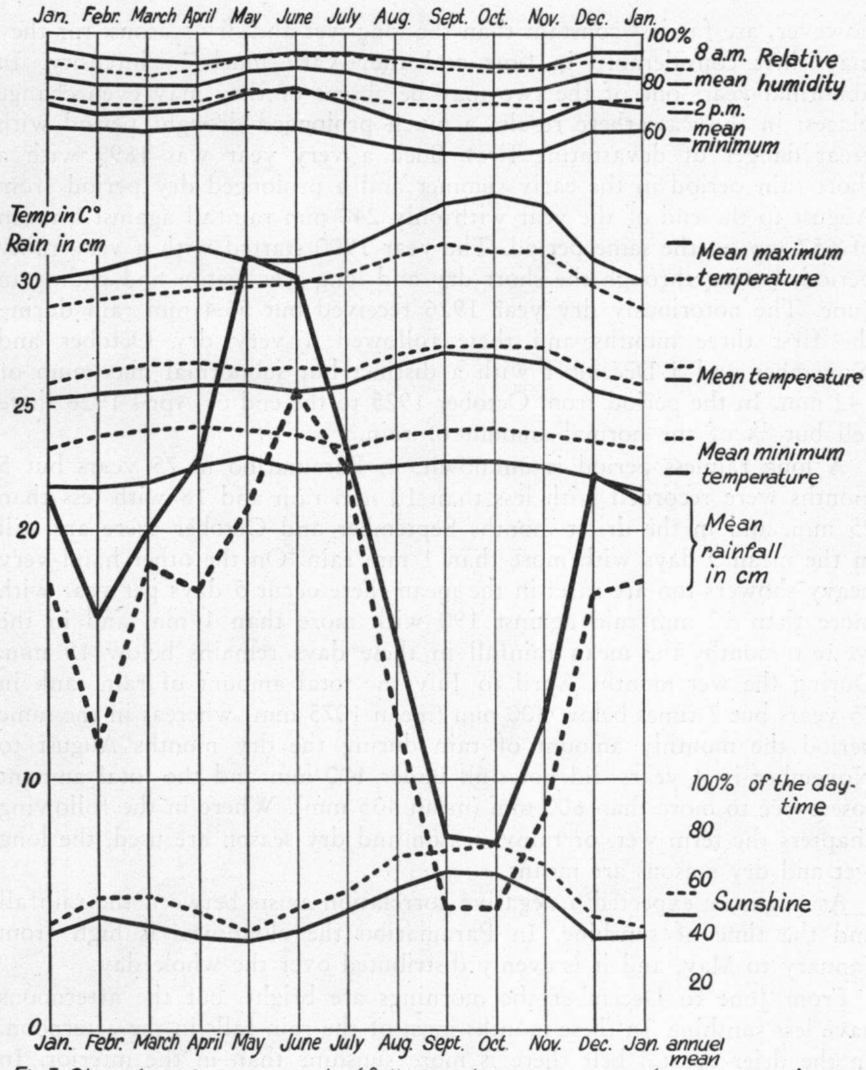
The top-soil usually contains much humus. Some analyses of these soils are given in the table.

The climate.

The data for this paragraph are taken from BRAAK (27) who summarized all available observations up to 1933. Suriname lies very close to the equator, between 2 and 6° N. Long. and has consequently a genuine tropical climate. The temperature is high (annual mean 26.1° C) with an annual variation of nearly 2° (a maximum is reached in the period from September to end October and a minimum in the months January and February). The mean daily range is in Paramaribo 9.2° C; near the coast it is smaller, e.g.: in Coronie 6.4° C, the maxima being lower and the minima higher. Landinwards the minima decrease slightly resulting in an increase in the daily range; the maxima remain the same. The mean monthly variations of temperature, rainfall, sunshine and relative humidity of the air observed in Paramaribo and Coronie are shown in figure I. The wind is fairly strong along the coast but the force diminishes rapidly when proceeding landinwards, and the nights in the interior are very calm. The trade winds blow with great steadiness during the whole year from directions between ENE and E or occasionally from slightly beyond that range. There are only slight indications of a system of land and sea breezes, but in the afternoon the direction of the wind vector shifts northward and may become NE.

The mean wind force in Beaufort scale is 2.9 in Coronie, 1.4 in Paramaribo and 1.1 in Kabelstation, 115 km from the coast. Suriname lies entirely outside the region of the West Indian cyclones and hard winds or storms are rare. Wind force 5 was recorded in only 0.5% of the observations, 6, 7 and 8 resp. 2, 0 and 0.4 times for 10,000 observations.

The rainfall is distinctly seasonal, but only in a narrow belt along the coast the monthly mean sinks in the driest month October below 40 mm. The greater part of Suriname belongs, according to the classification of KÖPPEN, to the region with a tropical rainforest climate (Af) characterized by at least 60 mm rain in the driest month. For most stations the average annual amount of rain lies between 2000 and 2400 mm. In the coastal belt it is around 1800 mm and at least near Coronie the climate approaches the limit of KÖPPEN's savanna climate (Aw), marked by 30 mm rain in the driest month with an annual mean of 1750 mm or 40 mm in the driest month with 1500 mm a year. From Galibi only few data are available,



FigI Climate of Paramaribo (full lines) and Coronie (broken lines)

but these make it very probable that it also has a savanna climate.

The year can be divided into 4 seasons, a long wet season usually beginning in April and lasting to August with a maximum rainfall in May or June. The latter comes the later, the further we proceed from the eastern part of northern South America to the western part. This main wet season is followed by the main dry season from August to December. October is, as said, in the average the driest month, but there is only a slight difference with September. A secondary maximum in the rainfall occurs, as a rule, in December or January, and this is followed by a secondary minimum, usually in February. These short wet and dry seasons, however, are far less constant than the long wet and dry seasons, for they may shift considerably in time and they vary much in intensity. In abnormal years one of the two may be absent or they may even change places; in this case there results a much prolonged drought period with great danger of devastating fires. Such a very year was 1899 with a short rain period in the early summer and a prolonged dry period from August to the end of the year with only 240 mm rainfall against a mean of 657 mm in the same period. The year 1900 started with a very rainy period, lasting through the short dry and long wet season and ending in June. The notoriously dry year 1926 received but 53.4 mm rain during the first three months and these followed a very dry October and November and a December with a distinct but subnormal maximum of 142 mm. In the period from October 1925 to the end of April 1926 there fell but ¼ of the normal amount of rain.

A long rainless period is unknown; in Paramaribo in 75 years but 5 months were recorded with less than 10 mm rain and 18 with less than 25 mm, and in the driest months September and October there are still in the mean 9 days with more than 1 mm rain. On the other hand very heavy showers too are rare; in the mean there occur 5 days per year with more than 50 mm rain against 190 with more than 1 mm and in the wettest months the mean rainfall in these days remains below 15 mm. During the wet months April to July the total amount of rain sank in 75 years but 7 times below 800 mm (mean 1075 mm) whereas in the same period the monthly amount of rain during the dry months August to November in 4 years did not sink under 100 mm and the total amount rose twice to more than 600 mm (mean 435 mm). Where in the following chapters the term wet, or rainy, season and dry season are used, the long wet and dry seasons are meant.

As might be expected a negative correlation exists between the rainfall and the time of sunshine. In Paramaribo the cloudiness is high from January to May, and it is evenly distributed over the whole day.

From June to December the mornings are bright, but the afternoons have less sunshine. In these months most of the rain falls in the afternoon. In the drier coastal belt there is more sunshine than in the interior. In Coronie from July to November it is usually bright all day long, but from December to February the afternoons are markedly sunnier than the mornings. From February to April there are in the coastal belt much less clouds than in the interior.

The relative humidity of the air is generally high and the monthly averages do not vary much. For Paramaribo they range from 76% in October to 86% in June. The humidity is highest in the night and the early morning (monthly averages at 8 a.m. 87—93%) and lowest in the afternoon (monthly averages at 2 p.m. 62—78%). The mean monthly minima range from 51—62%.

In Coronie near the ocean the fluctuation is less; at 8 a.m. the humidity is here slightly lower than in Paramaribo, but the mean monthly minimum at 2 p.m. never sinks below 71%. The monthly mean is somewhat lower from May to July; somewhat higher from August to November, the annual mean is 81% i.e. the same as in Paramaribo.

Before and during our expedition there happened to be several abnormalities in the rainfall. The year 1946 as a whole was rather wet, but the long dry season was followed by a short wet season with little rain and an intense drought in the prolonged short dry season. In February, March and April a total rainfall of only 77 mm was registered, the average being 595 mm. October and November 1947, on the other hand, were wet and in 1948 the short dry season remained in abeyance making this year a very wet one. The long dry season was normal, but the following short rainy season was abnormally long and wet. The postponement of the short dry season in 1949 was a lucky circumstance for my work as I had for this reason very good weather during my trip to Nickerie. This year the heavy rains came through at the end of May just after my departure.

CHAPTER II

AERIAL PHOTOGRAPHS

General remarks.

Field research in Suriname meets with the for a tropical region still rare but very fortunate circumstance that the whole northern half of the country has been photographed from the air in verticals on a scale of 1 : 40,000 and part of the coastal region also on scale 1 : 20,000. Thanks to the kind cooperation of the C.B.L. Centraal Bureau Luchtkaartering, or C.B.A.S. Central Bureau for Aerial Surveys in Paramaribo we could make use of the photographs 1 : 40,000 both during our field trips and later during the evaluation of the collected data. Moreover since our return to Holland there came available photos 1 : 20,000 of the visited areas in the coastal region and controlled mosaics in the form of photomaps on the scales 1 : 40,000 and 1 : 100,000 provided with a numbered network of squares of 2 × 2 km.

Suriname is a very thinly populated country. Except three cultivated areas in the coastal region, viz. around Paramaribo, Coronie and Nickerie, it is covered almost completely by a luxurious more or less natural plant growth. Bare areas are extremely rare; they are confined to some brackish lagoons near the coast, a small number of bodies of open water inland, and some steep rock surfaces in the interior.

Therefore the aerial photographs provide in first instance data on the vegetation and the topography.

Open water, rivers, the larger creeks and lakes are clearly discernable, and so are settlements with their sharp, angular contours, in which at the scale 1 : 40,000 dwellings too are visible.

The vegetation on the photos can be divided into 3 main types:

a. Herbaceous growth appearing as almost even areas which can have any colour shade from white to dark gray. Usually a mosaic of several shades can be discerned pointing to local differences in the vegetation.

b. Forest complexes which have a distinct speckled texture and show in stereoscopic view an uneven surface owing to differences in the tree height. The individual crowns of the larger trees in the upper story can be recognized and in the high forest their diameter is large enough to be measured. The absolute height of the trees can only be identified, where a clearing has been made, e.g. a field of the indigenes *(grondje)*; in that case it is possible to measure the height of the surrounding trees with a stereometer. By natural causes, like the fall of a tall tree, only rarely an opening is formed large enough to make the forest bottom visible, and this does not last long for the gap is always rapidly filled with secondary growth.

c. Those landscapes in which groups of shrubs and trees are scattered in a plain covered with herbs. Stereoscopically these bushes and tree groups emerge beautifully from their surroundings, in a natural landscape very often in the form of domes. In this case it is always possible to measure how far these groups rise above their surroundings, but the photos do not show whether the soil beneath them is plane or vaulted. The pictures reveal relief of the soil only if the differences in elevation are at least of the same order as the height of the vegetation cover.

This is what can be concluded from aerial photographs without any knowledge of the terrain itself. This is put here so plainly as any other interpretation without reconnaissance in the field is necessarily bound on generalisations and analogies with well known areas. Sometimes such comparisons lie close at hand, but they should always be handled with care, as we have repeatedly experienced in the field.

For instance it is impossible to tell from the photograph whether a herbaceous vegetation grows in water or on dry ground.

Difficulties with herbaceous vegetation; illumination effects.

In general treatises on photo interpretation it usually is said that in wetter places the plant cover shows generally darker. This may hold for low grass fields as they occur in temperate regions and cultivated areas, but in Suriname this is certainly not so.

GEIJSKES (30) points to the fact that certain stretches of swamp vegetation near Lelydorp look in the photos very light and that these are just those that are found in the deepest part of the swamp. This is one instance, but nearly all possible combinations occur. Therefore it was an open question whether we would meet in our transect from Moengo tapoe North of the Wane creek a vast swamp or a savanna. The last-named guess appeared to be the correct one, but it must be remarked that during the long rainy season this savanna is probably inundated for a considerable time. Furtheron in this line near km 15 strips of forest separated by zones of low vegetation marked the presence of ridges. Such ridges occur everywhere in the coastal region and are, as a rule, covered with forest and separated by swamps with mainly herbaceous vegetation.

In the area far inland, however, the situation appeared to be totally different. The lower zones between the ridges were here covered with dense marsh forest. The low growth which had suggested the presence of swamps was in fact savanna growing on the highest parts of the ridges, whereas on the slopes grew high forest which merged into the marsh forest in the depressions.

In the third type of landscape we meet, independently from the herbaceous vegetation, with the same difficulties for the tree groups.

In the clay savanna North of the Wane creek the forest domes appeared to occur in places where the soil was sandier and had a much better structure than in the savanna but where the surface showed almost no relief. On the other hand we experienced with mixed feelings that the belt between km 17 and 20 was an extensive up to 4 m deep swamp which was for the larger part covered by a floating peat layer overgrown with herbs. The scattered forest islands in it were real sand islands covered by high forest, the dome form being due to ecological differences and not to the elevation of the soil, the centre being only about 1 m above the swamp level. At last, in swamps near Nickerie I have come across dome-shaped *Erythrina* groves which grew in considerably deeper water than the surrounding swamp herbs.

All these facts stress once more the necessity of field reconnaissances for a reliable interpretation of the photos. The aerial photographs provide a very efficient help when we wish to choose suitable areas for field work, for one can see at once where the largest variation in vegetation types is found and where the latter are most clearly contrasted. After such an area has been surveyed the interpretation of the investigated strips may be extended by the aid of the photos to the adjoining area at least as far as the vegetation belts show no interruption. In case of discontinuity, however, one should be cautious, as unknown factors may begin to play a part.

The illumination is an important factor in the interpretation of the photos. Its effect is most pronounced on the smooth plane formed by deep open water, which acts like a mirror. In general, calm open water shows black on the photo, but when the reflected sunlight enters the camera lens the water will show dead white. A section of a river can display both aspects in two successive photographs of a run as a result of a difference in the observation angle. The image of open water however is so distinct that the phenomenon never causes difficulties, but it may do so in photos of the vegetation.

Plant leaves disperse the light by reflection and absorb a larger or smaller amount depending on the nature of their surface. This results in a shade of gray in the photo. Usually the position of the leaves varies so strongly that the reflected light has an almost constant intensity through wide ranges in the angle of view. On the contrary the differences in the amount of light reflected in various directions becomes very appreciable when the leaves show a definite orientation. In this case the same vegetation type may produce different colour tones in various parts of a photo or the same plot may have a different appearance on two photos of a stereo pair.

GEIJSKES (30) reports that in the photographs of swamps near Lelydorp those areas with a cover of *Eleocharis* and *Rhynchospora* are very light coloured whereas those with grass, *Jussieua* and *mokomoko* show a darker gray. Dr SIMONS said in a discussion that this is a question of shadow, the larger the number of leaves on the plants the more shadow and therefore the darker the tone in the photo. In my opinion the amount of shadow is of secondary importance, the reflection by the leaves being the primary factor. GEIJSKES remarks that in the field the light impression was reversed to that in the photos, but the observation angle is in the two cases also quite different.

Eleocharis and *Rhynchospora* have smooth, shining, nearly vertical culms and leaves, which reflect most of the incident light in definite directions, but the grasses and *Jussieua,* with leaves pointing in all directions disperse the light, i.e. they reflect only a small part of the incident light in a definite direction. For this reason the impression of the observer changes with his point of view in the field as well as from the air. *Mokomoko* has shining leaves which arise under a rather constant angle from the stem and this causes preferent directions for the reflected light. This phenomenon can easily be observed along river banks, where pure belts of *mokomoko* are very common. Sailing on a sunny day along the winding stream now and then patches of *mokomoko* flash in our eyes when we cross the line of maximum reflection.

In swamps many species are provided with nearly vertical leaves which may cause variation in colour tone and added to this there is the common local dominance of various species. These factors make many swamps look like a mosaic of gray tones, which can be interpreted only with great difficulty and many uncertainties.

In photos from swamp areas near Nickerie I have observed similar tone differences in *koffiemama* groves *(Erythrina)* that had been identified as such in the field. Other swamp woods, however, did not show the phenomenon. As also slight differences in texture in the photo image of the groves were found, identification of *Erythrina* stands and mixed swamp woods was possible over a considerable area.

On savannas nearly bare sand patches form a very good reflector in every direction producing almost white spots in the pictures. Herbs absorb much of the light and give a gray tone. After writing this chapter I laid hands upon the book of SPURR (19) on the use of aerial photography in forestry. He treats this matter in a similar way and comes to the same conclusions.

Interpretation results.

We shall conclude here with the results of the comparisons of the photographs and field data.

Starting from a well-marked point separate bushes and tree groups are readily recognized on the photo by their position and form. Conspicuous trees can also be traced, and in forests emergent trees may be identified by exact measurements of their location.

In herbaceous vegetation on the photo discernable limits must usually be located in the field by measurements or correlation to distinct marks, as several small changes observed in the field do not appear on the photographs, whereas often limits in the picture are not easily observable on the ground where we can view but a small area at a time.

Many features are much more distinct on the scale 1 : 20,000 than on the scale 1 : 40,000. *Maurisie* palms *(Mauritia flexuosa)* in savannas and along swamps can be discerned in photos on the last scale but the individuals are distinct only in photos on the first scale.

The two groups of *Acrostichum* ferns about 4 m in diameter close to our Wiawia tract in the 3d swamp were on 1 : 40,000 at the border of visibility, but on 1 : 20,000 they could easily be identified, and some other groups could be detected further away from the line. Only in the photos on the larger scale the understory of *pina* palms *(Euterpe oleracea)* found in the swamp forest on the old plantation Berendslust (Suriname River) could be recognized; the palms were visible in the gaps in the upper story by the light colour produced by their shining leaves.

Mangrove and swamps.

The mangrove belts along the coast and the estuaries of the rivers can not be misinterpreted. Open strand mangrove can be recognized by its light colour; it is usually bordered by a white strip which marks the bare beach. In the lagoons in and behind the mangrove belt a diffuse cloudiness points to the presence of submerged aquatic plants, viz. *Ruppia maritima.* Shallow lagoons show a gray tone and not the black one of deep water.

Floating aquatics reflect a large amount of light in upward direction and they appear therefore as white margins along bodies of open water. In the lagoons the floating plants are mainly waterlilies and *Limnobium stoloniferum;* and their presence indicates that the water is oligohalinous; *Ruppia,* on the other hand, tells us nothing with regard to the salinity. The coastal swamps have simple outlines but the vegetation shows much diversity and the differences can not be interpreted without field work. Only some general remarks can be made. Swamps of my 1st and 2nd type occur behind the mangrove belt and may contain scattered groups of *Avicennia* or *Laguncularia.* In all swamps investigated by us only one type of scrub was met, the *brantimakka* scrub *(Machaerium lunatum),* which can be recognized by its very uniform fine-grained texture and its dull gray tone, and viewed stereoscopically by its flat canopy with only rare trees rising above it. The swamp woods can be separated in *Erythrina* stands *(koffiemama)* and woods of other species, usually mixed. HEINSDIJK (44) reports that it is usually possible to recognize stands of *Triplaris, mierenhout,* and of *Pterocarpus, waterbébé,* where they are nearly pure but I have not enough experience to confirm this. At least in photos on the scale 1 : 40,000 this will be difficult.

Brantimakka is an indicator for a more or less saline habitat. It is frequently associated with groves of *koffiemama,* but the latter species avoids polyhalinous water. The surrounding herbaceous vegetation may belong to my 2nd or 3d type (see chapter V).

Other swamp woods can stand only oligohalinous water but like *koffiemama* they occur also in fresh water. The swamps as a whole belong to my 4th and 5th type.

Maurisie palms are found only at the margin of completely fresh swamps of the 4th to 6th type and look like light balls floating distinctly above the undergrowth. The 6th swamp type can probably be discerned from the other types by its more irregular outlines and by the presence of islands with high forest. The existence of this type on the other hand makes it more difficult to separate the swamps from the savannas, for in the latter too very often *maurisie* palms are found. However in the savanna, groups of shrubs are usually present.

Savannas.

White sand savannas are easily recognized when the sand is locally seen through the open vegetation giving it a white-dotted appearance. This and the centrifugal drainage pattern, these savannas being low watersheds, produce a very characteristic effect. Along the shallow gullies wood gradually decreasing to dense scrub penetrates the savanna and in these strips of wood the *maurisie* palms are concentrated. Sand savannas entirely covered with scrub are not so easily recognizable, but they show similar features.

Clay savannas have a more gray tone by the presence of a grass cover. They are sometimes of the orchard type with many stunted small *Curatella* trees by the presence of which they can be recognized. Difficulties are met in the older parts of the coastal region where marshes, swamps, savannas and all possible transitions are represented in a usually very intricate mosaic. Real swamps in inundated depressions can be recognized by their irregular but distinct boundaries. The surrounding forest ends abruptly on the border of the swamp, parts of which may penetrate along former drainage channels into the forest in the shape of gray fingers.

For the rest field observations will be necessary to allow a somewhat detailed interpretation of a landscape like the area crossed by our expedition North of the Wane creek.

Forests.

The main forest types can be recognized by a part of the physiognomical characters used in field work, the structure of the upper stratum, the form of the crowns in the canopy layer, the variation in height of the visible trees. Marsh forest has an irregularly broken canopy layer with considerable variation in crown diameter and tree height. In gaps palms can often be recognized by their light colour. In the rain forest the crowns of the largest trees rise like domes over the canopy layer.

Savanna forest shows a rather regular canopy of small crowns with a few emergent trees. The trees are sometimes distinctly lower than in the surrounding rain forest.

For further information the reader may be referred to HEINSDIJK's pages in ZONNEVELD a.o. (44). He states that forests dominated by the following species can be recognized.

Hura crepitans, possentrie, on swampy spots on and along ridges.

Mora excelsa, mora, on river banks in the Western part of Suriname.

"*Foengoe (Licania sp.)* in the neighbourhood of swampy areas", must be the *Foengoe-facies (Parinari campestris)* of the ridge forests.

Eperua falcata, wallaba, on sand.

Mora gonggrypii, moraboekia, in hilly country in western Suriname.

Goupia glabra, kopie, only in small areas.

Dimorphandra conjugata, dakama, savanna forest, misleadingly cited under the heading swamp forest.

Where palms dominate in the canopy layer in the photos on scale 1 : 20,000, the species can in many cases be identified, namely *maurisie (Mauritia flexuosa), maripa (Maximiliana maripa), pina (Euterpe oleracea), kiskismakka (Bactris spp.).*

In Venezuela inventarisation was made of the oil palms (105), as the latter may be of economic value. This was carried out, by means of aerial photographs on the scale 1 : 9,000. After sufficient data had been obtained by detailed field work it proved possible to identify on the photos many species at least where they were dominant and to estimate the seed production of the stands.

In mixed forest it is very difficult to identify any species. The investigations of PAYMANS (12) may be mentioned here as an illustration. He examined several forest types in Celebes (Indonesia) on plots of 9 hectare and found that only individuals of 2 species in the upper story could be identified with certainty and one other with a fair probability, although the available aerial photographs were on a much larger scale than those of Suriname, viz. 1 : 10,000.

SPECIAL PART

CHAPTER III

DESCRIPTION OF THE LANDSCAPE IN THE INVESTIGATED AREAS

I. Transect from Moengo tapoe to the 'Wiawia bank' or Wiawia flat.

With the following description should be compared map I and fig. II which will be found in the back flap, and the photos 4—22. Figure II gives a diagrammatical sketch of some illustrative sections of the transect to show the reader in one look the relation between soil, relative elevation and aspect of the vegetation. This sketch is as realistic as the factual data allowed. To emphasize the differences, it was necessary to use different scales. To produce visible elevation differences in such a flat country, the vertical scale had to be much larger than the horizontal one (10 times enlargement was chosen). In the vegetation however strata of ½ m high had to be pictured as well as strata between 20 and 35 m and to cover this range I have made a gliding scale, the first meter being exagerated 4 times and the following ones represented by gradually decreasing lengths until at a height of 40 m no further increase is added and this maximum is twice the horizontal length. This was allowable as 40 m is the maximum height which is reached by a small number of tree individuals only.

This line was cut and investigated in two parts; first the section which extended from Moengo tapoe, a bush-negro settlement along the Weyne-road half way between Moengo and Albina, northwards up to the "Grote Zwiebelzwamp", what may be translated by "Great Swaying swamp", a distance of about 20 km. The name "Grote Zwiebelzwamp" was spontaneously created by someone and readily accepted by the whole staff for its plastic alliteration. The latter points to the floating peat layer that covered most of this 3,5 km wide swamp and swayed and heaved under one's feet when he tried to walk on it.

The second section started in a fishermen camp situated on a narrow sand bar behind the vast Wiawia mud flat and extended for ± 14 km in a south-southwestern direction, ending at the northern side of the Great Swaying swamp.

The first 5 km from Moengo tapoe to the Wane creek belong to the region of the bauxite hills, which near Moengo are in exploitation. These hills do not belong to the coastal region proper. They are covered with beautiful forest, which is cut down in several spots by the bush negroes in order to obtain room for their shifting agriculture. The valleys between the hills have a marshy forest which is rich in palms.

All the rest of the transect lies on marine alluvia, which were deposited in several phases. Their development is an object of study of the geomorphologists.

For the sake of clearness we will begin the description of the regions visited by us at the sea side and proceed from there landinward, and not in the sequence in which the investigations actually were carried out.

The saline coastal belt.

The "Wiawia bank" is a vast, soft mud flat, at low tide about a kilometer wide, but so low-lying that at each high tide it is completely submerged for several hours.

It is a dorado for birds, several species of herons and numerous waders; part of them are migratory. The most spectacular bird is the flaming red ibis which lives there in flocks.

After a nice sailing trip from Galibi (Marowijne River) in small Indian sailing boats, called "piakka's" we landed on the coast at a point where this was formed by a narrow and low offshore bar of white sand on which the fishermen camp was situated. This bar is formed of sand derived from a series of former offshore bars, the youngest ridges, which East of the camp strike the present coast line under a narrow angle and have partly been broken down by the sea. Westward the sand bar which at high tide is regularly overflown forms a bare beach some 12 m wide with occasional groups of *Avicennia* shrubs. With a marked jump it passes into a part covered by vegetation. Near the camp a barrier crest is found which is about two feet high and which is slightly being eroded by the sea at spring tides. The top is protected by a vegetation mat mainly consisting of the grass *Stenotaphrum secundatum.* Furthermore the vegetation consists of *Ipomoea pes-caprae* and *Canavalia maritima,* species found on all tropical beaches.

Around the camp only a few shrublets are seen, furtheron an open scrub is met formed of *Avicennia nitida* or *parwa,* and *Laguncularia racemosa* or *akira,* and a few other shrubs.

Behind the offshore bar lies a very shallow lagoon into which it gradually slopes. Along the border a sharply delimited band of the grass *Sporobolus virginicus* is found and only a few cm lower patches of *Sesuvium portulacastrum* and *Iresine vermicularis,* two succulent halophytes, are seen.

The depth of the lagoon amounted in November, i.e. at the end of the dry season, to 5—15 cm. We observed the way in which it was fed during spring tide with sea water coming in over the lower parts of the sand bar and through the mangrove forest beyond it. In the intervening periods strong evaporation is taking place, and the salt concentration rises to twice the value found in the sea, but this value is not yet harmful to the halophytes.

Behind the camp many tree stumps indicated that not long ago the lagoon was covered with *parwa,* which had been cut down by the fishermen as fuel in order to "barbacot", i.e. smoke over a low wood fire, the fish they had caught. Now the stiff clay soil was bare save here and there a small clump of *Sesuvium* or of *Iresine.* To the West these two halophytes formed large patches alternating on somewhat higher spots with *Sporobolus virginicus.* Here many healthy *parwa* shrubs threw a light shadow, but near the end of the sand bar where the open scrub passed into a closed *Avicennia* wood the herbs disappeared almost completely. In the *parwa* forest we saw great numbers of crabs and in the open swamp too they were still frequent. The southern border of this first swamp is a tiny ridge of only a few meters wide and scarcely emerging from the water; nevertheless it was very conspicuous in the landscape as it bore a row of tall *Avicennias* with an undergrowth consisting of shrubs of *Hibiscus tiliaceus, maho.*

The second swamp is as salt as the first one; it begins with the remnants of a *parwa* forest which has been cut out and burnt and was replaced by patches of the same herbs as in the first swamp with the addition of *Eleocharis mutata.* The water here is up to knee deep but towards the South the clay soil rises slowly and there the typical bluish-green, triquetrous culms of *Eleocharis mutata* gain complete dominance. A wide zone of the swamp where a little time before a fire had swept over it was entirely covered with the slant young culms of this species. This and the following zone are visible on the aerial photographs which reveal their momentary extent, but give no clue that can be used for a general interpretation as the aspect is not always the same; the photos 1 : 40,000 show other colour tones for the zones than the photos 1 : 20,000.

This zone was sharply delimited against a 20 m wide, fresh-green grass belt consisting of *Sporobolus* mixed with a few poor specimens of *Cyperus articulatus* and *Acnida cuspidata* and looking like a lawn girdling the foot of the wood on the second ridge and giving it a park-like aspect. The slope of the ridge bears salt-tolerant shrubs, especially *Rosenbergiodendron formosum* with its large and fragrant white flowers and *Hibiscus tiliaceus* and was hung densely with twiners which crept also out into the grass.

The top of the ridge about 2 m above the surrounding swamp level is covered by an open wood which is poor in species. At the South side sand has been washed down from the ridge over the clay which forms the swamp bottom. The foot of the ridge bears a 3 m high scrub belt of *Dalbergia ecastophyllum* and the zone which has a superficial sand layer shows a remarkable form of *Brachypteris ovata,* which normally is a woody twiner but appeared here in the form of a 1.5—2 m high shrub, probably about 3 years old and sprouting from bases that had survived after a swamp fire had swept the area.

Typha-Cyperus articulatus swamp and *Machaerium lunatum* scrub.

When we have passed this scrub we enter the first of a number of mesohalinous swamps. The 3d swamp in our series showed at the time of our visit hardly any surface water. It was overgrown with a dense mass of *Typha angustifolia* and *Cyperus articulatus* which dominated patchwise. These plants were accompanied by grasses and twiners. Here and there a group of the enormous fern *Acrostichum aureum* was seen, and against the border of the second ridge some strange-looking woods caught the eye. They appeared to consist of a nucleus of *Avicennia* trees and a horseshoe-shaped zone formed by *brantimakka, Machaerium lunatum,* one of the most dreadful plants to meet with. The very patent branches are criss-cross entangled and the whole shrub is armed from the very base up to the nerves of the leaves with strong, recurved prickles ready to transfix every object that might touch it. Through a small tunnel cut in the *brantimakka* wall we were able to penetrate on hand and foot in one such grove. In the centre the soil was covered with numerous pneumatophores of the *Avicennia* trees which emerged from a 15 cm thick but very loose layer of roots and peat, resting on the wet clay. The ground water here was distinctly more saline than in the open swamp, 15,400 mg Cl/l against 8800.

In the 4th swamp a 4 m high belt of *Machaerium* scrub had to be tunnelled. The passage was extra disagreeable as this scrub was so old that under it a knee-deep layer of vegetable mud had been accumulated. This mud had the consistency, colour and odour of fresh cow dung and appeared to be a characteristic product of the *brantimakka* scrub. The roots and cut-off branches in it gave the foot but a rather tricky hold, and no one reached the other side unscratched. South of this belt the soil was higher and drier. It proved to be inhabited by *Montrichardia, Jussieua leptocarpa, Echinochloa polystachya* and a few accompanying species. The southernmost 50 m was formerly covered with *Machaerium,* but here the *brantimakka* scrub had recently been burnt down. Between the coaled remnants a pioneer vegetation consisting of *Jussieua leptocarpa, Cissus parkeri* and *Mikania micrantha* had established itself.

Third to sixth ridge with *Cereus* wood.

The vegetation on the 3d and following ridges becomes gradually richer in species, although some coastal species disappear. The most remarkable species is a *Cereus,* a columniform cactus whose stems reach here a height of 10 m and a diameter of 20 cm and are woody at the base. As far as the 6th ridge it was frequent, but beyond the latter it was missing. The tree individuals grow taller the farther they are away from the coast;

on the 3d and 5th ridge they form an open wood 8—10 m high as they do on the second one, but on the 200 m wide 4th ridge they form a forest which contains *lokus* trees *(Hymenaea courbaril)* 18—20 m high. The 5th ridge is too small to bear a forest although it shows some well-developed trees. The small 3d and 5th ridge are fringed by a 4—5 m wide strip which forms a transition between the swamp vegetation and the subgrowth of the forest on the centre of the ridge. Notable species are *Panicum mertensii,* a tall grass, *Solanum stramonifolium,* and *Heliconia psittacorum;* the last named species growing in groups.

The 4th ridge is like the 6th and following ones provided with a fringe a few meters wide consisting exclusively of about 3 m high *mokomoko, Montrichardia arborescens,* a very conspicuous Aracea with heavy erect stems. This species occurs also in nearly every type of swamp except in the salt ones but in the swamp its dimensions are smaller and here it grows either widely scattered or here and there somewhat more close together.

Leersia hexandra swamps and *Erythrina glauca* groves.

The 5th to 8th swamps belong to one type in which the curious grass *Leersia hexandra* dominates. Its lower internodes are slightly inflated and by the aid of the latter the lush-green carpet formed by the upper ones floats on the water. At the time of our visit, i.e. in November, but little water was left, and the chlorotic lower parts of the culms had sunk down and were lying all in the same direction under the carpet. They had a length of about 60 cm which means that in the rainy season the green mat can be lifted to a height of two feet. On my last trip I have actually observed this in a swamp near Nickerie, where the water had a depth of 1 m. BEARD (48) mentions for Trinidad the presence of floating mats formed by an unidentified *Leersia* in pools where the water rises periodically to a height of 2 m. He does not say whether the grass was rooted in the mud at the bottom, but judging from what I have seen in Suriname, I suppose that it will have been.

But few other plants are growing between the grass. In the 5th swamp which is still brackish (4100 mg Cl/l) some small clumps of *papaja gras, Cyperus giganteus* (or *comosus*) appear and these tall Cyperaceae become more and more prominent in the following swamps. As a rarity we met here a large patch of the cosmopolitan *Phragmites communis.* This euryoecious species is rare in Suriname and restricted to brackish habitats. This probably means that the competition in the fresh-water swamps is too severe for it.

In all swamps of this type we found groups of *brantimakka,* and in the 5th and 6th ones also burnt remnants of this scrub whereas the 6th to 8th are characterised by the presence of groups of *Erythrina glauca* or *koffiemama,* which is widely used in coffee plantations as a shade tree. In the grass swamp the dome-shaped groups of these trees present a beautiful sight, especially when they are covered with the bright orange flowers and fringed by dark green *mokomoko*. The water of the 6th and 7th swamp contained 1000—2000 mg Cl/l and that of the 8th was only slightly oligohalinous with 100—200 mg Cl/l. The last-named swamp already showed large patches of *Cyperus giganteus*, especially in its southern part, and it forms therefore a transition to the fresh-water swamps found between km 5.5 and 9.5.

Second series of ridges and *Cyperus giganteus* swamps.

The 8th swamp is separated from its neighbours by the extensive forests of the 7th and 8th ridge. These ridges are not like the first 6 single sandbars but they consist of several sandbars formed in so close succession that only slight depressions are left between them. These depressions bear a marsh forest. They are visible on the aerial photographs as distinct streaks running through the forest.

In the 8th ridge two of the depressions are wider and deeper than the other ones, and form narrow strips of swamp. The one at km 5.2 contains the same species as the 8th swamp and in addition shrubs of *Chrysobalanus icaco;* the other one at km 5.7 has a dense vegetation of *Cyperus giganteus* just like the large swamps between km 6.5 and 9.5 which interchange again with single sand bars. In most parts of these swamps *Cyperus giganteus* grows in a more or less closed stand. Near the border of the swamps it is densest, nearly pure and up tot 4 m high; in the centre where the water is deeper the individuals are about 2 m high, further apart, mixed with some *mokomoko* and with an undergrowth of the fern *Dryopteris gongylodes*, which is sometimes accompanied by *Blechnum indicum*. A few twiners wind through the tall herbage.

Starting with the 7th ridge the margins and the depressions remain all the year round more or less soaked and are occupied by marsh forest with *Triplaris surinamensis (mierenhout)*, *Virola surinamensis (baboen)*, *Euterpe oleracea (pina)*, *Cecropia peltata (bospapaja)*, *Genipa americana*, *Simaba multiflora*, *Caryocar microcarpum* and *Aulomyrcia pyrifolia* as important trees and a palm, *Bactris sp.*, in the understory. Typical for the lower parts is *Bonafousia tetrastachya*. Near km 6.5 the first *maurisie* palms, *Mauritia flexuosa* appear, which further to the South become dominant along the margin of the swamp, but penetrate as single specimens in the swamp proper. These palms with their large palmate leaves are a very characteristic feature. In many instances they grow up to magnificent trees which are even recognizable on the aerial photographs. They are generally accompanied by numerous individuals of the shrub *Chrysobalanus icaco*.

On the aerial photographs of this region in some swamps of this type a very curious feature was noted. In the uniform gray of the herbaceous growth clumps of woody plants formed a kind of check pattern. In our transect we met such a spot between km 9.2 and 9.5, and we found that the pattern was formed by rows of low dams and islets, which rose 30—50 cm above the present swamp level and were covered with shrubs and small trees. The latter belonged to the same species as were found in the marsh forest. About the origin of these nicely arranged elevations we are still completely in the dark.

In the marsh-forest belt in several places gullies are present and the formation of these gullies may be of a similar nature as that of the check pattern.

The old ridges beyond km 9.5.

At km 9.5 we reach a new extensive ridge-complex which shows greater differences in relief than the earlier ones. Landinwards we see from the data provided by the levelling of our transect a general though very slow rise of the surface but there is also an increase in the relative height of the ridges above the surrounding swamps (see fig. II).

The bottom of the first four swamps lies circa 40—50 cm above the mean sea level, that of the following four circa 70—80 cm. The youngest ridges reach elevations of 2 m, the 4th and 6th of 3 m, and the 7th and 8th ridge-complex rise locally to 4 or 5 m. The *Cyperus giganteus* swamps all have a bottom level of circa 1.70 m. The small ridges between them and the first half km of the ridge-complex South of these swamps rise to 4.20 m and in one place only to 4.70 m, but beyond km 10 the ridge-complex rises markedly and forms plateaus between 7 and 8 m high the maximum of 8.85 m being reached near km 12.7. West of km 11 a tip of a swamp penetrates into the ridge-complex and comes to within 100 m off our transect. It is covered with a nearly pure stand of *Rhynchospora vs. gigantea*, a large Cyperacea with sharply toothed leaves, but this swamp was not more closely investigated.

Smaller depressions in the ridge-complex are filled with marsh forest. The dry parts bear up to a height of 6 m a forest which comes in its composition very close to the lowland forests outside the coastal region, but shows in the canopy a marked dominance of *foengoe, Parinari campestris.* The plateaus that rise above 6 m are occupied by a new vegetation type, savanna forest or savanna wood which consists of a small number of tall trees and a large number of slender, medium-sized ones and shows but little undergrowth. As soon as a ridge is formed, leaching of the sand by rainwater sets in and for this reason we note an increasing podsolisation of the soil, when we cross the ridges from North to South. In the higher parts of the old ridges this process has been at work for a long time and much more intensely than in the lower parts. If clay in the profile is almost completely lacking an A-horizon of purely white sand occurs, which on account of its situation far above the ground water level desiccates very strongly in the dry season. On these white sands the savanna forest has developed. It is in its composition very different from the common ridge forest (see chapter IX).

The swaying swamps.

At km 13 we enter a swamp belonging to the last and most remarkable type that occurs in this region. This is the already mentioned "zwiebelzwamp". At the end of November the water level stood here at 3.70 m above sea level, i.e. considerably above the level of the *Cyperus giganteus* swamps. As is clearly shown by the aerial photographs these swamps form a coherent system. The ridge crossed between km 13.4 and 13.7 is interrupted at several places and the 2 islands some 700 m South of this ridge are apparently relicts of another one. It is not yet certain whether this holds true also for the islands in the southern part of this swamp.

According to BAKKER (26) this area must have obtained its present aspect after an invasion of the sea through the forelying ridge-complex. This would have happened at a time when the coast line lay somewhere near km 10. The invading sea must have destroyed parts of the existing ridges and strong tidal currents must have eroded the swamp bottom and worn out deep channels in it. This would explain that these swamps nowadays reach a depth of several meters; in one place even a gully was measured 5.50 m deep.

Where these swamps are more than 1 m deep we find a peat layer floating on the surface, and we note that the latter becomes stronger and thicker when the depth of the swamp increases. In the swamp between km 13 and 13.4 and in the northern half of the great swaying swamp the peat layer is strong, 1.5—2 m thick and well passable. The dominant plant here is *Lagenocarpus guianensis*, a 1.5—2 m tall Cyperacea with sharp-edged leaves, accompanied by *mokomoko*, *Eleocharis interstincta* and *Rhynchospora triflora*, a meagre and inconspicuous species, not previously reported from Guiana. A few *maurisie* palms are scattered over the swamp, and 50 m South of the last ridge a strip is covered with small shrubs of *Chrysobalanus icaco*. Especially between km 13.2 and 13.3 but elsewhere also small bodies of open water are found with submersed *Mayaca longipes* and *Nymphaea odorata* floating in it. This little waterlily known from the southern U.S. and Cuba flowers with spotless white flowers which are open only in the morning hours and contrast beautifully with the dark brown water and the bright green leaves. Along the margins of these pools we find *Drosera capillaris* and sometimes *Lycopodium meridionale*. Our visits were too short to find out in which way these pools were formed. In some places they are found rather close together and this points to the possibility that the peat layer may at one time have been torn to pieces, and that these pieces later on may once more have grown together in a similar way as ice-floes, leaving gaps between them. In these pools the bottom of the swamp could be fathomed, but this was not possible everywhere. To our surprise the pools between km 13.2 and 13.3 were only knee-deep, with a continuous peat layer at the bottom. This peat layer was still so strong here that the pools could be crossed without difficulty. For the origin of these pools another explanation will have to be found.

It struck me that a correlation might exist between the gaps and the scattered *maurisie* palms. When such trees are uprooted by one of the rare storms, their rootsystem might take with it a disk of peat which in that case would dry out and decay in the air. We may expect that in due time the trees will disappear without leaving a trace, but we found as yet no actual facts to support this hypothesis.

The walls of the pools are always vertical. Some of the plants growing along the border penetrate here and there into the pools. They belong mainly to *Eleocharis interstincta, Rhynchospora triflora* and *Fuirena umbellata.* However, the conquest of the pools by new peat formation is apparently slow.

In the southern half of the great swaying swamp our traject crossed two of the more or less roundish islands. Between these two islands the swamp was about 2 m deep, while the peat layer was only 40—50 cm thick and very loose. This made it very difficult to move over it and at several spots it was necessary to lay sticks on the peat in order to prevent that we sank through it. However, our efforts were richly rewarded because we detected here a real floating savanna, complete even with the small shrubs, a thing we had never heard off. The species that are typical for the vegetation on the strong peat are all the same present although rather poorly developed and rather far apart. The true savanna species, like *Hypolythrum pulchrum, Burmannia bicolor* Mart., *Polygala appressa* Benth., *Xyris spp., Abolboda americana* (Aubl.) Lanj., *Panicum cyanescens* Nees, *Catasetum spp., Lycopodium spp.,* and *Utricularia spp.* must have penetrated into this area from the savannas further South.

A 100 m North of the southernmost island at km 18, measured from Moengo tapoe, the bottom of the swamp rises rather rapidly to half a meter below the surface and here the floating peat ends abruptly. The plants are rooting now in the heavy clay which forms the bottom of the swamp and they form an open community dominated by another coarse sedge viz. *Becquerelia tuberculata.* Its associates are *Rhynchospora cyperoides* and the species that are typical for the peat. This community extends to the southern border of the swamp, but an isolated patch was found in the form of a small bog in a depression in the savanna at km 12.1. South of the last island floating in the open water between the plants some fine *Utricularias* were found and also the closely related *Biovularia olivacea,* one of the smallest Phanerogams. It has solitary white flowers, 2 mm across, and a few threadlike vegetative parts.

South of these interesting swamps on the way to the oldest ridges we reach a scrub vegetation which is intermediate between savanna scrub and the marsh forest along the swamp borders. The soil under the scrub shows well developed *kawfoetoes,* i.e. the bad hogwallow structure which is the result of alternate inundation and desiccation and soil erosion on heavy clay. The Surinam name *kawfoetoe,* meaning cow's foot, is derived from its resemblance with mud trampled by cattle.

The oldest ridges and the savannas.

The oldest series of ridges has maximum elevations of 6.75 to 7.50 m. Here too the depressions between them are occupied by marsh forest, and the slopes and lower parts by forest dominated by *Parinari campestris, foengoe.* This is just as on the ridge complex North of the swaying swamps, but the central plateaus are here further degraded and no longer covered by savanna forest but by a savanna. The latter consists partly of a dense scrub partly of a herbaceous vegetation with scattered bushes. The soil has an ABC profile with an A stratum of poor, white sand and an up to 50 cm thick, continuous, impenetrable iron pan at a depth of 70—90 cm. This iron pan is sligthly convex allowing in this way the rainwater to drain away to the sides of the ridge where, under the forest, the pan gradually becomes less resistent and less continuous and in the end disappears. As the soil of the savannas is separated by the hard pan from the groundwater it severely desiccates in the dry season and this seasonal water deficit is apparently the limiting factor to tree growth. Only a few *maurisie* palms thrive here. As other authors already have suggested they seem to be able to traverse the iron pan with their roots.

South of the ridges from km 14.2 to km 6 we meet with a very flat savanna landscape showing both in the field and from the air all the features of an old coastal area consisting of shallows and mud flats. The surface of the mud flats has an elevation of 3.5—4.5 m above the present mean sea level, some of the shallow depressions one of 2 m. From North to South the savanna soil generally changes from fine light-coloured sandy clay to heavy clay with a very bad structure in which plantroots can penetrate only along cracks and fissures. In the type of vegetation we found but slight differences between sand and clay savanna, and seen from the air all these savannas have the same aspect. Many species are independent from these two soil-profile types. Apparently the structure of the clays is so bad, that the water capacity is very low and the root-volume of the plants very small. The floating savanna in the last swamp grows in oligotrophic water. All these habitats have a low pH and a deficiency in available nutrients, though the exact figures are not yet available. The plant cover varies from a dense thicket, necessitating much cutting to make passage possible, to an open plain with widely scattered shrubs and very incomplete coverage of the ground with some grasses, many small and larger sedges and numerous other herbs and subshrubs.

Wherever drainage and structure of the soil are better, the savanna vegetation gives way to more or less well developed forest. This close correlation, combined with apparently complete absence of savanna fires, (the Indians in the neighbourhood knew nothing of savanna fires in this area) and of abrupt changes from one community to another plead for a high degree of naturalness of these coastal savannas.

The savanna is not only intersected by belts and patches of forest but also by some creeks. One we crossed at km 12.9, was dry at the time of our visit, but the soil which was rich in humus was damp and the bed filled with trees, mostly *Symphonia globulifera, matakki,* with knee-shaped pneumatophores. Outside the bed we find zones of low bush on *kaw-foetoe* or hogwallow soil which is inundated only in the long rainy season.

A larger creek flowing from East to West is the Djai creek; at km 8.7 it was still half a meter deep, but at other places it had run dry. The southern bank is steep and rises directly to a well-developed forest, but on the northern bank we find a 100 m wide foreland with many-stemmed shrub-like trees, mainly *Aulomyrcia pyrifolia* and *Amanoa guyanensis.*

Southward the savanna is bordered by a forest belt extending along the Wane Creek, which has forelands with a rich mixed marsh forest, and South of this creek we enter the area of the bauxite hills mentioned at the beginning of our report.

II. Coronie.

Halfway on the road between the mouth of the Coppename River and the settlement Coronie, i.e. near km 21, we found a camp that had been used during the building of this road. As it had been repaired for us, we could at once move into. A small map of the area is found as inset of map II, and fig. II shows at the base a sketch of two sections of our second transect. Two years before the surveyor VAN AMSON had cut, measured and leveled several lines in this area. Two of these lines from km 20.8 and 21.6 southward were opened once more, and as it appeared that most of the hectometer marks were still intact and readable, we could use the figures reported by VAN AMSON.

Brackish area North of the road.

From km 21.6 a new line, 3.5 km long, was cut northward to the sea. Here it ended abruptly on a low cliff which is constantly beaten by the waves and which therefore gradually draws back. The cliff consists of stiff clay and bears a dense mangrove forest which stands just a little above the normal high tide mark and is destroyed at the same rate at which the cliff recedes (photo 23).

The abraded material is deposited by the sea in the form of a very soft mud flat at the foot of the cliff. The regression of the coastline is irregular so that little bays are formed, which are very conspicuous in the aerial photographs. The mangrove is here a *parwa* forest with a few *Laguncularia* shrubs and some small specimens of the fern *Acrostichum.* These plants are unable to withstand the inroads of the sea. The very shallow rootsystem is easily undermined and by their own weight the trees tumble forwards in the sea and perish.

Away from the sea the land slopes very gradually down into an oligohalinous swamp and there the *parwa* forest passes first into a dense

Laguncularia thicket near km 2.1 (measured from the road), and then into a variable swamp vegetation. Stretches dominated by *Typha* alternate with groups of shrubby trees, mainly *Andira inermis, Ficus sp.* and *Annona glabra,* and with dense stands of the fern *Blechnum indicum* (photo 24).

The last *Avicennias* were seen near km 1.7, where the swamp water proved to contain 360 mg Cl/l. Westwards the swamp vegetation becomes more and more herbaceous whereas eastward the shrub and tree groups behind the mangrove belt coalesce to form a swamp forest.

This swamp, whose water depth varies from 5—40 cm, reaches up to the shell ridge over which the road is built, and which down to a depth of somewhat more than 2 m consists of several layers formed alternately of entire and of broken shells, and is underlain by sand.

Ridge complex and fresh-water swamp South of the road.

Across the road the ridge rises around our camp to 1 m above mean sea level, and then drops in our 2nd line into a small swamp wood with much *koffiemama, Erythrina glauca.* This wood borders a 70 m wide and ± 90 cm deep swamplet which bears a strangling vegetation consisting of *Ipomoea parkeri, Polygonum acuminatum* and *Panicum mertensii.* These plants are rooted in a some 40 cm thick floating layer of peat. Under the weight of a man the mat was submerged, but it held and it allowed therefore a fairly easy passage.

Then follows a marsh wood interspersed with bushes consisting almost entirely of *Hibiscus tiliaceus, maho,* and merging into mixed forest where the ground rises a little. We are here on a slightly undulating ridge complex running from km 0.2 to 1.7 and rising only 0—80 cm above mean sea level. This complex must have sunken with respect to the present sea level, for now the lower parts are permanently waterlogged and covered with marsh forest but the upper soil strata everywhere are decalcinated down to about 40—80 cm and this can only be the result of leaching by rainwater in a period when the groundwater table was lower. At a greater depth the sand contains shell fragments but not in great quantities. Between km 1.63 and 1.7 a shell concentration is found at the surface and at this place we find many big *kankantries, Ceiba pentandra.* The sand is rich in muscovite and the soil water is more or less brackish: 200—6800 mg Cl/l. The marsh forest is locally dominated either by *pina* palms, *Euterpe oleracea,* by a widely branched and buttressed *Ficus* species or by *Hura crepitans, possentrie.* Between km 0.6 and 1.0 the last one forms on the wettest places closed stands of big trees up to 30 m high and 80 cm in diameter.

The forest on the dry parts resembles in aspect the ridge forests we met in the Wiawia transect, but it contains a number of species that are not found there, for example *Couroupita guianensis,* a canopy tree, and *Trichilia trinitensis,* a small tree. Whether the higher amount of calcium and muscovite is responsible for their presence or not, is a question that can not yet be decided as we have no data with regard to other shell-ridge complexes.

At km 1.7 the ridge ends and its vegetation passes via a narrow belt of *pina* marsh forest and a broad belt of swamp forest with *Tabebuia* or *zwamp panta, Pterocarpus officinalis* or *waterbébé, Ficus sp.* and the fern *Dryopteris gongylodes* into a fern swamp (mainly *Dryopteris* and *Blechnum*) with over 50 cm water and a strong peat layer of 50 cm on the clay of the subsoil in Suriname called *pegasse.* In this swamp grow scattered shrubs and treelets, under which *maurisie* soon plays an important part furtheron accompanied by *Chrysobalanus icaco.* The water is completely fresh, 50—70 mg Cl/l, and dark brown from the presence of humic acids.

Between km 2.6 and 2.7 a narrow ridge crosses the line and beyond that a swamp stretches uninterrupted up to the Wayombo River as VAN AMSON, who conquered it in the course of his surveys, reported. The aerial photographs confirm this, but show that the vegetation varies considerably. The first part we visited, bears the same type of vegetation as the swamp to the North of it, but southward extensive swamp forests appear on the photos.

A parellel line, our first, starting from km 20.8 on the road, shows the same general picture, the small swamp South of the shell ridge being reduced here to a wide ditch. The sandy ridge complex is here slightly drier and in the depressions *possentrie, Hura crepitans,* is absent. This line was not cut further than well into the swamp South of this ridge complex that ends at km 1.7.

Third and fourth line.

A little more westwards the sandy ridge complex is split in two and at road km 18.9, a good 300 m South of the road, a fresh-water swamp begins, here already 600 m wide and covered by a similar floating mat as is found in the small swamp in the first described line. The reason why we wished to make a short line at this point, was the presence in the swamp of a dome-shaped grove which caught the eye on the aerial photographs for its unique appearance. As mentioned in chapter II field reconnaissance showed that it was a pure stand of *Rhizophora mangle,* which grew here at a large distance from its normal habitat, but apparently thriving quite well in 1.20 m deep fresh water.

North of the road small shell bars have been deposited, separated by narrow strips of swamp bearing thickets of *brantimakka* but showing no other essential differences with the swamp vegetation North of km 21.6.

Totness.

The last day we paid a short visit to the settlement Coronie. From Totness the fresh-water canal leads southward through the ridges which are here mainly planted with coconuts, into a vast swamp, where *Cyperus articulatus, Typha angustifolia* and *Rhynchospora corymbosa* locally dominate as has been described by LANJOUW (35), who studied this area in 1933. At the point where the canal crosses the road it is provided with a lock; the northern part is in open connection with the sea and serves as harbour. East of this part of the canal the swamp has been reclaimed and is now in use as a rice polder.

The coastline here is formed by a narrow shell bar deposited on the clay and covered with an open scrub consisting of *Avicennia* and *Laguncularia* with patches of *Sesuvium*. From the bar the clay slopes rather steeply to the muddy foreshore. Here too the coast is in regression, as is shown by the remnants of shrubs on the foreshore, but the erosion did not lead to the formation of a cliff.

Near the mouth of the canal we find much *Sporobolus* and further *Iresine, Sesuvium, Batis, Fimbristylis spathacea* and *Capraria biflora.*

III. Nickerie.

I obtained an impression of this NW-corner of Suriname during a number of short trips made in several directions. I had the good luck to come just at a moment when in the swamps that were selected to be impoldered in the near future many exploration lines had been cleared. The lines investigated by me are traced with bold dots on map II. The data collected along two of them are already made historical facts, as at the time of writing the Nanni polder situated along the Corantine River between the Clara polder and the Nanni creek has been made ready, and East of Paradise the works on the polder Groot Henar are advancing rapidly. The trial polder South of Paradise, which I have seen before it was laid dry and also two weeks later after it had been drained, is already for some years in production under the new name of Prins Bernhard polder.

North of the Nickerie River I visited as guest of some Hindustani fishermen the swamps along the Huntley creek and the Bigie pan, the westernmost of a series of open lagoons behind the mangrove belt, where the fishermen have their camps built on piles above the water.

The longest trip was along the Nickerie River to Cupido, an Indian village, a short distance up the Maratakka River from where a one year old line could be used over one of the rare ridges of considerable extent that have been formed in this area. In the forest this line was easily visible but where it merged into a swamp thicket it disappeared altogether.

Mangrove belt and brackish swamps North of the Nickerie River.

If we follow now the vegetational changes from North to South, we find along the coast the usual broad belt of *parwa* forest which narrows and bends inwards along the banks of the Nickerie River. West of the mouth a triangular mud flat called Blufpunt protrudes seawards. It is covered with a thicket of *Laguncularia* and *Avicennia* shrubs backed by an open strip with halophytic herbs. The latter extends along the dyke that protects the polders. West of Blufpunt the coast line in front of the dyke is regressing under the attacks of the sea and from aerial photographs we see (fig. III, p. 51) that in ten years the sea has gained here up to 500 m on the land.

A little further West a magnificent mixed mangrove forest with tall trees fronts the ocean. It stands on a 1—1.5 m high cliff, and here too the coast is receding (photos 25, 26).

Fortunately not everywhere the coastline goes back; North of the lagoons silt is being deposited and over it a mangrove scrub presses seaward. Near the new Kanja creek (the middle one of three creeks connecting the Bigie pan with the sea) this scrub zone is 1 km deep. It consists of young more or less shrubby *Avicennias* mixed with much *Laguncularia* and decreasing seaward in height from 6—7 m to about 3 m. Still younger plants have established themselves in front of the closed scrub on small elevations in the mud which are separated by a network of shallow gullies. At this place the coast is apparently still advancing. In the oldest part the soil has been silted up to above the normal high tide mark but the border of the full-grown *parwa* forest at the back is markedly higher. Away from the sea the land slopes very gradually into the lagoon. Just where the creeks break through the high old clay bar we find in the *parwa* forest open clay flats only with some specimens of *Sporobolus virginicus* and *Sesuvium*. According to the fishermen these places were formerly shallow open pools. High salinity may be the reason why the vegetation has been suppressed. Along the margin of the old land a narrow band of shells has been deposited. Near the Kanja creek it was only 5 m wide, but the vegetation on this strip was different from the surrounding one. Under the mangrove shrubs we noted several grasses, and the creole fishermen who had a camp here, on the highest point of the creek bank, had even planted some potatoes. They told us that this miniature ridge runs slightly winding, and furtheron also widening, as far as the mouth of the Nickerie River. This is confirmed by the aerial photographs, on which it can be traced as a light line because the shrubs and herbs on the shell bar do not form a closed cover. Where it reaches the present coastline, it forms a bare beach. Where the soil has sunk well under the water table of the lagoon the *parwa* forest gradually opens up. First there appear small openings and where the water was about 50 cm deep at the time of my visit in May, the forest is disrupted into groups of trees surrounded by a dense carpet of pneumatophores, which rise from the bottom to a height of about 10 cm over the water surface. Between these roots we find seedlings of *Avicennia* and clumps of the grass *Paspalum vaginatum* and some specimens of *Iresine vermicularis*. Here and there a group of *Acrostichum aureum* is seen (photo 27).

South of this water-park the open lagoon offers fine, 60—90 cm deep fishing waters. Clusters of *Ruppia maritima* form its only vegetation. At the southern side a beautiful scenery strikes the eye. Here scattered trees and groups of *Avicennia* appear once more in the midst of a varied mosaic of herbs. Richly flowering *Nymphaea ampla* forms together with floating clumps of algae and duck weed the base of the pattern. On this base are spread disks and rings of *Limnobium stoloniferum,* fresh green on the outside, old and brown in the centre, where, if the water is 50—55 cm deep, this species is replaced by *Paspalum vaginatum* or *Eleocharis mutata.* The patches formed by these two species are not always fringed with *Limnobium* and most of them are crowned by a central bouquet of *Jussieua decurrens, Torulinium ferax* or *Acnida cuspidata* (photos 28, 29). Where the depth decreases to 40—45 cm the patches approach each other and may form a nearly pure stand of *Eleocharis mutata.* In a following stage in the succession groups of *Typha angustifolia* make their appearance and southward *Typha* becomes dominant and remains so over an unknown distance. Under and in the *parwas* several common climbers flower. Finely coloured birds are busying around and enliven the scene and against the sky small *akkas,* prey birds which house in colonies in the *parwa* trees are circling. They feed on the numberless water snails living between the *Nymphaea.* Along the Huntley creek which is everywhere except near the mouth fringed with *parwa* trees we find vast swamp savannas consisting of *Eleocharis mutata* and *Cyperus articulatus* with scattered groups op *parwa* (photo 30). These swamp savannas are in the wet season submerged in a shallow layer of water but in the dry season the soil is merely boggy. Close to the mouth of the creek the vegetation changes into a belt of swamp forest, similar to that in the sea line near Coronie, along the Nickerie River. Mangrove is confined here to a narrow strip along the bank.

In the middle of the swamp savannas a band of low forest could be seen which must grow on one of the scarce and small ridges in this area. Lack of time prohibited to penetrate to this ridge but a farmer has shown me the remainder of a similar ridge opposite Nieuw Nickerie some 400 m North of the river enclosed by *parwa* forest growing on stiff saline clay. It had a soil consisting of light-coloured, fine sand, was only slightly higher than the clay around and possessed brackish ground water (6000 mg Cl/l); the vegetation was low mixed wood with many lianas very sharply set off against the *parwa* forest and related to that on the second ridge in the Wiawia line.

BONE, the chief of the fishermen told me something about the history of the lagoons. The Bigie pan must once have been a vast *Typha* swamp before the creeks by which it is now connected with the sea, came into existence. After the gaps in the relatively high clays of the *parwa* forest were formed the sea deepened the creeks and invaded the *Typha* swamp converting it into an open lagoon. Then silting at the foreshore began and the sea lost much of its influence on the lagoon. The salt water was gradually substituted by fresh water, and so the present oligohalinous state arose. From the South the vegetation presses forward with a speed which in the eyes of the fishermen who earn their living in the open water is highly alarming. Between the waterlilies they can still fish, but where

Paspalum and *Eleocharis* have established themselves this is out of question BONE said, that the zone where I investigated the succession mosaic, was five years before open water. On the southern side, where now many groups of *parwas* were present, 10 years before only a few scattered individuals could be found.

The water level sinks considerably in the dry season, but only in the excessively long and intense drought of 1946—47 the water fell so far that large parts of the lagoon bottom became exposed and that all the larger fish died. In that year many *parwa* seeds germinated on moist places; under water germination seems impossible. In earlier years the fishermen had their fishing waters due North of Nieuw Nickerie and closer at hand, but in 1930 they must have worked there for the last time because then nearly all open water had disappeared. The aerial photographs now show a dense and uniform herb carpet similar to that of the swamp savannas we visited along the Huntley creek.

Fresh-water area South of the Nickerie River.

From the Nickerie River an immense fresh-water swamp extends southwards. Around Nieuw Nickerie and Waterloo parts of this swamp have been and are being impoldered. The vegetation is a mosaic with *Typha angustifolia, Cyperus giganteus* and swamp ferns, either alone or in combination, as local dominants, and groves or woods of *Erythrina glauca, koffiemama,* or consisting mainly of *Pterocarpus officinalis* or *waterbébé,* and *swamppanta,* here *Tabebuia aquatilis* (photo 31, 32).

The depth of this swamp varies from 30 cm to 1.20 m and more. The soil is clay covered with more or less pegasse. Under fern stands I have measured up to 60 cm of this peat, but a superintendent of the Service of Public Works told me that in other prospection lines up to 2 m peat was found. Since the dam in the Nanni creek has been built which was done in order to lead the water into the "van Wouw" canal, the water level in these swamps has been stabilized at a relatively high level. Before that time the water fell considerably in the dry season. I was told that the vegetation had not changed after the stabilization, but that *Cyperus giganteus* did no longer reach its former size. This is very well in accordance with what we saw in the Wiawia transect where the tallest *papajagras* grows on places that are marshy only in the dry season.

In the western part a few small ridges are found in the polders. Those South of the Clara polder I have seen in a fairly natural state, the only interference being cattle that were pastured in the swamp situated East of the ridge and that came to these ridges to rest in the shade of the trees. One piece of a ridge along the van Wouw-canal close to the Nanni creek was so low that the surface was 5—20 cm under water. The wood on it showed a mixture of swamp and ridge species with a very dense subgrowth.

Where, going up stream, we see the Nickerie River bend to S.E., the mangrove along the banks gradually gives way to mixed forest on the levees. This forest on clayey soil has many species in common with young ridges. The periodical inundation at spring tides and other high floods does not hamper the growth of these trees. A little West of post Utrecht at the mouth of the Maratakka River parts of prospection lines could be used. The levees slope backwards slowly towards swamp. On the northern bank the forest changes gradually into a swamp scrubwood with many climbers and large herbs, which is very difficult to penetrate, so that we had no opportunity to reach the dry forest beyond. On the southern bank the levee forest passes into swamp wood. At the same time it opens up, which allows patches of tall Cyperaceae to appear. The latter approach each other more closely, as the swamp treelets begin to disappear, and finally coalesce. In the herbaceous swamp most of the treelets were dead as the result of a fire which had swept across it some years before in the dry season.

The Indian village Cupido at the Maratakka River is situated on a ridge. On the western side of the river beyond an old loop that had been cut off, this ridge continues slightly undulating and showing many marshy strips between the dry parts. In the marsh forest *Euterpe oleracea*, the *pina* palm, reaches in several places complete dominance, while *Carapa procera*, *krappa*, too was very well represented; it yielded in May a rich harvest of ripe fruits. In the village women were busy to make oil out of the large seeds. A conspicuous feature of the dry forest was formed by several gigantic nests of leaf-cutting ants, *Atta cephalotes*. These nests are built in the soil and the excavated sand is deposited in numerous bare cones, which are up to 0.5 m high and 2 m in diameter.

North of the ridge we met a very dense marsh scrub-wood with much *Hibiscus tiliaceus*, but this wood was not crossed. Furtheron a swamp must follow.

IV. Tibiti.

The Tibiti savanna was investigated during our third trip. It is just outside the coastal region and will therefore not be discussed here in detail, but some records from this area will be used for comparison. A very brief sketch is inserted here and a small map is added to map II.

The Indian village Tibiti sabana is situated on a high part on the southern bank of the Tibiti River in a circ. 300 m wide forest strip. Our camp was made at the western edge of the village where behind the high bank the soil forms a depression with *Mora* forest. The latter formed the continuation of the vegetation on the low bank below our camp. Behind this forest strip lies an oval artificial savanna of 3 by 2 km which is burnt every year in the dry season. The lower part has a good soil consisting of sandy clays with a varying content of humus in the top-layer and a high content of coarse sand. This part of the savanna reaches an elevation of about 5.50 m above the mean sea level. Southwards the surface rises to 12 m, and the soil becomes sandy and more and more leached. The fire savanna is surrounded by forest and in the South by savanna wood interrupted along the 1st line by patches of open herb and scrub savanna. Eastward from the savanna a line was cut across the valley of the Koemboe creek. It passed alternatingly through savanna wood and forest and ended in an open white-sand savanna at km 5.8 lying at about 12 m altitude. Small creeks have cut deep into the sand. The bottom of these valleys is occupied by marsh forest on deep peaty mud and wet, grey clay rich in humus, whereas along the lower part of the Koemboe creek belts of swamp forest are found.

From the trip to the Nassau mountains some 150 km up the Marowijne River only a few observations of the forest on the badly drained river terrace at the foot of the mountain and one record of the forest on the slope will be used.

CHAPTER IV

MANGROVE AND STRAND

I. Mangrove belts along the lower part of the rivers.

Along the whole coast of Suriname a belt of mangrove is found varying in width from 0.5 to 4 km or, rarely, more. At the mouths of the large rivers the mangrove bends land inwards and follows the river banks for a longer or shorter distance. During many travels Dr GEIJSKES made observations on the changes along the riverbanks in the tidal zone and in some places we could extend these during our expedition. As we intend to discuss this matter in a separate paper, I will confine myself here to some general remarks. In the coastal and savanna region the larger rivers have very little fall up to the first rapids in the hill country, and tidal movements are perceptible far inland while the current pendulates over a considerable distance. At Tibiti sabana, for instance, 80 km from the mouth of the Coppename River the mean difference between flood and ebb was of the order of 1 m (1.20 m at spring tide) and at each tide the water flowed upstream for about 4 hours.

The salt content in the estuaries varies considerably. In the rainy season down to a point near the mouth, the water may be fresh, but in the long dry season the salt limit shifts over a considerable distance land inwards. In excessively dry years this may cause difficulties for the plantations in this region for when there is a shortage of water, this can be remedied only by letting in the brackish water from the river.

As a rule the vegetation along the riverbanks shows the following pattern. At the mouth as soon as wave action becomes of little importance *mangro, Rhizophora mangle,* occupies the greater part of the steep tidal zone along the bank and forms a dense 10—15 m high strip of wood in front of the *parwa* forest which grows on and behind the levee. Locally the *mangro* belt may be interrupted by groves of *akira, Laguncularia racemosa,* which in these places apparently never reaches tree habit, and very soon — where the water is not more than polyhalinous — also by *brantimakka* scrub. Land inwards the *parwa* forest decreases in depth with decreasing salt influence, and at the same time *akira* decreases in number and soon disappears. Where as a rule the water is either fresh or oligohalinous, *mokomoko, Montrichardia arborescens,* makes its appearance in the front line and soon forms dense, up to 4 m high stands in a zone from about neap-tide level downwards to a depth of at least 2 m below it.

Beyond the limit where *parwa* forest is replaced by mixed levee forest *parwa* does not disappear altogether but there occur scattered trees in the low marginal belt, in the same way as *mangro* higher up the river where it is beyond its optimum. In this way both mangrove species occur well beyond the salt limit in completely fresh water. This we know from the data collected by the Service of Public Works, which during many years has determined the salt content of water samples, that were and still are taken daily at high and low tide in several localities.

The occurrence of *Rhizophora* and *Avicennia* in permanently fresh water makes it fairly certain — though no soil samples from such localities were analysed — that both mangrove species can thrive well without salt, a fact discussed many times but never fully proved.

Davis (66) has grown *Rhizophora* and *Avicennia* in the laboratory in saltless soil, but after some years the plants succumbed. This, however, may have been due to unnatural conditions. Davis reports the occurrence of isolated *Rhizophora* stands at the inland borders of fresh-water swamps. The salt content of the water was here in 3 successive years 55, 39 and 44 mg Cl/l. In his conclusions he is very cautious. "The soil solution usually is more saline and fluctuates less than the surface water." "Only a few saltmarsh and mangrove plants are halophytes that definitely depend upon high salinity. Most of the mangroves are facultative to a wide range of salinity. A brackish condition (1—2% NaCl) is most favourable for the optimum growth of mangroves." Huber (84) observed *Rhizophora* in the Amazone estuary in fresh water, but in these localities he recognized a different form with many-flowered racemes, *var. racemosa.* In a later publication (85) he reports to have found this variety in other rivers in Brazil near the coast in salt water as well. Hitchcock (81) supposes that under the fresh water in the rivers a salt undercurrent should penetrate as far as halophytes occur, but Mr Ferguson, a hydraulic engineer, working in tidal areas, told me that near the mouth of a river fresh and salt water are effectively mixed by turbulence and that therefore the presence of a salt undercurrent far from the mouth is highly improbable.

On one hand the Suriname rivers are unusually deep, 10—25 m, favouring stratification in the water but on the other hand they are all barred at the mouth by mud flats which leave a passage of only a few meters depth where fresh and salt water will be mixed. How the situation in reality is we do not know. In the Nickerie River at Post Utrecht only, both superficial and deep water samples have been taken, these pairs showed very small differences and contained always less than 100 mg Cl/l (40 a). Further down the river the surface samples showed a very irregular variation in salt content in the long dry season. At Henar where the water is fresh most of the time a maximum of 9100 mg Cl/l was found. From the fact that *Avicennia* and *Rhizophora* grow well near Utrecht and that no residual salt was found in the soil of the surrounding area, we may conclude that both species are facultative halophytes.

Along the rivers *parwa* disappears in general before *mangro*, but the difference is not great. At post Utrecht, where the Maratakka comes into the Nickerie River, the water is always fresh but both species are still frequent. Up the Maratakka River however the last *parwa* was seen 5 km and the last *mangro* 10 km from the mouth or about 60 km from the sea. *Brantimakka* goes some distance further inland, but along the Maratakka it does not reach the Indian village Cupido. In the Tibiti River the *brantimakka* fringes along the river bank ended a fair distance downstream of the village Tibiti sabana, but one isolated patch was encountered several hours with a speedboat above the village at the mouth of a creek.

Where *mangro* and *parwa* become rare, *Bombax aquaticum, watercacao,* comes into prominence in the forest margin, and locally *Pterocarpus officinalis, waterbébé,* a tree with huge buttresses, sometimes appears. In the Western half of Suriname *Mora excelsa* completely dominates the fresh-water tidal forest over considerable distances; its stands reach from the water edge sometimes to several hundred meters from the river bank. As *Mora* is a valuable timber tree it is important that these nearly pure forests can be traced on aerial photographs.

Mangrove along rivers outside Suriname.

Partly in contradiction with this picture of the Suriname riverbanks is the statement of BENOIST (53) that in French Guiana *Rhizophora* and *Laguncularia* disappear first but *Avicennia* and *Conocarpus* go farther inland. The last species was not observed in Suriname. For the banks beyond the mangrove area he quotes as characteristic tree besides *Bombax aquaticum Macrolobium bifolium,* which is also present along Suriname rivers. Next to *Machaerium* he mentions *Muellera* as another thorny shrub, but the species is not indicated.

ANDERSON (45) reports for the N.W. district of British Guiana extensive *mangro* belts along all rivers, outside the distinctly brackish zone, sometimes mixed with *Carapa guianensis* or *Pterocarpus officinalis* and usually backed by a palm swamp of *Euterpe edulis* and *Manicaria saccifera.* Higher up the rivers *Bombax aquaticum* and *Macrolobium vaupa* J. F. Gmel. dominate in the forest margin; *Machaerium* grows sometimes in front, but is rather rare in this district, whereas it is very common in the rest of British Guiana. *Mora* forest follows still further from the mouth.

HUBER (83) states that, where in the Amazone estuary *Rhizophora* decreases, usually a palm forest occupies the levees with *Mauritia flexuosa* locally dominant and much *Euterpe, Manicaria* and *Bactris spp.* Beyond this palm forest zone follows the mixed varzea forest with *Bombax aquaticum* prominent in the margin again.

In British Honduras (113, 115, 123) *Bombax aquaticum* and *Pterocarpus officinalis* are common along rivers, and near the mouth of the Temash river *Manicaria* dominates as it does in many places in the Orinoco-delta (105).

Epiphytes and other accompanying species.

Some authors report abundance of epiphytes in mangrove along rivers, but in Suriname we have only occasionally observed an epiphyte or a Loranthacea in the trees. Only one Loranthacea *Struthanthus dichotrianthus Eichl.* was collected on *mangro;* the same species has been collected several times before along the lower rivers in the mangrove area, but the host has been indicated but once e.g. on *parwa.*

BEEBE (51) reports for British Guiana that in the *mangro* belts at Kartabo, 42 miles above the mouth of the Essequibo, epiphytes are numerous, on the roots mosses and lichens and on the branches Bromeliaceae, Orchidaceae; lianas too are frequent. Under and between the trees grow the silt-catching *Xyris tenella* Kunth and many inconspicuous *Utricularias.*

STEHLÉ (116, 117) mentions *Tillandsia polystachya* L. under the species growing in the mangrove of Guadeloupe, and for Martinique he adds the orchid *Ionopsis utricularioides* Lindb. SCHIMPER (107) observed in Brazil *Tillandsia spp.* and *Aechmea gamosepala* Wittm.. For the Lesser Antilles (VERDOORN 123) *Clusia rosea* Jacq. is mentioned only as a species, but it is problably a semi-epiphytic shrub there like *Clusia purpurea* in Suriname. The latter was collected in *parwa* forest at the mouth of the Suriname river by STAHEL (with the addition on the label: abundant on *parwa* trees) and by Focke along the Matappica creek.

In brackish and salt water the peculiar, arched and dichotomously branched proproots of *Rhizophora* are covered with epiphytic algae, mostly Rhodophyta. Near the mouth of the Corantine River I collected a *Bostrychium sp.* HUBER (83) reports from the island Marajo in the Amazone delta *Catenaria, Polysiphonia* and *Rhizoclonium,* and SCHIMPER (107) mentions from Gamboa, a small island off the S. Brazilian coast *Catenella impudica* and *Bostrychia radicans.* These roots may offer a promising field for an algologist.

HUBER adds that between the *mangro* roots *Eleocharis caribaea,* a *Psilocarya sp.* and *Crenea maritima* were growing. The first-named species is also mentioned by STEHLÉ for the mangrove of Guadeloupe and as the plant is small and inconspicuous but widely distributed it should be looked for in the *Rhizophora* belts elsewhere. *Crenea maritima* too has a wide distribution and has been collected several times in the mangrove area in Suriname.

II. Coastal mangrove.

Regressing coast.

Along the coast the mangrove consists mainly of *parwa*. Under the influence of winds, waves and sea currents the coast line is constantly changing. In most places abrasion takes place and the mangrove forest is gradually destroyed. Where this is the case, the coast has, seen from the air, an irregular, scalloped aspect, first described by GEIJSKES (31). In the field we find, as described from the sealine near Coronie, a mature *parwa* forest on compact clay, ending abruptly with a low cliff on a soft mud-flat with the remnants of uprooted trees. CASE (58) supposes that these remnants act like hammers under the wave action and so speed up the erosion but we have found no proof for this idea. Usually the sea is so calm that the pieces of wood stick in the mud and are not carried about by the waves. At occasional stormtides a lot of debris is thrown over the cliff into the *parwa* forest where it does not damage the standing trees and is immobilised once more.

We still know very little with regard to the rate of coastal regression. GEIJSKES (31) points out that the inland border of the mangrove is in general straight and he supposes that it can give indications for the former coastline, if we accept that the mangrove belt originally had a uniform depth of some 4 km, the maximum now found. For several reasons I do not attach much value to this supposition. First GEIJSKES himself mentions that he saw in several places dead trees along the inland border. These trees had died as a result of fires in the swamp savannas and such fires may effectively straighten the margin of a forest. Then on the aerial photomaps the mangrove limit is not so regular as GEIJSKES says, and it proves to be distinctly correlated to the local topography. In the neighbourhood of open lagoons scattered *parwa* groves are abundant, even far from the coast.

From the West point of Suriname we have some figures, as the old settlement Nickerie situated about 1.5 km due North of the present tip of Blufpunt on the right bank of the Nickerie river had to be abandoned in 1869. Where the sea dyke West of Blufpunt now borders directly on the sea, an aerial photograph taken in 1939 shows a coastline about 500 m further to the North (fig. III). FERGUSON (29) gives on his map the low-water line in 1926 (measured by KREMER). The tip of Blufpunt was then 1 km NNW. of the tip in 1948 and the coast line ran from that point westwards about 1 km in front of the present sea dyke.

Accrescent coast.

On the other hand an accrescent coast is found between Nickerie and Coronie, at the Saramacca point and near the mouth of the Matappica creek. In front of the mature mangrove belt North of Bigie pan (Nickerie map II) a zone of scrub mangrove starts, at first very narrow but gradually broadening to 1 km and extending eastward over a distance of about

27 km. Then it ends in a cape which is now abraded again at the eastern side as the scallops show. This zone has developed in a very recent time and is at least at the western end still growing. Here *parwa* seedlings grow scattered on the mud flat. In a later stage as the sedimentation proceeds, they form together with *Laguncularia* a dense thicket. In the same way *parwa* presses seaward near the Matappica where GEIJSKES made observations, but here coastal growth is very local. The aerial photographs make it probable that all over the Saramacca point North of the mouth of the Saramacca River the process is most active, for here the shrub zone is over 2 km wide and the increase in height is very gradual. No interruption is seen between the shrub zone and the mature *parwa* forest; they merge into each other and the whole mangrove belt reaches here a depth of about 6 km. A growing mangrove coast was also observed by GEIJSKES (31) from the air at the West bank of the Corantine estuary North of Springlands and ANDERSON (45) reports the local occurrence of young *parwa* groves along the coast of British Guiana. MARTYN (96) tells that the coast of British Guiana is constantly changing; now here then there abrasion takes place and in another period the coast accresces again as a result of the ever shifting course of the sea currents.

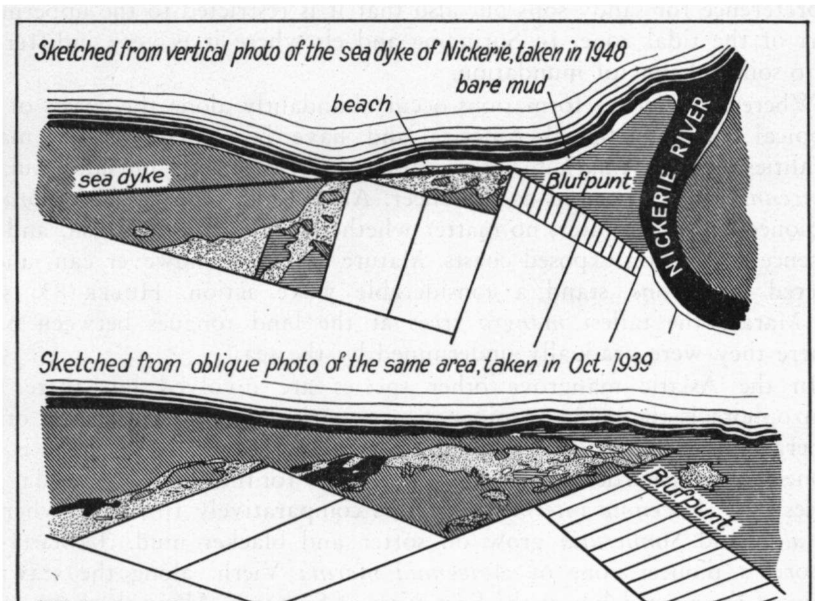


Fig. III. Recent abrasion of the coast near Nickerie

Where silt is deposited *Avicennia* and *Laguncularia* occupy the new land and consolidate it. In some places where silting is very rapid *Spartina brasiliensis* is the pioneer. It occupies first the higher islets between the small tidal gullies, but later on the clumps unite to an almost continuous grass carpet.

As soon as the flat has been built up above normal high tide a flood mark can be deposited in which seeds of *parwa* and *akira* are concentrated. These seeds germinate and then very rapidly a mangrove scrub develops, and in its shade *Spartina* is doomed to disappear. In this way a stretch covered with *Spartina* and scattered mangrove seedlings had developed in 3 years into a 5—6 m high scrub. A very good example of this succession was studied by MARTYN near Georgetown. Here it was initiated by the construction of a seawall with groins causing rapid silting on the foreshore.

In Suriname we have seen *Spartina* together with some Cyperaceae along river banks in the brackish tidal zone where mangrove had been destroyed. The same phenomenon is reported by DANSEREAU (63) from S. Brazil. He tells how after destruction of the *Rhizophora* belt *Avicennia* may occupy part of its site, and how *Avicennia* in its turn may partly be replaced by *Laguncularia,* which is normally confined to the highest mangrove belt. The rest of the denuded zones where tidal inundations last to long to allow the establishment of *parwa* or *akira,* is generally taken in by *Spartina.* It is remarkable that in Brazil *Laguncularia* not only shows a preference for sandy soils but also that it is restricted to the uppermost part of the tidal zone. In Suriname and elsewhere it is very indifferent as to soil and time of inundation.

Whereas mangrove formations occur abundantly along the coasts of all tropical and subtropical America and have been described in many localities, it is remarkable that apparently nowhere outside Guiana *Avicennia* is encountered as a pioneer. All authors report *Rhizophora* as a pioneer in quiet water, no matter whether it is salt or brackish, and its absence as such on exposed coasts. Mature mangrove however can, under altered conditions, stand a considerable wave action. HUBER (83) saw on Marajo the tallest *mangro* trees at the land tongues between bays where they were gradually undermined by the sea.

In the Asiatic mangrove other species are involved but there too Rhizophora is the common pioneer in estuaries and Avicennia and other genera come in the second rank. On open coasts, however, *Avicennia* is the pioneer, as has been described by WATSON (151) for the Malay Peninsula. He states that *Avicennia intermedia* prefers comparatively firm clay whereas *A. alba* and *Sonneratia* grow on softer and blacker mud. TROLL (148) reports a pioneer zone of *Avicennia marina* Vierh. along the seaward front of the river deltas at the East coast of Sumatra. Along the river arms *Rhizophora* is the pioneer. He quotes that GRASS has found the same situation in the delta of the Rufiyi River in East Africa, where the same species are involved. For the mangrove in West Africa which is very similar to the American mangrove and contains the same species (other varieties?) I found nothing about *Avicennia nitida* as a pioneer (129-131). According to VAN STEENIS (147) in Malesia *Avicennia* can act under certain conditions as a pioneer in calm water but not on sand.

The fact that *Avicennia* can establish itself as a pioneer along the open coast of Suriname may be correlated to the climatic conditions which produce little wave action and few storms. Floating *Rhizophora* seedlings were not seen along the coast while they were frequent in the estuaries. Hence the absence of *mangro* may partly be due to scarcity of diaspores, but the latter can not be entirely absent as a few *mangro* shrubs were met on the Wiawia beach.

Accompanying species.

In the pioneer scrub as well as in mature *parwa* forest undergrowth is virtually absent. A few poor specimens of *Batis, Sesuvium, Iresine, Sporobolus* or *Acrostichum* may be found inside the forest, but other species can grow only in the margins where enough light is available. There two vines are very common: *Rhabdadenia biflora* and *Brachypteris ovata;* both have been reported by several other authors for mangrove areas in other countries. At the end of the sealine near Coronie on top of the cliff a few specimens of *Paspalum vaginatum* and *Muellera moniliformis* next to some *Iresine* and *Sesuvium* were found in the *parwa* forest and on the landward side several swamp species occur together with *Avicennia* and *Laguncularia* in a transition zone, but these species do not belong to the *Avicennia* community.

Machaerium lunatum and *Hibiscus tiliaceus* have a very wide distribution in brackish areas and are thus associates of the mangrove in the widest sense, but they belong to distinct communities both also occurring outside the mangrove area.

In the *brantimakka* belts along rivers sometimes some *mokomoko* is present. For the *brantimakka* scrub in swamps see p. 75. The role of *Hibiscus tiliaceus* which prefers sandy soil will be discussed later in this chapter.

From other countries many species are quoted in the literature as associates of the mangrove, but as by most authors the transition zones are included, it is difficult to conclude which species, not yet mentioned by me, may belong to the mangrove sensu stricto. *Pavonia scabra* reported from Guadeloupe, Porto Rico and Panama may grow in the same habitat as the related *Pavonia racemosa* which in Suriname has been found several times along river banks in the mangrove area. About other species like *Parkinsonia aculeata* L. reported from Martinique and *Picrodendron macrocarpum* (Rich.) Britton from Cuba, I can say nothing at all.

SILVEIRA (110) opposes the view that the Old World mangrove is much richer than the American mangrove and he records 35 species of brackish and salt water which would occur frequently in the latter. Apparently he has a very wide conception of mangrove and sometimes his fantasy must have played him tricks. As an illustration for the rich mangrove in Suriname he cites for example from PULLE's Enumeration (36) *Conomorpha magnoliifolia* and *multipunctata* (A. DC.) Miq. apparently because he has found that in Brazil Myrsinaceae occur in the mangrove. PULLE however has given no localities nor habitat indications and we now know that the first species is characteristic for savanna forest and the second occurs in the interior only. The defence of his view therefore is very weak; a comparison can only be made if detailed descriptions from many localities are available.

Mixed mangrove forest.

A high, mixed mangrove forest is found at the corner between Blufpunt and the mouth of the Corantine River. Tall trees of *mangro* and *parwa* up to 25 m high and 1 m diameter and smaller trees of *Laguncularia* were seen. This forest resembles the mature mangrove association of DAVIS (66) which grows on the West coast of Florida on peat. Both forests lie above normal high tide and undergo frequent variations in salinity as sea and rivers bring in salt and fresh water alternately. In the forest DAVIS saw also some trees normally not found associated to mangroves. In the forest near Nickerie I have not seen other tree species but I may very well have overlooked them during my very superficial visit. The number of proproots on *Rhizophora* was conspicuously low. The same fact was found by DAVIS in the dense mangrove forest with very little tidal fluctuation.

SCHIMPER (107) investigated a mixed mangrove forest on the coast of Gamboa, an islet at 27° S.L. in the state Santa Catharina (Brazil). *Rhizophora* and *Laguncularia* formed a flat canopy with dome shaped *Avicennia* crowns emerging from it. On the branches he observed *Tillandsia spp.* and *Aechmea gamosepala.*

Strand mangrove.

Up to this point we have only met with the types of mangrove vegetation occurring on clay. In Suriname only one other type is present, the strand mangrove on sand and shells. For Jamaica and Florida CHAPMAN (59) and DAVIS (66, 67) report two more types, one mangrove on peat and one on coral reefs. Peat formation by mangrove is not known from the Guiana coast and not to be expected either as the authors point out that peat is formed only where the water contains no silt, a circumstance not to be found along the North coast of S. America where in a broad zone the seawater is notoriously muddy. For the same reason coral reefs, which can develop only in very clear water, are absent.

Where a low sand or shell bar is formed along the coast, we meet an open shrub vegetation of *Avicennia* and *Laguncularia* with some other shrubs and a more or less dense undergrowth of herbaceous strand plants.

A good example of this strand mangrove in an early stage is the vegetation on the sand bar at the Wiawia flat. A few shrubs of *Hibiscus tiliaceus, Muellera moniliformis, Dalbergia ecastophyllum, Caesalpinia bonduc* and *Cordia macrostachya* were present and the dense herb layer was dominated by *Ipomoea pes-caprae* and *Canavalia maritima,* while *Stenotaphrum secundatum, Ipomoea cf. stolonifera, Sesuvium portulacastrum* and *Sporobolus virginicus* formed scattered clumps. On the beach a few *mangro* shrubs and some groups of *parwa* shrubs were found. On the slope to the first swamp *Sesuvium* gained dominance and here many clumps of *Fimbristylis spathacea* and occasional ones of *Mariscus ligularis* appeared.

Where the sand became wet *Sporobolus* formed under the mangrove scrub a dense 50—60 cm high mat, in which apart from an occasional poor *Sesuvium* plant no other herbs were found, and this facies passed without change from sand to clay. On the latter it ended abruptly at the line where, at the moment of our visit, the water became deeper than 3 cm. On the first ridge we noted a row of tall *parwa* trees with an understory of *parwa* and *Hibiscus* shrubs and a mat of *Sporobolus* with some *Sesuvium.* North of Galibi parts of the sandy river bank were occupied by an 8—10 m high *parwa* wood which contained some *Laguncularia* shrubs but no herbs. The bank showed here a 50 cm high abrasion cliff. This was formed by the clay of the subsoil but above it the sand gradually rose to a height of 1.5 m. It showed signs that at very high tides the water flows over the bar into the swamp at its back.

On the shallow shell deposit along the coast North of Totness (Coronie) *Sesuvium* was the only herb found in the open mangrove scrub. On the narrow shell ridge near the fishermen camp at the Kanja Creek (Nickerie) we collected *Ipomoea tuba, Cenchrus echinatus, Mariscus ligularis* and *Digitaria horizontalis* Willd.

III. Hibiscus tiliaceus scrub.

Where a sand bar rises well above spring-tide level *parwa* and *akira* are replaced by scrub, usually dominated by *Hibiscus tiliaceus.* On the Wiawia flat East of the head of the first ridge this contained, apart from the abundant *Hisbiscus, Cordia macrostachya, Dalbergia ecastophyllum, Caesalpinia bonduc,* a few small trees of *Terminalia catappa* and *Spondias mombin. Cereus,* the same species as we found on the young ridges, was also represented by some specimens. *Sporobolus* formed large patches on the sand and there were also some *Crinums (1350)* that at the time of our visit were flowering. As climbers *Allamanda cathartica* and *Alternanthera ficoidea* must be mentioned. A similar vegetation consisting of *Hibiscus tiliaceus* mixed with species that are characteristic for the young ridges was observed along the river bank near Galibi and on the low ridge-remnant in the *parwa* forest North of Nieuw Nickerie (see table II record 38 and 39). On the northern slope of the 2nd ridge in the Wiawia line *Hibiscus* and *Rosenbergiodendron formosum,* a species frequently associated with it, are both abundant and they are almost all draped with vines. The lower part of the southern slope of the 2nd ridge, on the other hand, is covered by a *Dalbergia ecastophyllum* scrub. A nearly pure stand of *Hibiscus* was found in the marshy zone between the small swamp and the ridge forest in the second Coronie line near km 0.2, and some *Dalbergia* shrubs were seen at the border of the swamp. *Olyra latifolia,* *Helosis cayennensis* and some poor specimens of *Renealmia sp.* formed the scarce undergrowth.

Though *Hibiscus* prefers sand, it tolerates clayey soils, e.g. on the levee of the Corantine between Clara polder and Nanni creek where, accompanied by some *Triplaris* and *Phyllanthus acidus*, it occupied the bank behind the *mangro* belt. The most inland site where I have seen *Hibiscus*, was the marsh wood between km 10 and 10.65 in the Cupido line (Nickerie, table II record 51). Here it formed a dense scrub 4—5 m high in a very open stand of *Triplaris* with an understory consisting of *Heliconia sp.*, some *Bonafousia tetrastachya* and *Helosis*.

DANSEREAU (63) describes how near Rio de Janeiro behind the three mangrove belts a zone is found that is reached by spring tides, and that is occupied by a *Hibiscus* scrub sometimes mixed with and usually followed by *Acrostichum*. On sand *Iresine portulacoides* Moq. (taking there the place of *I. vermicularis)*, *Sesuvium* and *Sporobolus virginicus* are pioneers, on silt *Salicornia gaudichaudiana* Moq. and a large Cyperacea.

SCHIMPER (107) found in the state Santa Catharina on high, consolidated silt behind the mangrove *Hibiscus* and *Acrostichum* together with some *Annona glabra*, *Schinus sp.* and a Myrsinacea, and along the San Francisco River between the true mangrove and non-saline bank forest a mixture of *Laguncularia* and *Hibiscus* with *Annona glabra* and a Myrsinacea.

In the Old World tropics *Hibiscus tiliaceus* is often reported from similar sites as are other pantropical coastal species.

Strand scrub in the Caribbean.

In the Caribbean *Hibiscus tiliaceus* is not a prominent species in strand vegetation. MARSHALL (93) records it for Trinidad as associate of *Coccoloba uvifera*. In the Nariva swamp it is found at the base of "Sandhill", where the herbaceous swamp merges into forest.

On most sandy coasts in the Caribbean a distinct succession series is found. The Atlantic *Ipomoea pes-caprae-Canavalia maritima* community occupies the frontline; then comes a zone dominated by *Coccoloba uvifera*, and this is followed by a more or less xerophytic scrub. Where conditions are favourable, this in turn gives way to a littoral woodland.

The first community is the only one found in Suriname. It occurs here in poor form as precursor of strand mangrove or *Hibiscus* scrub. *Coccoloba uvifera* is completely absent, the three collections made in Paramaribo being from cultivated specimens and the most characteristic species of the dune scrub, *Thespesia populnea* (L.) Soland, *Hippomane mancinella* L., *Lantana involucrata* L. and strand plants like *Chamaesyce (Euphorbia) buxifolia* (Lam.) Small, *Scaevola plumieri* (L.) Vahl, *Tournefortia gnaphalodes* R. Br., etc. are also entirely lacking.

The principial reason why they are absent here and as far as I know along the whole Guiana coast, may be the lack of diaspores, but other factors may also have influence. The climate in the Caribbean is in general much drier than in Guiana. The beaches in the Caribbean are, as a rule, rich in coral sand, whereas the Suriname sands are poor in lime, and although occasionally shell deposits are found they may be too small. At present the sand supply is nowhere large enough to allow the formation of high offshore bars. In the past when the present ridges were built up, the situation must have been different. Therefore in Guiana the strand and dune shrubs may not find at present the habitat they require, and whether they have not done so in the past we do not know.

Another species probably absent by lack of a proper habitat is *Conocarpus erecta,* common in the Caribbean on higher sandy soil behind the mangrove belts sensu stricto. There in many places the land rises gradually out of the sea and on sandy soil the *Avicennia* forest above the normal high-tide line is replaced by a *Conocarpus* vegetation. Between the two types of vegetation there is often a transition zone dominated by *Laguncularia.* In Suriname the mangrove never fringes dry sandy areas and *Conocarpus* is virtually absent. The species was once collected about 100 years ago and for the second time in 1943.

Sociological units.

Some remarks may be made here on the names given to the communities by various authors.

STEHLÉ (116, 117) regards the American mangrove as a single association dominated by *Rhizophora* and *Avicennia,* whereas most ecologists recognize in the latter distinct belts each with its own conditions of life, and accept these as separate communities. I share the last opinion and should raise STEHLÉ's association to the rank of alliance with *Laguncularia* as first characteristic after which it can be named *Lagunicularion.* DANSEREAU (63) calls the *mangro* belt in the deepest water *Rhizophoretum manglei,* and the *parwa* forest, at the back of it *Avicennietum tomentosae.* MOLDENKE, the monographer of the genus, regards *Avicennia tomentosa* merely as a form of *A. nitida,* an opinion to which I can fully subscribe, for I have seen in Suriname a complete series of transitional forms growing in the same locality. Therefore the association should be renamed *Avicennietum nitidae;* it is identical with the *Avicennia consocies* of DAVIS (67) and CHAPMAN (59).

DAVIS (66) divides the *mangro* stands in a *pioneer Rhizophora family* in deep salt water, a *mature Rhizophora consocies* growing between mean low water and neap-tide level and a *Rhizophora swamp locies* in brackish or fresh water. CHAPMAN (59) mentions only the latter two units.

DANSEREAU's *Laguncularietum racemosae* growing on sandy soil in the zone of the highest tides was not encountered in Suriname. It can not be compared with the *Laguncularia* scrub found in the *Rhizophora* belts along river banks, as this has a quite different habitat and must probably be considered a pioneer stage preceding the establishment of *mangro.* On the other hand it appears to be identical with the *Laguncularia consocies* of DAVIS and CHAPMAN found in S. Florida and Jamaica between the *Avicennia* and *Conocarpus* belts. The mixed mangrove represents probably a fourth association, comparable with DAVIS' *mature mangrove forest associes*. The *Hibiscetum tiliacei* of DANSEREAU is related to the communities with abundant *Hibiscus tiliaceus* in Suriname, but the latter are richer in species and show a wider ecological range combined with considerable variation in composition. For the moment I think it best to take all these stands together, and for this Suriname form of the *Hibiscetum tiliacei* I am inclined to regard *Rosenbergiodendron formosum* and *Cordia macrostachya* as characteristic species. In the Caribbean this association is replaced by two communities growing on different sites. The first, the *Conocarpus associes* of CHAPMAN and DAVIS is found behind the mangrove, and the second, the strand scrub formed by *Coccoloba uvifera* and other shrubs, the *Coccoloba uvifera formation* of a.o. STEHLÉ (116) and RAUNKIAER (104) succeeds the *Ipomoea-Canavalia* community. MARSHALL (93), in his paper on Trinidad and Tobago, calls it *beach forest*, and states that *Coccoloba uvifera* is the most prominent species and *Hibiscus tiliaceus* the next in order of prevalence. This forms a good connection between the communities of Guiana and the islands.

IV. Herbaceous strand communities.

The strand communities are usually joined in one unit, characterized in the first place by *Ipomoea pes-caprae* and *Canavalia maritima*. RAUNKIAER (104) and STEHLÉ (116, 117) call it *formation* of *Ipomoea pes-caprae* and *Canavalia maritima*, DAVIS (66, 67) *strand associes*. CHAPMAN (59) describes it for Jamaica as *Sesuvium- Sporobolus- Ipomoea-associes*, whereas DANSEREAU (63) who studied it in the vicinity of Rio de Janeiro splits it up in a series of very small associations, which are comparable to the sociations of the Scandinavian sociologists and have probably only local value.

I prefer for the strand vegetation one wide association. *Ipomoea pes-caprae* and *Canavalia maritima* are prominent along beaches both in the New and Old World, and characteristic strand plants in the tropics and subtropics are *Caesalpinia bonduc*, *Dodonaea viscosa*, *Remirea maritima*, *Ipomoea stolonifera* and *tuba*, *Suriana maritima* L. (absent in Suriname), whereas the widely distributed halophytes *Sesuvium portulacastrum*, *Sporobolus virginicus*, *Paspalum vaginatum*, *Fimbristylis spathacea* are not restricted to sand coasts.

Mariscus ligularis, *Iresine vermicularis* and *Stenotaphrum secundatum* occur outside America at least also along the West coast of tropical Africa.

The strand vegetation of tropical America contains besides these very widely distributed elements a fair number of American species like *Tephrosia cinerea* var. *littoralis*, *Batis maritima*, *Alternanthera ficoidea*, *Capraria biflora*, *Heliotropium curassavicum*. Therefore it is in my opinion best regarded as a single association, which might be called *Ipomoeeto-Canavalietum americanum* to distinguish it from the Old World strand association. The latter has according to RICHARDS (14) *Spinifex spp.*, *Thuarea involuta* R. Br. and *Zoysia matrella* Merrill as common differential species.

In Suriname the association is rare. We met it on the Wiawia sand bar around the fishermen camp where the strand mangrove had been cut down. It has therefore to be regarded as secondary, and would without interference by man develop again into strand mangrove.

I owe a description of the beach at the mouth of the Matappica creek to my friend P. A. FLORSCHÜTZ, who paid a short visit to this area in 1951. Sand is deposited only in a triangle West of the mouth. The coastline is formed here by an about 1.5 m high offshore bar and a mud flat in front of the latter which remains below the high-tide line. The seaward slope of the bar is bare; on top he found mainly *Sesuvium*, less *Ipomoea pes-caprae* and scattered plants of *Alternanthera ficoidea*. The landward slope is covered with *Ipomoea pes-caprae* and *Canavalia maritima* and occasionally shrublets of *Caesalpinia bonduc* and *Dodonaea viscosa*.

Behind the sand bar he found an open flat that very gradually sloped into a salt swamp, which in turn is followed by *parwa* forest with some *Cereus*. The flat consists of mixed sand and clay and is grown with *Sporobolus virginicus* and some *Rhynchosia minima*, *Sesuvium* (parasited by *Cuscuta umbellata*), *Tephrosia cinerea* var. *littoralis*, *Vigna luteola* and *Batis maritima*. On this flat the wind has blown up some small falcate dunes.

Though the sand is apparently actively shifting under the influence of the wind, a beach must have existed at this place for more than a century, as most of the species observed by FLORSCHÜTZ were also collected here in the middle of the 19th century by WULLSCHLAEGEL and FOCKE.

From the strand at Braamspunt East of the mouth of the Suriname River we have only the collection made in 1913 by SOEPRATO, but this is enough to show that the richest strand vegetation of Suriname is probably found at this place. The same species as on the Matappica strand have been found there and in addition *Ipomoea nil* Roth, *I. tuba*, *Crotalaria retusa* L. and *Muellera moniliformis* have been collected.

CHAPTER V

THE HERBACEOUS SWAMPS

From the descriptions of the visited areas it will be clear that the swamp vegetation shows much diversity, and that the various parts of the coastal region present, besides similarities, considerable differences as well. Also in one and the same swamp different groupings occur which are often sharply delimitated, but grow, as far as we could ascertain, under precisely the same ecological conditions. Very little is known of the stability of the swamp communities and good descriptions from neighbouring countries are still completely lacking.

As stated earlier I consider it premature to draw up a set of plant sociological units. The main vegetation types, as I now recognize them, are discussed here in the same sequence as in the description of the lines, i.e. from the coast landinwards. This must roughly be in accordance with the sequence in time, but a full discussion of the successional relations between the different communities will be postponed to a following chapter.

Records of the investigated swamps can be found in table I, for important species the numbers in the table are added in brackets.

I. Eleocharis mutata community.

In several places behind the mangrove belt we have met nearly pure fields of *Eleocharis mutata.* They may be regarded as representing a distinct association for the simple reason that outside these fields the species occurs with decreased vitality only; it is therefore an absolutely constant and moreover nearly exclusive species. As associates, but scattered and in small numbers only, we found *Acnida cuspidata, Cyperus articulatus* and in the swamps along the Huntley Creek also sterile *Mikania micrantha, Nymphaea ampla* and *Ceratopteris deltoidea.* This association, which we may call *Eleocharetum mutatae,* shows a wide amplitude in its demands as to salt content and acidity of the habitat because *Eleocharis* itself can live in water that varies from completely fresh to at least twice as salt as the sea. It forms always a pioneer vegetation; in a salt habitat it can grow in water up to 30 cm deep or on mud that periodically falls dry. In oligohalinous and fresh water it occurs to a depth of 50—60 cm, but here it is soon superseded by larger herbs.

In fresh-water swamps, e.g. South of the Nickerie River, here and there patches of *Eleocharis mutata* are met. I suppose that they grow on spots that accidentally have lost their ordinary vegetation, and that their presence is temporary only.

The associates mentioned above occur only in brackish water, they do not stand high salt concentrations and the habitats in fresh-water swamps can probably not be reached by their diaspores. This does not apply to the spores of *Ceratopteris,* but it was nevertheless not met there.

Hardly anything could be found on the occurrence of the *Eleocharetum mutatae* as pioneer association outside Suriname. A. C. SMITH (123) mentions the presence in Guiana of stretches of *Eleocharis geniculata* in and behind the mangrove in salt milieu. Here a confusion with *Eleocharis mutata* must have taken place, for *E. geniculata* does not occur in the coastal region; it seems to be absolutely salt-avoiding and grows preferably along river banks outside the tidal zone. How this confusion could occur I can not see, as both species differ widely in appearance; *E. mutata* has triquetrous, bluish-green culms and *E. geniculata* terete, fresh-green ones; it resembles *E. interstincta,* another fresh-water species.

E. mutata is known from the coastal strip of S. America up to the temperate zone, also from Central America and the West Indian islands. Probably it is a pioneer in these regions too, but the literature does not tell anything with regard to this point.

SVENSON enumerates one find far from the coast in the Cerros de Tobaty in Paraguay.

STEHLÉ (117) mentions from Martinique an association of *Dryopteris gongylodes* and *Eleocharis mutata* in acid swamps. These two species are never found together in Suriname, for *Dryopteris* grows only in completely fresh water.

We too have observed that *E. mutata* turns its habitat strongly acid. It colours the water dark brown by the production of humic acids, and in the second swamp in the Wiawia line, where the periodically entering sea water has a pH of about 8, we measured in a patch of *E. mutata* in the 30 cm deep stagnant water a pH below 4. This indicates that besides humic acids also strong mineral acids are produced (OLSEN 11).

II. Brackish Typha angustifolia-Cyperus articulatus swamps.

In this swamp type *Typha* [7] and *Cyperus articulatus* [6] are the dominants, sometimes one alone, sometimes both, alternating or mixed, while but few accompanying species are present.

We met vegetations of this type in the 3d swamp in the Wiawia line, where in the dry season only small, some cm deep pools were left; in the greater part of the swamp the mesohalinous ground water stood a few cm below the surface of the wet clay. Here *Typha* and *Cyperus* dominated patchwise; *Typha* showed perhaps a slight preference for the lower places, but the difference was insignificant. *Paspalidium geminatum* formed nearly everywhere an easily overlooked, but in number of culms notable, subgrowth. Only where the *Typha* stands were very dense they possessed little subgrowth. In more open stands of *Typha Cyperus articulatus* was present as well. The associates *(Torulinium ferax, Acnida cuspidata, Jussieua leptocarpa, Mikania micrantha)* grew scattered whereas *Brachypteris ovata* was locally abundant.

Here and there in the 2—2.5 m high growth we noted a patch of *Eleocharis mutata* or a group of *Acrostichum aureum.*

On the soil we found remnants of *Salvinia auriculata* which in the rainy season covers the water surface at those places where the other plants do not stand too close.

South of Bigie pan the *Typha* stands are very sharply delimitated from those of *Eleocharis mutata* and *Paspalum vaginatum.* Under the *Typha* cover both species can just maintain themselves and only for a time. *Acnida cuspidata, Torulinium ferax* and *Jussieua decurrens* may also be present but they are always rare.

Along the Huntley creek in the southern swamp savannas *Cyperus articulatus* dominates; *Eleocharis mutata* is still present in fair numbers, but the culms are thin and further apart than in the *Eleocharetum.* Sterile

Mikania micrantha, Ceratopteris deltoidea and *Sesbania exasperata* grow scattered. In this area therefore both variants of the community are present in oligohalinous habitat, and here we see a marked difference; *Typha* grows in water up to 45 cm deep, whereas the habitat of the *Cyperus* stands was at the time of our visit, i.e. in May before the heavy rains set in, merely soggy. In the scattered groups of *parwa* trees we saw some *Solanum stramonifolium* and the vines *Funastrum clausum, Cissus sicyoides, Mikania micrantha* and *Paullinia pinnata.*

North of the Coronie road between our camp and Coronie vast swamps are found with *Typha* and *Cyperus articulatus* as dominants. They must belong to the type described above but could not be investigated. The data from a swamp near West Coronie visited in 1933 by LANJOUW are inserted in table I, where they fit in well.

In the line from our Coronie camp to the sea between the *parwa* and *akira* groves behind the closed mangrove we found patches of *Typha* with numerous clumps of *Acrostichum aureum* and also some other ferns, *Blechnum indicum* and *Nephrolepis biserrata,* which tolerate a little salt. Many climbers decorate the vegetation here with their flowers. Closer to the road we met patches dominated by *Blechnum indicum;* in some of these *Typha* is even completely absent and, while *Brachypteris ovata* soon disappears, other associates come in. The water depth was in December 20—30 cm, locally somewhat more. Because of the presence of *Blechnum* and *Nephrolepis* and a fairly high number of associates this vegetation forms a transition to the 4th swamp type (compare table I).

Between the *Avicennia* forest and the first ridge opposite Braamspunt STAHEL and GEIJSKES found a vast *Typha* swamp where *Fuirena umbellata* was the only associate they collected.

Opposite Nieuw Nickerie behind the *parwa* zone along the river I visited a swamp savanna which was in May soggy and polyhalinous (14,300 mg Cl/l). Later in the rainy season the salt content decreased to 4200 mg Cl/l, as I learned by the kind cooperation of the Service of Public Works, which during several months determined the salt content of water samples taken on behalf of my study. It was covered with a sward consisting of 30—40 cm high *Sporobolus virginicus* interspersed with clones of thin *Cyperus articulatus* and *Eleocharis mutata* and clumps of *Cyperus polystachyos* and *Fimbristylis ferruginea.*

The owner of a coconut plantation nearby told me that the presence of *Cyperus articulatus* and *C. polystachyos* indicates a decrease in the salt content, and that when the salinity decreases, these species strongly expand. This is very well in accordance with other observations. *Cyperus articulatus* appears, as we saw in the description of the Wiawia line, in the second swamp with a few meagre plants, and becomes dominant in the third swamp. Along the sea-water canal of Totness a few poor specimens were seen, whereas on the other side of the road along a ditch healthy robust clumps were noted.

Cyperus polystachyos is much less common than *C. articulatus* in

Suriname swamps, but except a recent find on the sea dike near Nickerie of which I can say nothing, this species has been collected in Suriname only on slightly brackish or completely saltless places.

Whether the deviating composition of this swamp savanna is determined by the soil, is not known, but it is noteworthy that all other swamps investigated by us have a heavy clay soil with hardly any sand whereas the soil of this one contains 25—30% fine sand (see table III). Moreover, from *Sporobolus*, *Cyperus polystachyos* and *Fimbristylis ferruginea* we know that they thrive as well on pure sand as on clay. This makes it probably that it is not a mere coincidence.

In the Wiawia line the borders of the 3d and 4th ridge which become inundated in the rainy season bear mainly species that occur in the swamps as associates, and moreover, as a differential element *Heliconia psittacorum*, which forms large groups. As these belts closely resemble the second swamp type, they are mentioned here.

Along the Coronie road at the swamp borders also this *Heliconia* is frequently met, but there, owing to the intervention of man who clears the roadsides, no distinct zonation is found. Here we saw also groups of *Canna glauca* which may be another characteristic species of these transition zones.

Distribution outside Suriname.

Many species from this swamp type are found in all tropical and suptropical regions, and *Typha angustifolia* is even cosmopolitan. Therefore similar vegetations may be expected outside Suriname, but the literature furnishes only scattered and vague indications.

COUDREAU (60) tells that salt swamps with "roseaux, joncs et carex" occur everywhere between Marowijne and Amazone in and behind the mangrove. They are found on stiff clay inundated a few feet during most of the year. He uses the names of French plants that more or less resemble the American species, and we may therefore conclude that these swamps probably are of our second type.

In S. Brasil according to DANSEREAU (63) *Typha* grows together with *Scirpus spp. Cyperus articulatus* is mentioned by GRAHAM (78 a) as dominant in the coastal swamps of British Guiana. In the West Indies brackish swamps show new combinations. On Porto Rico in the Cañô Tiburones between the distincly brackish mangrove and the fresh *Typha-Cladium* swamp GLEASON and COOK (77) mention the presence of a field of *Acrostichum aureum* with groups of *Typha angustifolia, Cladium mariscus* and *Phragmites communis.*

On Guadeloupe (116) *Fimbristylis ferruginea* together with *Cyperus elegans* covers slightly brackish swamps. Apparently the last species takes there the place of *Cyperus articulatus.* On Martinique (117) it occupies together with *Cyperus esculentus L.*, the borders of lagoons. *Fimbristylis ferruginea* forms there together with *Paspalum distichum* slightly brackish, soggy meadows.

III. Leersia hexandra swamps.

A number of swamps dominated by *Leersia hexandra* [14] are set apart here as a special type because in case of dominance *Leersia* forms a floating meadow as described on p. 32. Where it is mixed with tall herbs it cannot display its floating capacities well.

In the 5th, 6th and 7th swamp of the Wiawia line this type is beautifully developed as a dense, green carpet. Next to *Leersia* locally *Sacciolepis striata* [13] plays an important role. As associates we found the same species as in the second type except the halophilous *Acnida* and *Brachypteris,* although the water was mesohalinous here. Species that become common in the following type, make their entry, but ferns lack completely. *Phragmites communis* we met in a loose group in the 5th swamp.

The same type occurred in fresh-water and oligohalinous swamps near Nickerie. South of the Clara polder in the top of triangle West of the van Wouw canal we found in May in ± 20 cm water, an undisturbed dense grass mat, and next to it separated by a ditch there was a plot used as pasture ground for cattle. The composition of the flora on this grazed and badly trampled ground was largely the same as in the undisturbed plot, but the total coverage amounted to ± 40% instead of 100%, and in trample holes aquatics had found a temporary hold. Westward, where the cattle came only exceptionally, followed again a well developed meadow.

In this swamp some interesting species were collected, viz. *Echinodorus grandiflorus* and *Sphenoclea zeylanica* which are both new for Suriname. The last one is probably introduced and dispersed by cattle. *Pluchea odorata* was only collected near Nickerie; it reaches there apparently the eastern border of its area which extends over Venezuela, C. America and the West Indies.

Behind Paradise (Nickerie) a *Leersia* vegetation was encountered as pioneer community on a fallow rice field.

Except the already mentioned *Leersia* mats on Trinidad no report of this vegetation type was found.

IV. Cyperus giganteus-Typha-Scleria swamps.

In this type are brought together various communities covering together vast areas of swamp with fresh or very slightly brackish water. The plants usually constitute a stratum of tall and one of medium-sized herbs.

In the upper stratum of 2 up to 4 m high *Cyperus giganteus* [16] often dominates, in the second place comes *Typha angustifolia* [7] either alternating with *Cyperus* in a mosaic or mixed with it. Locally important species are *Scleria eggersiana* [48] and *Thalia geniculata* [41]. *Montrichardia arborescens* [20] must be mentioned as a species with high presence but usually low abundance.

The lower stratum varies from very dense to virtually absent, in the former case the upper stratum is more or less open, in the latter it is so dense that a deep shadow reigns between the culms. These variations are probably connected with different phases in the development. The substratum consists of ferns, mainly *Blechnum indicum* [17] and *Dryopteris gongylodes* [18], and grasses. *Leersia hexandra* [14] is the commonest grass, then follow *Sacciolepis striata* [13], *Luziola spruceana* [46] and *Hymenanche amplexicaulis* [47]. Cyperaceae do occur, but as a rule in such spots only where the upper stratum is interrupted; *Cyperus articulatus* is found here in loose groups mixed with the other associates of this community.

Furthermore a number of twining species are met as associates, and where enough room and light are left on the water surface small aquatics like *Salvinia, Azolla, Nymphoides,* etc. occur. These floating species are probably best regarded as fragments of a distinct community, which belongs to the open water, but penetrates occasionally into the swamp communities. In quiet open water this community is well developed and the diaspores of the component species are easily dispersed throughout the swamps. Wherever these diaspores find some space and light they start to develop.

Polygonum acuminatum [42] deserves mentioning as a species that is frequently present in small numbers. The locally important role of this species will be discussed in chapter X. Other species may be found in table I.

In some places shrubs and small trees appear in the swamp as the first signs of the development into swamp forest, but so long as they give but little shadow their effect on the growth of the herbs is very slight.

The community as a whole covers the range from oligohalinous via eutrophic to oligotrophic habitats and future research will probably reveal the presence of several variants that are correlated with the nutritive capacity and other factors of the habitat. I suppose e.g. that *Scleria eggersiana, Thalia geniculata, Mikania micrantha* and *Typha* indicate a more or less eutrophic habitat. For those variants that grow together as a mosaic in the same habitat, this explanation, of course, falls away. The correlation between the height of *Cyperus giganteus* and the depth of the water has already been discussed on p. 33.

In the Wiawia line *Cyperus giganteus* becomes only very locally dominant in the 8th swamp, where the water is not quite fresh (100—200 mg Cl/l). In the swamps between km 6.5 and 9.5 it is the principal dominant; we found it in very pure stands and robust on such places where at the time of our visit in November the soil was merely soggy or less than 20 cm under water. In the deeper parts of these swamps the *Cyperus* stratum was lower and rather open with a fair amount of *mokomoko* and abundant ferns in the substratum.

South of the Nickerie River I met *Cyperus giganteus* in several places as sole dominant, but here it alternated with fern stands and plots with *Typha* or with *Typha* and *Cyperus* mixed, and also with large swamp woods.

Ferns turn their environment strongly acid, and are apparently the most effective producers of pegasse. Close fern stands are always found on a peat layer which points to a long period of development. This fact was already recognized by JENMAN in the swamps of British Guiana and will be discussed in the chapter on succession. Therefore, where ferns take part in a mosaic this may be caused by original differences in the depth of the water or in difference in the level of the underlying clay soil. Another cause for local dominance will be the vigorous vegetative propagation by stolons or rhizomes of the important species.

Eastward near the Maratakka River in the transition from marsh forest to open swamp and in the first part of the swamp itself *Scleria eggersiana* and *S. microcarpa* play an important part. They form pure dense patches in a mixed vegetation. Beyond km 0.8 there comes a plot with *Cyperus giganteus* and *Typha* mixed; the stand remains rather loose because the vegetation is fairly often destroyed by fire.

LANJOUW (35) reports the occurrence of this type for swamps behind Coronie, and mentions a variant where *Typha* is dominant together with *Cyperus articulatus* and *Leersia*. By the presence of *Leersia* and its occurrence in fresh water it differs from my second type. Another swamp described by LANJOUW as dominated by *Cyperus articulatus* and *Leersia* with some *Crinum* and *Jussieua leptocarpa* as associates, I prefer to place here too. This variant we have observed also in 1948 during a flying visit along the fresh-water canal of Coronie, where it alternates with *Typha* plots.

Distribution outside Suriname.

All important species of this swamp type have like those of the preceding one a wide distribution, and a number of communities have been described which indicate that the type itself is also widely distributed. Not a single date was found proving the presence of the type in British or French Guiana, where its presence would be expected in the first place, but BEARD (48) mentions nearly pure *Cyperus giganteus* swamps in Trinidad, where they grow on alluvial clay, which becomes soggy in the dry season but is well inundated for the rest of the year. They are therefore very similar to parts of the swamp in the Wiawia line.

From Venezuela and the Guiana plateau MYERS (98, 100) describes vegetations of lagoons in the savanna with *Thalia, Oryza sativa?, Sacciolepis vilfoides* Chase and *Montrichardia* in rather deep water, and in somewhat shallower parts stretches of *Cyperus articulatus* and *Eleocharis geniculata,* which show resemblances with the coastal swamps.

In the savanna region of eastern Bolivia HERZOG (80) met small swamps with *Cyperus giganteus, Fuirena robusta, Thalia, Polygonum acuminatum,* a number of associates a.o. *Azolla, Salvinia, Aeschynomene fluminensis* Vell., *Pacourina edulis, Jussieua sp., Hydrolea spinosa* and the treelet *Tecoma leucoxylon* (= ? *Tabebuia insignis).* He adds that this vegetation closely resembles that of the swamps bordering the Upper Rio Paraquay.

DANSEREAU (63) mentions *Cyperus giganteus* swamps from S. E. Brazil, especially on rich, quaternary, alluvial clay. Large tracts have been reclaimed through drainage and are now converted into very valuable arable land. On the island Marajo in the Amazone estuary HUBER (83) found swamps with *Cyperus giganteus, Thalia, Typha* and *Leersia.* For a partly inundated terrain near Dunas he records *Cyperus giganteus, Thalia, Neptunia plena, Hymenanche amplexicaulis, Paspalum repens, Oryza sativa, Utricularia foliosa, Nymphoides humboldtianum, Neptunia prostrata, Eichhornia natans,* some *Nymphaea rudgeana,* etc. agreeing well with the Suriname type.

In C. America also we find closely related communities. For the shores of the Gatun lake in Panama STANDLEY (112) records *Cyperus giganteus, Cladium mariscus, Sagittaria, Pluchea, Polygonum punctatum, Hibiscus sororius, Pontederia cordata* and *Jussieua spp.*, while KENOYER (88) describes the succession along the shore at the sheltered side of Barro Colorado island in the lake. From this series the *Cyperus giganteus* stage agrees very well with my 4th type (see table I), and the preceding *Typha* stage with *Acrostichum, Sagittaria lancifolia, Hibiscus sororius* and *Crinum erubescens* comes close to it. In British Honduras and Costa Rica (113, 114) *Typha, Cyperus giganteus* and *Thalia* play also an important part and according to the species list given by OCHOTERENA (102) even the *Typha* swamps in S. Mexico have still a number of species in common with the Suriname swamps, to wit *Thalia, Phragmites, Blechnum indicum, Acrostichum, Neptunia plena, Hydrocotyle umbellata* and most aquatics. Very remarkable is the vegetation in the shallow, less than 1 km wide Lake Zotz far from the sea at an elevation of several hundred meters in the mountainous Petén district of N. Guatemala (91). Here a floating peat mass covers about one fifth of the lake and bears a vegetation of *Typha, Scleria eggersiana,* ferns, etc., which fits very well in my 4th type (see table I). In the shallow zone between peat and shore *Nymphaea ampla* dominates and *Typha,* etc. grow in scattered groups. Along the shore *Polygonum acuminatum* is an important species and in the periodically inundated zone there are clumps of *Rhynchospora corymbosa, Scleria eggersiana* and *Heliconia spp.* as well. In the 16 by 3 km wide Lake Petén the same *Nymphaea* community occurs with usually an *Eleocharis interstincta* belt as protective wave-breaker. Along the southern shore stretches of *Cladium* are found.

On the West Indian islands nearly all important species occur, except *Cyperus giganteus,* but there they have a place in other communities. STEHLÉ (117) combines all communities on the various islands occupying the same ecological place on alluvial clay soils into one association on the ground that they agree in characteristic and preferent species, but he does not say which ones. On account of the reported species it is evident, that his *Fuirena umbellata-Rhynchospora aurea* community on Martinique and his *Mariscus-Fuirena* community on Guadeloupe are closely related (see table I) and it is possible that the brackish swamps of British Honduras in which according to STANDLEY and RECORD (115) *Fuirena* and *Mariscus spp.* are common, may be related with them. How on the other hand STEHLÉ wants to defend that the *Typha-Mariscus* swamp of Porto Rico described by GLEASON and COOK (77) belongs to the same association, I cannot see. Except *Cladium mariscus* and *Rhynchospora stellata* the only species it has in common with STEHLÉ's communities are *Eleocharis interstincta, Hydrocotyle verticillata* and *Bramia monnieri* and all these three are wide-spread swamp species. The publication on Haiti mentioned by STEHLÉ I could not lay hands on. The swamp of Porto Rico is in my opinion far more closely related to the vegetation of the Everglades in Florida and the swamps in the N. American coastal plain described by DAVIS (68) and PENFOUND and HATHAWAY (103).

In connection with the *Cyperus giganteus* swamps attention may also be drawn to the *Cyperus papyrus* swamps in Africa, which show in their structure and development striking parallels to the former.

MIGAHID (139) studied the "Sudd" swamps along the Upper Nile in which *Cyperus papyrus* is over large areas the only and absolute dominant with as associates some climbers, viz. *Ipomoea aquatica* Forsk, *Cissus ibuensis* Hook. f., *Luffa cylindrica L.* and *Vigna nilotica* Hook. f.. The habitat along the Bahr el Jebel varies considerably, near lake No papyrus stands in a swamp which is in a very dry season still 60 cm deep, but where the water level rises ± 25 cm in the rainy season. 100 km South of the lake the swamp was only 20 cm deep, 300 km South the soil had risen to 41 cm over the lowest river level but the soil was still saturated with water and became inundated during the rainy season. Further South the banks rose more and more over the river and the papyrus fringes became narrow and at last they disappeared completely. The best papyrus growth is found in the middle part of the area where the swamp loses its surface water for a short period in the dry season by drainage towards the river. Just like *Cyperus giganteus* under permanent inundation it does not reach its optimum development and on drier spots the plants die with the exception of the rhizomes and rest untill the rainy season. A difference is that *C. papyrus* forms distinct clumps 50—70 cm in diameter and about a foot apart which rise gradually by the formation of successive layers of rhizomes. The old rhizomes and culms decay to a peat layer rather sharply set off against the underlying clay.

By its fast growth papyrus suppresses other swamp species like *Phragmites* and *Typha australis* Schum. et Thonn. and the grass *Vossia cuspidata* Griff. which occur in similar localities. Only along the borders where papyrus can not grow they get a chance. In water deeper than 80 cm papyrus can not root in the soil but here the rhizomes can form a floating mat, an ability I do not know from *Cyperus giganteus.*

Very different is the vegetation of the Namanve swamp in Uganda (133), which stretches like a tongue landinwards at the North side of Victoria lake. Here *Cyperus papyrus* is also dominant on a 1.5—3 m strong peat layer which is soaked but not covered by water, but it is accompanied by numerous other species. Frequent to abundant are the grasses *Miscanthidium violaceum* Robijns and *Panicum chionanche* Mez and the ferns *Dryopteris striata* C. Chr. and *D. thelypteris* A. Gray.

In relation to the *Cyperus giganteus* swamps the presence of the following species may be mentioned: *Fuirena pubescens* Kunth, *F. umbellata, Typha latifolia* L., *Polygonum serrulatum* Lag., *Cyperus haspan, Leersia hexandra, Cissus adenocaulis* Steud. ex. A. Rich., *Mikania scandens* Willd., *Scleria sp.*

V. Rhynchospora corymbosa type.

Rhynchospora corymbosa [56] though occurring sometimes in scattered clumps in the preceding type is the characteristic species of this community, which is probably restricted to old oligotrophic swamps with a thick pegasse layer. We met this type in the extensive swamp area South of the ridge complex along the Coronie road near our camp. Ferns formed here the bulk of the vegetation; they formed a 1.5 m high dense jungle submerged about 0.5 m in dark brown acid water and overtopped by 2 m tall *Rhynchospora* and *Montrichardia.* Scattered shrubs of *Chrysobalanus, Tabebuia, Pterocarpus, Palicourea crocea* and young *maurisie* palms indicated the transition to swamp wood. Beyond the common ferns *Blechnum indicum* [17] and *Dryopteris gongylodes* [18] we found here also *Nephrolepis biserrata* [19] and *Pityrogramme calomelanos.* Interesting is the occurrence of the very inconspicuous, thin and flaccid *Eleocharis plicarhachis* [57] which appeared to be new for the Suriname flora.

A variant of this community with grasses instead of ferns is described by LANJOUW (35) from the swamp along the southern part of the freshwater canal of Coronie. Next to *Rhynchospora* the dominants are there *Leersia hexandra* [14] and *Panicum grande* [53] which are responsible for the formation of a floating flexible mat just strong enough to bear the weight of a man, but not allowing him to stay for long on one spot. In the fern swamp this mat is missing and here one has to stumble over the submerged roots and the mass of peat.

We do not yet know this type from the eastern part of Suriname although it will probably be present there. In the *Cyperus giganteus* swamps some *Rhynchospora corymbosa* was found and in the swaying swamps the closely related *R. gigantea.* At km 11.6 the Wiawia line passed within 100 m of the tip of a swamp which was nearly exclusively covered with *Rhynchospora vs. gigantea.* The species is not quite certain as no specimens were collected in this swamp, but from four places in the line beyond km 10 material of this species was gathered whereas *R. corymbosa* was found only between km 3 and 8. Thus a slight ecological difference seems to exist between the two species, but to prove this detailed research will be necessary.

Distribution outside Suriname.

In British Guiana in the Pomeroon basin SCHOMBURGK (108) found swamps covered with a floating mat formed by tall grasses and Cyperaceae which could be passed only on the risk of sinking through the mat. Furtheron he met swamps with dominance of *Blechnum* and *Dryopteris* and groups of Cyperaceae. In the light of the following we may conclude that these swamps belong to the *Rhynchospora* type. MYERS (98) estimates that at least 95% of what he calls swamp savannas in Guiana and the Orinoco delta are grown with a coarse brown *Rhynchospora*. This may be true for the western part of Guiana, but it certainly does not hold for Suriname. MYERS himself says that in East British Guiana most swamps are drained and grazed and in the adjacent district Nickerie *Typha* swamps with *Erythrina* islands occur.

This are the only data applying to this swamp type. The remarks of A. C. SMITH (123) are apparently based on the paper of MYERS but the latter's description was not correctly interpreted. Of the 7 species mentioned by MYERS for the swamp vegetation along creek banks SMITH has selected four and promoted these with little justification to important swamp plants. *Sacciolepis striata* can be abundant on small plots but occupies just like *Hymenanche* in general a subordinate place in the swamps.

Of *Eleocharis geniculata* I have said before that it prefers current water; in swamps the resembling *E. interstincta* occurs frequently but only under special conditions it is found in large quantities (see chapter X). At last *Panicum elephantipes* is a species which so far as I know occurs only along river banks.

The community of ferns and Cyperaceae described by EGGELING (133) from the Namanve swamp (Uganda) in Central Africa shows a distinct affinity with this type. This community succeeds a *Nymphaea* community, and grows either in undeep water or in deeper water as a floating belt preceding the *Cyperus papyrus* swamp. Except scattered groups of up to 3.5 m! high *Rhynchospora corymbosa* the principal species are *Dryopteris striata* C. Chr., *Pycreus mundtii* Nees, *Fimbristylis subaphyllus* Boeck., *Cyperus haspan*, *Leersia hexandra*, *Fuirena pubescens* Kunth, *F. umbellata* and *Polygonum* aff. *serrulatum* Lag.

VI. Lagenocarpus guianensis-other Cyperaceae type.

As the last type of herbaceous swamp I will mention here the vegetation of the "zwiebelzwampen" or swaying swamps about half way between Moengo tapoe and the Wiawia flat. In most places where the peat layer proved to be strong, *Lagenocarpus guianensis* [69], a very coarse sedge defined the aspect. It formed very dense, pure, 2 m high patches in a lower and less dense vegetation of the same species together with *Montrichardia* [20], *Eleocharis interstincta* [43], *Rhynchospora triflora* [68] (new for Suriname), *R. cyperoides* [65] and *R. gigantea* [66]. Near the northern border of the great swamp a zone of *Chrysobalanus* shrubs had developed and from the borders *maurisie* palms invaded the swamp with a closed front and scattered precursors. In the swamp between km 13.1 and 13.4 in the Wiawia line *Rhynchospora gigantea* is fairly frequent and reaches a height of nearly 2 m. The other above mentioned Cyperaceae are present in small numbers all over the swamps, but around gaps in the peat layer they grow best and form clumps.

In the southern part of the great swamp where no peat was found and where the water was during our visit only 10—50 cm deep, a variant of the community was found with *Becquerelia tuberculata* [70] dominant and *Lagenocarpus* with the other Cyperaceae far behind. The same variant was also met in a small peat bog which had developed in a depression in the savanna 5 km to the South.

In the part of the swamp South of the second island where the peat was still thin, loose and nearly unpassable, most of the species of the *Lagenocarpus* community were present but small, and the numerous savanna species (see p. 36) in between made the vegetation look like a savanna. Remarkable was the abundance of *Lycopodium meridionale* [71] forming a stratum of its own over the surface of water and peat and probably playing an important part in strengthening the floating peat layer and weaving it together.

We have not seen this vegetation type in other parts of Suriname, but our Indian foreman HENDRIK TEMPICO told us that it also occurs in the region of the Lower Coppename River and this statement finds support in the aerial photographs. For the area North of the Wayombo between Coppename and Nickerie River the photographs show an intricate pattern with forested islands which shows resemblances but also differences with the great swaying swamp. The most remarkable feature is the interchanging of very light to nearly black shades in identical parts of the mosaic on subsequent prints. Therefore an investigation of this area seems very promising.

Distribution outside Suriname.

From French Guiana COUDREAU (60) reports perilous "savanes tremblantes" where a man easily sinks in the loose peaty mass of these meters deep swamps. These swamps may belong to this type, and in British Guiana it may also be expected from the descriptions of swamps given by SCHOMBURGK (108) and JENMAN (87). They are covered with large Cyperaceae, speckled with pools covered by waterlilies and other aquatics and fringed by pure belts of *maurisie* palms which also gird the scattered forested islands.

On Trinidad in the Aripo savannas (48) *Lagenocarpus guianensis* dominates in a vegetation on solid clay which during most of the year is wet. It shows affinities with both the clay savannas and the swaying swamps of eastern Suriname. *Rhynchospora longibracteata* Boeck. and *Bulbostylis junciformis* Kunth are subdominant, a distinctive character not met in Suriname where both are subordinate species in savannas. On the other hand *Paspalum pulchellum* Kunth, *Drosera capillaris*, *Utricu-*

laria spp., terrestrial orchids and *Chrysobalanus* occur also in the floating savanna in the great swaying swamp, where *Ilex martiniana* takes the place of *Ilex arimensis* (Loes.) Britt.. *Bactris savannarum* Britt. reported by BEARD as endemic in these savannas is very similar and certainly closely related to the *Bactris* species of the savannas in the Moengo tapoe line. At last the Aripo savannas merge into palm marsh predominantly consisting of *Mauritia* and *Chrysobalanus;* this is very similar to many swamp fringes in the Wiawia-Moengo tapoe transect (see chapter VII).

CHAPTER VI

SWAMP FOREST

The records of these and the following forests can be found in table II, for important species the number used in the table has been added in brackets. In swamps and on at least periodically waterlogged soils several types of woody vegetation are encountered which BEARD (48) divides in swamp- and marsh forests on account of the time of inundation, the former all the year round the latter only a part of the year. This distinction appears to be very useful also when we make a division based on the floristic composition and it is much easier for use in the field. Therefore we will start with a description of the swamp forests, i.e. the forests on soils that are as a rule permanently inundated but which may in excessively dry years become superficially dry.

I. Mixed swamp wood.

As first type we sometimes meet directly behind the coastal mangrove belt a mixed, rather open, low swamp wood. In the transect from our Coronie camp to the sea we crossed the salients of a large swamp wood which more eastward extends over the whole swamp from the mangrove up to the road. Important species are here *Annona glabra* [4], *Andira inermis* [16], *Ficus spp.* [6], and furthermore *Tabebuia* [3], *Triplaris surinamensis* [1], *Ilex guianensis* and *Chrysobalanus icaco* [5], with a subgrowth of *Acrostichum* [144], *Blechnum* [143], some *Nephrolepis biserrata, Heliconia psittacorum* [163], and the climbers that are common to most swamps (table II). Important is the presence of *Andira inermis* as this species is not known to me from any other swamp wood, although it is widely distributed in marsh and other forests. GEIJSKES (30) reports for the low swamp wood found behind the mangrove North of Paramaribo and opposite Braamspunt *Annona glabra* as the dominant tree; mixed with it was *Chrysobalanus.*

North of the Coronie road in the neighbourhood of Groningen I saw early in September richly flowering *Triplaris, mierenhout,* in apparently pure stands. They were recognizable from a long distance in the herbaceous swamp.

The mixed type is also found along the short lines North and South of the Coronie road at km 19.2 and behind the levee forest of the Nickerie River West of the mouth of the Maratakka. Here the density decreases gradually the further we leave the river behind us, while the subgrowth of swamp herbs becomes dominant. From the levees individuals of several marsh and tidal-forest trees penetrate for some distance into the swamp wood e.g. *Cordia tetrandra, Ceiba pentandra, Spondias mombin, Coccoloba latifolia, Bactris, Cecropia peltata, Inga ingoides, Phyllanthus acidus.*

In the swamps between Corantine and Maratakka also large and small swamp woods occur. Many of these consist mainly of *Pterocarpus officinalis* [2] and *Tabebuia aquatilis* [3].

GONGGRIJP and BURGER (34) deal only with the variant dominated by *Pterocarpus, waterbébé,* and point out the remarkable appearance of this forest where the trees possess high snake-like winding buttresses, give deep shade and make the impression of trees in fairy-land. According to the authors this kind of forest is often found directly behind the mangrove belt to which should be added: along the lower river courses. ANDERSON (45) mentions similar habitats for British Guiana, and for Brazil too the presence of *Pterocarpus* in river bank mangrove is reported.

GEIJSKES (30) mentions *Pterocarpus, Triplaris, Tabebuia insignis var. monophylla* and *Inga vera* for swamp woods. The last-named species does not occur in Suriname, but on the Caribbean islands; the species he had in mind is the closely related *Inga ingoides* which was found by us too.

BEARD (48) describes a tall and nearly pure *Pterocarpus* forest from Trinidad and *Pterocarpus* forests are known also from Porto Rico and the Lesser Antilles.

In British Honduras *Pterocarpus officinalis* forms together with *Bactris minor* Jacq. swamp forests in the tidal zone (113). According to STEHLÉ (117) the analogon on Martinique of the *Pterocarpus* forest of Guadeloupe is an *Annona glabra-Dalbergia ecastophyllum* association dominated by *Annona* and growing in coastal lagoons with stagnant, fresh, acid water. Companions are the vines *Paullinia pinnata, Hippocratea volubilis, Brachypteris ovata, Cissus sicyoides* and some epiphytes. *Dalbergia* apparently takes there the same place as *Chrysobalanus* opposite Braamspunt. In Suriname *Dalbergia* was only found along the margins of ridges, not in the swamps.

In this connection we may mention also the *Annona glabra* woods of S. Florida which in former days covered large areas on the swampy shores of lake Okeechobee. DAVIS (68) mentions as subgrowth of these woods *Cyperus haspan, Thalia, Sagittaria, Dryopteris gongylodes, Blechnum indicum* and *Osmunda regalis L.*. He cites *Chrysobalanus* and *Rapanea guyanensis* Aubl. under the associates in swamp woods consisting of northern tree species.

How far swamp woods of this type range in a south-eastern direction I cannot tell. All tree species mentioned above occur in Amazonia, but with regard to their occurence in coastal swamps I have found nothing.

II. Erythrina glauca swamp wood.

As second type of swamp wood I present here the very uniform *koffiemama* wood with *Erythrina glauca* as absolute dominant and only a few lianas and herbs in small numbers and an occasional treelet as associates. We met in the groves *Dryopteris gongylodes, Blechnum indicum, Desmoncus horridus, Heliconia psittacorum, Mikania micrantha* and *congesta;* LANJOUW (35) mentions also *Panicum grande, Entada polystachya, Cordia tetrandra, Sesbania exasperata* and *Aeschynomene sensitiva,* the last two probably in the border. Ir. VAN BEUKERING orally informed me that in Nickerie *paloeloe, Heliconia sp.,* entered as companion mainly in the border zone.

Around the groves usually a narrow ring of tall *mokomoko* is seen. This species is present in the swamp and scattered in the groves as single individuals, but finds at the border of the groves for unknown reasons an optimal habitat to form dense stands. In this connection the fact may be stressed that wherever *Montrichardia* is gregarious it grows in fringes backed by forest, a.o. along river banks and ridge borders.

The striking uniformity of these woods may be due to special properties of *Erythrina* which prohibit the germination or the development of other trees in its immediate surrounding. One factor might be the deep shadow the tree casts most of the year, another one the trend to form groups either from seed or by vegetative propagation.

If a mature tree falls down it does not succomb as a rule but forms over the whole length of the trunk secondary stems. Whether root saplings can be produced I could not ascertain. Besides this point the influence of the tree on the habitat should be investigated, for it is remarkable that the tree grows in deeper water than the surrounding herbaceous vegetation. This was experienced both in the small *koffiemama* groups in the 5th up to 8th swamp in the Wiawia line and in the woods, often several hundred meters in diameter, South of the Nickerie River. We find on the soil beneath the groves but a thin cover of humus whereas in the surrounding swamp a thick pegasse layer is present. This explains the actual difference in water depth but not the processes involved in the development to the present status. However in a completely different area, S. Louisiana, the same phenomenon has been described by PENFOUND and HATHAWAY (103) for the transition of *Typha* swamp into *Taxodium* forest; here obviously a succession takes place during which the earlier formed peat layer is rapidly destroyed. This happens as soon as *Taxodium* trees invade the *Typha* swamps. In the case of the *Erythrina* woods a similar development seems probable for I think it unacceptable that the pegasse layer should have been formed after the local establishment of *Erythrina* as this would imply that these groves have had their present extent from the start of the peat growth.

What chemical and physical changes can be brought about by certain trees and how these changes can lead to the decomposition of peat offers an interesting subject for future research.

GONGGRIJP and BURGER (34) place the *Erythrina* stands under fresh water seasonal swamp forest, but as we have seen they are typical for permanent swamps. They are found in the same habitat as the swamp woods of the first type, though as far as we know never directly behind the coastal mangrove. On the other hand they tolerate mesohalinous water (5th swamp 4100 mg Cl/l), more brackish than that found in woods of the first type.

Sometimes both types are met close together in the same swamp as in the area South of the Nickerie River, but the complexes are always strictly separated.

GEIJSKES (30) stresses the curious fact that *koffiemama* seems to be absent in the central part of Suriname as a wild tree although it is used here everywhere as shade tree in the coffee plantations. In the eastern part of the coastal region it is frequent in meso- and oligohalinous swamps and rare in fresh water, whereas in the western part it forms large complexes mainly but not exclusively in fresh swamps. North of the Coronie road between our camp and Coronie *Erythrina* woods could be discerned far into the brackish *Typha* swamp and North of the Nickerie River East of Paradise extensive woods are present, as I learned by local in formation and could verify afterwards on the aerial photographs. STANDLEY (112, 113) records the presence of extensive *Erythrina glauca* woods in swamps in the Lancetilla valley (British Honduras) and in Panama. From elsewhere they have not been described but as the species is indigenous to all tropical America we may expect stands in other coastal areas.

Erythrina occurs on wet spots in the interior too, but not in pure stands. In Suriname the species was collected along the Koetari and Lucie River, and it has also been reported from Amazonia and HERZOG (80) even met it in E. Bolivia in marsh forest in the savanna region. A distinct disjunction seems to exist between the coastal area of the species and its distribution in the interior.

III. Machaerium lunatum scrub.

The third type of woody swamp vegetation is the horrible *brantimakka* scrub described on p. 31 in its typical form i.e. when it is a virtually pure stand. In the 4th swamp in the Wiawia transect a very few small *Ficus* trees and one *Annona glabra* rose above the flat scrub canopy and some *Salvinia* plants floated on the water. In the swamp strips North of km 19 near our Coronie camp the shrubs made passage already difficult and had produced a layer of the characteristic organic mud, but they did not yet form a closed canopy and between them several swamp species were still frequent.

Besides brackish swamps this scrub inhabits also vast stretches along river banks in the tidal zone, where the water is polyhaline to fresh. On the bank side the shrubs are 3—4 m high, in the outward edge they slope down to the water; the lowest branches extend far over the stream and become even submerged at high tide.

Palm swamp.

GONGGRIJP and BURGER (34) like to see an equivalent of BEARD's palm swamp in the *maka-palm* swamps in Suriname. This should be a palm forest of *Bactris minax* Miq. and *Desmoncus spp.* with low subgrowth. In this form we have not met it. BEARD's palm swamp (48) consists of very tall palms up to 30 m high over an understory varying from scrub to 18 m high forest, but poor in species. *Bactris spp.* on the contrary are short-stemmed palms usually in the understory of my first type of marsh forest, but apparently sometimes tending to form more or less pure stands. I regard the *maka-palm* stands therefore as a local variant of the marsh forest and certainly quite different from the palm swamp of BEARD.

BEARD's *Roystonea oleracea* consociation near the sea is lacking in Suriname; his second consociation the *Mauritia* swamp he records also for the Orinoco delta and the Guianas. It covers the margins of swamps of my 4th, 5th and 6th type. Successionally it is the initial stage of marsh forest. In its composition it is so closely related to BEARD's palm marsh that I bring it to the same association (see p. 82).

CHAPTER VII

MARSH FOREST

Habitat.

The scarcity and incompleteness of the data now available on one hand and the many gradual transitions met especially in the coastal region on the other, make it very difficult to distinguish general types in the forests growing on not permanently submerged ground. Not only are the floristic data necessarily too limited but also too little is known with regard to the habitat as we have only snapshot surveys taken in the various areas in different seasons. The periodical changes, among which especially those of the ground-water level are very important, could only be estimated indirectly or guessed at.

The soil profile gives us an aid in this matter. Where the water rises well over the surface in the rainy season and in normal years does not fall so far below it to allow the superficial layers to dry out, the litter decays rapidly, and a black brown top layer rich in humus develops which gradually becomes less rich in humus downwards changing into a horizon with brown or red iron stains. In depressions with bad drainage that become filled with water in the rainy season we meet this profile under marsh forest. If the soil stays soaked and remains submerged during a large part of the year, a black nearly structureless peat accumulates, as is found along the borders of older ridges. This marginal forest is richer in species than the true swamp woods and is treated here under marsh forest, but in fact it is intermediate.

Along rivers and creeks over vast distances low forelands are found that are flooded seasonally. In Brazil these are called *varzea* whereas the wooded permanent swamps behind high levees usually found in the centre of wide meanders are designated as *igapo*. For the water household the varzea forest joins up with the marsh forests but they are enriched seasonally with sediments brought down by the river. Furthermore the vegetation is more or less differentiated because at the forest margin light intensity is high down to the water surface enabling many species to thrive here luxurious; moreover there is always some change in the soil, the levees being more or less elevated and containing less fine particles than the sediments farther away from the stream. Some species seem to be exclusive to the river-bank forest margins. The most conspicuous species is *Bombax aquaticum* very common along the middle course of rivers in Guiana and Amazonia, but as far as I know never seen within a forest.

At last the tidal forests along the lower river courses are left. They are submitted to a very intricate series of changes of the water table, differing from place to place and challenging every classification. This holds especially for the vegetation of the levees that are subject to the direct influences of the tides. The milieu of the swamp forests behind the levees is much more stable because only the top of the tidal waves passes the levees. The soil remains submerged, and although the water level fluctuates, this variation is of little importance for the aeration of the subterranean parts of the plants.

The levees on the other hand emerge at least several hours a day enabling the establishment of a number of species which cannot resist a prolonged submergence. On the levees no pronounced layer of humus is formed, probably because the litter is washed away by the floods. The tidal forests grow in fresh or nearly fresh water. Where the water is distinctly saline during a good part of the year, the levees are occupied by mangrove forests. A second point of importance is the extent to which the top soil dries out in the drought season as the bulk of the root system of the trees seems as a rule to be found in the upper two feet of the soil.

BEARD (48) describes a badly draining soil or a soil provided with an impermeable layer at slight depth which causes a rapid water-logging and inundation in the rainy season as typical conditions for the development of marsh forest. In the dry season however after the stock of water has been used up, an excessive desiccation sets in. The intensity of the drought, of course, is important. In Suriname where the dry season is less pronounced than in Trinidad, this situation occurs locally but there no marsh forest is developed, but a savanna vegetation. In the true marsh forests which in Suriname develop over impermeable subsoil the watercapacity of the top soil which is rich in humus, and the layer under it together form a sufficient reserve to cover in normal years the loss during the dry season.

This is well illustrated in the clay savanna area North of the Wane Creek in the Moengo tapoe transect. In the savanna the impermeable subsoil is found only ± 40 cm below the surface, but where a slight depression in the subsoil is present and the covering ground is 80—100 cm thick marsh forest is developed.

In the flat coastal region the water level in the rivers does not fluctuate very much in the course of the year. Therefore we meet here no terraces that are flooded at one time of the year and parching several meters above the river at another time. Such terraces occur in the middle course of the rivers.

On the contrary all over the coastal region the rivers are subject to tidal influence which supplies the forest along the bank permanently with water.

To get a good idea of the various habitats and of the corresponding forest types on river banks all along the course of a river a series of regular observations on many points and during a number of years will be necessary. Some authors have pointed to the changes in the riverbank vegetation occurring all along its course, but these changes have never properly been studied. Some remarks on the changes along the lower parts of the rivers are made in the chapter on the mangrove.

Floristic composition.

If we pass on now to the floristic data, we see that in the marsh forests in general those species which also inhabit the swamp forests play an important part. Besides these many species that are common in rain forest come in, viz. those that tolerate periodical flooding, and we see from table II that a distinct connection exists between the composition of a certain marsh forest and the neighbouring dry forest. Within rather wide limits the presence of diaspores seems to be more important for the occurrence of a species than the habitat. Many trees produce heavy seeds and although we know little about the way of seed dispersion, this supposition does not seem improbable.

A third group of species seems to prefer marsh forest, but occurs also in forest where the soil is never submerged. Judging however from the elevation which was found by levelling the lines, the species of this group are restricted to those parts of the forest where a permanent good water supply is guaranteed.

A complication is usually met with in transition zones, where not only the water supply but also the soil structure changes. Along the margin of the ridges we see the ridge sand merge more or less like a wedge into the clay of the swamp and erosion or peat formation may complicate the situation. Along many creeks which have eroded a deep bed in a period when the sea level was several meters lower than it is at present, we now meet terraces of peaty mud that are sometimes several meters deep, and which may fill a large part of the old valley.

On account of the now available data I have distinguished two main types of marsh forest, the representatives from various areas however showing a wide range of variability (compare table II).

I. Triplaris surinamensis-Bonafousia tetrastachya type.

This type is characterized by the high presence and abundance of *Triplaris surinamensis, mierenhout* [1], and by the fact that this species is often accompanied in the subgrowth especially on the wetter places by the shrub *Bonafousia tetrastachya* [142]. Differential species with respect to the second type are, apart from the two mentioned ones, *Cordia tetrandra* [9], *Ficus sp.* [6], *Cecropia vs. peltata* [10], *Spondias mombin* [12], *Ceiba pentandra* [13], *Annona glabra* [4], *Coccoloba latifolia* [11], *Hymenaea courbaril* [38].

This type we met in the younger parts of the coastal region. In the Wiawia transect along the margins and in depressions of the ridges between km 2.9 and 10, in the shell-ridge area near our Coronie camp and on levees and fragments of low ridge around Nickerie. HUBER's record (83) of tidal forest along rivers on Marajo in the Amazone delta accords well with it (table II rec. 51).

II. Symphonia globulifera type.

The second type is characterized by *Symphonia globulifera, matakki,* which in these wet habitats is always provided with numerous knee-shaped pneumatophores which protrude 30—100 cm over the soil surface and which sometimes highly hampered our passage. Differential species with regard to the first type are, besides *Symphonia* [30], *Rheedia kappleri* [34], *Catostemma sp. (barmanni)* [35], *Licania macrophylla* [31], *Copaifera guianensis* [36], *Eschweilera longipes* [32].

This type was observed only outside the younger parts of the coastal region and there it occurred in various forms. In the Wiawia line we found it along the margin of the older ridges beyond km 10, and as strips separating the older ridges in the Moengo tapoe part of this transect. Still further South in this transect in and along creeks in the savanna belt it was also present.

Near the Tibiti savanna it filled the creek valleys and along the Tibiti and other rivers we observed it on many places where the bank was low. Even in the Nassau mountains we met it on the plateau at a height of 530 m in a shallow depression along a creek.

The conditions along creeks come close to a swamp habitat. HEINSDIJK (44) states that swamp forest with *Symphonia, Tabebuia, Pterocarpus* and *Virola* is the most common and wide-spread type, especially along the rivers in the middle course. This forest should be my second marsh-forest type. I have visited but one forest of this type along the larger rivers at the former plantation Berendslust (Suriname River), which was inundated 50—60 cm in April 1949 after a very wet period. Whether it was a real swamp forest and not a marsh forest I can not tell, but the abundance of *pina* palms suggests that the inundation is not permanent (see following paragraph). Therefore I must leave open the question whether the *Symphonia* community is also adapted to real swamp conditions or not, untill a series of observations made in all seasons and in many places is available.

Features that are common to both types.

A fairly large number of species may be found in both types. In the first place *Virola surinamensis, baboen* [18], and *Euterpe oleracea, pina* [17], show a high presence. The last-named species shows within one marsh forest complex a very marked variability in abundance which proved to be closely correlated to the elevation. At many places it reaches absolute dominance in a definite zone in the forest forming as much as 90% of all the trees. This trend is promoted by the peculiarity of this palm to form in favourable spots clusters consisting of several stems. The species is distinctly moisture-loving and disappears where the soil rises more than a few meters over the marsh-forest level but does on the other hand not penetrate into permanent swamps. The dominance of *Euterpe* is apparently bound to a narrowly circumscribed periodicity in the fluctuation of the ground water, in which both the length of the inundation period and the normally lowest ground-water level probably are important. When this periodical changes of the water level will be investigated in detail, *Euterpe* may appear as one of the best indicators for the water household in marsh forests.

Other hygrophilous species are *Pterocarpus officinalis* [2], *Genipa americana* [22], *Simaba multiflora* [23], *Mauritia flexuosa* [20], *Caryocar microcarpum* [21], *Diospyros guianensis* [27], *Tabebuia insignis*-group [3], *Maximiliana maripa* [29], *Carapa procera* [28].

Of those species which penetrate into this type of forest from the dry forests several appear not to be restricted to one of the types and for several other ones the number of finds is too small to pronounce upon.

The aspect of the marsh forest varies considerably. In its best developed state it is a forest with tall trees overtopping a canopy stratum of 8—15 m high trees, but in many instances the tall trees are absent. Lianas and epiphytes are scarce. Subgrowth is only locally important where one or two species form groups. Many trees form buttresses or stilt roots. The second type may take the habit of a scrub wood along creeks on peaty mud with most trees divided at the base in several inclined stems as seen along the Djai Creek and the Wane Creek in the Moengo tapoe line. In this case *Aulomyrcia pyrifolia* [24] and *Amanoa guianensis* [25] are dominant and grow like shrub trees.

III. Hura crepitans forest.

Economically important is the *possentrie* forest, which we encountered only in one small plot in the line behind our Coronie camp. It is a high forest with *possentrie, Hura crepitans* [121] forming an upper story of 25—35 m tall trees with a stem diameter reaching over 1 m. The understory is very open and consists in the visited plot of young *Hura* and

Euterpe oleracea, Triplaris, Pterocarpus officinalis, Virola surinamensis and *Tabebuia.* A subgrowth of herbs, etc. is nearly completely absent.

Of *Montrichardia* and *Bonafousia tetrastachya* but a few individuals were found. On account of the floristic composition this forest belongs to my first type though as a very distinct variant. It also seems to demand a particular habitat. We found it on a low marshy part of drowned shell ridge with slightly brackish groundwater. According to GEIJSKES (30) this is the typical habitat. HEINSDIJK (44) says that it usually occurs along ridge margins and sometimes extends also into the swamp. Especially in regard to the timber value of *Hura* it is important that these pure forests can be recognized on aerial photographs. In the Wiawia line only a few stunted individuals of *Hura* were met. *Hura* forests occur as far as I know only in the middle and western part of the coastal region.

It is a noteworthy, but as yet unexplained, fact that the distribution of this species in Suriname is apparently very restricted whereas in other countries it grows over a wide area and in various forest types not only in the lowlands but also to a considerable height on mountain slopes.

The forest with a probably only periodically wet but not really flooded clay soil and with but little humus can not be reckoned to the marsh forest but must, on account of the resemblance of its flora to that of the rain forest, be considered a wet variant of the latter and will therefore be discussed in the next chapter.

GONGGRIJP and BURGER (34) call the marsh forest seasonal swamp forest and discuss variants with *Carapa, Hura* or *Virola* as dominants. They are of the opinion that forests with *Erythrina, Symphonia* or *Triplaris* belong here. An example of the first variant is the tidal marsh forest in the line near Cupido along the Maratakka River, of the third the forest at Berendslust (Suriname River) where *Virola* was the principal species in the open upper story, though the number of individuals was not high and *pina* in the second story determined the aspect. The *Erythrina* type is as we have seen a distinct swamp wood; for the last-named forest the supposition holds only partly as many *Triplaris* stands are swamp woods. The fifth one belongs to my second marsh forest type.

Dominance of palms.

BEARD (48) records as marsh forest for Trinidad: the *Calophyllum lucidum* faciation of the *Manicaria-Jessenia-Euterpe* association, a new name for MARSHALL's *Calophyllum-Palmae* association (93) which was found represented in British Guiana by the "*truli* swamp"; where the same palms are dominant but *Calophyllum* is absent. *Truli* is the indigenous name for *Manicaria saccifera,* a palm reported for the western part of Suriname along the lower part of the rivers. On low river banks in Suriname on many places palms *(Mauritia, Euterpe, Maximiliana maripa)* are dominant and these stands may be equivalent with BEARD's association, but we had no opportunity to investigate them. On the other hand the alternation along the river banks of spots dominated by palms and others where dicotyledonous trees take the first places gave me the impression that the palm stands are only a facies of the tidal marsh forest along the lower parts of the rivers.

Extensive *Manicaria* stands are also reported from the Orinoco delta. ANDERSON (45) describes how in British Guiana *Euterpe edulis* and *Manicaria saccifera* often are dominant on the levees behind a *Rhizophora* belt. Locally *Bactris* palms are prominent along the rivers.

According to HUBER (83) *Mauritia flexuosa* is locally dominant in the tidal forest along the rivers on the isle Marajo, and in the Amazone delta *Mauritia* stands are often pure and often mixed with *Euterpe*. He adds that deeper into the forest *Mauritia* becomes scarce through lack of light, and its place is taken by several other palms *Oenocarpus spp.*, etc.; 100 m from the river bank only rarely a *Mauritia* is found. Prominent Dicotyledons are *Virola surinamensis*, often growing together with *Mauritia*, *Carapa guianensis*, *Hevea brasiliensis*, *Spondias mombin*, *Plumeria sucuuba* and many Papilionaceae.

Other palms that are often observed in abundance on the levees, are *Bactris maraja* Mart. and other species and *Manicaria saccifera*.

BEARD recognized in Trinidad two other marsh formations; palm marsh and savanna, both waterlogged in the wet and completely dried out in the dry season. As the periodical complete dryness is the essential factor for the savannas and inundation in the rainy season is not obligate, I will mention them in chapter IX in connection with the savanna forest.

IV. Mauritia-Chrysobalanus association.

BEARD (48) calls the palm marsh a *Mauritia-Chrysobalanus* association which occurs under drainage conditions intermediate in severity between marsh forest and savanna. This is true where the association occurs in depressions in the savannas, especially along drainage channels which generally contain water only during the rainy season. The *Mauritia* [20] stands in and along the borders of the fresh-water swamps however are also characterized by *Chrysobalanus* [5] and must be reckoned to the same association. The accompanying species show much variation according to the habitat and the neighbouring vegetation, and allow thus a subdivision. The wet subassociation, BEARD's palm swamp, is differentiated by *Virola surinamensis*, *Genipa americana*, *Pterocarpus officinalis*, *Montrichardia arborescens*, *Triplaris surinamensis*, *Bonafousia tetrastachya*. The last-named two species enter only where the swamps are bordered by marsh forests of the first type. Further landinwards the subassociation merges into marsh forest of the second type. In the Wiawia transect *maurisie* belts were found associated with both types of marsh forest, in the swamp South of the ridge complex near Coronie we met an initial phase with dense subgrowth of swamp herbs.

In the clay-savanna area North of Moengo tapoe and near the Great

Swaying Swamp the conditions come apparently closest to the palm marsh found in Trinidad in the area of the Aripo savanna. The soil here is periodically inundated and desiccated, clayey and of a very bad structure. Besides the characteristics *Aulomyrcia pyrifolia, Tabebuia vs. insignis* and *Clusia nemorosa* are more or less important.

In sand savannas the inundation is probably of short duration, but the desiccation is not so severe as on the higher parts of the savanna. The vegetation in this habitat is enriched by several savanna plants and goes in the direction of the savanna scrub, but no details are available.

One point must be mentioned here. BEARD (48) refers all the *Mauritias* of Trinidad to the species *M. setigera* Gris. et Wendl., which was originally described as endemic in that island, and he states that his *Mauritia* palm swamp is also found in the Orinoco delta and the Guianas. The common *Mauritia* of Guiana and Brazil, however, is currently named *M. flexuosa. Mauritia setigera* has recently been reported outside Trinidad, but as both species are very similar in the field, they have apparently nearly never been distinguished. Therefore many trustworthy observations will be necessary to answer the question what the distribution of both species is, and whether there exist ecological differences between them.

CHAPTER VIII

EVERGREEN SEASONAL FOREST

Two kinds of dry forests with striking physiognomical and floristic differences will be observed by the traveller; the first type is the rain forest which the population distinguishes in lowland and upland forest on account of the topography, the second one is the savanna forest.

Let us first pay attention to the lowland and upland forests. They belong to BEARD's evergreen seasonal forest with three stories of trees, a highly discontinuous stratum of emergent trees reaching 30 m and more, an almost continuous canopy layer at 15—27 m (BEARD (48) gives 12—27 m, GONGGRIJP and BURGER (34) 14—30 m) and a continuous lower story at 3—12 m (BEARD 3—9 m, G. and B. 3—10 m). My own figures have been taken from our 100 square meter sample plots. The understory rises everywhere to 12 m. Trees with an estimated height of 13 or 14 m are rare, whereas trees of 15 m and upwards are frequently met with. Also when we take into account the inexactness of the estimations and make a correction for it the depression in the height curve between 12 and 15 m remains evident, whereas other irregularities disappear (see figure IV).

Shrubs and herbs are of no importance, but lianas and epiphytes are frequent. Palms are scarce to frequent.

This type of forest we meet everywhere on the ridges where the soil is well drained i.e. where it is never flooded in the wet season nor cut off from the ground water by the presence of a continuous iron pan. Where on the old high ridges the sand has been leached so intensively that a hard continuous iron pan has been formed, the ridge forest has been replaced by savanna forest.

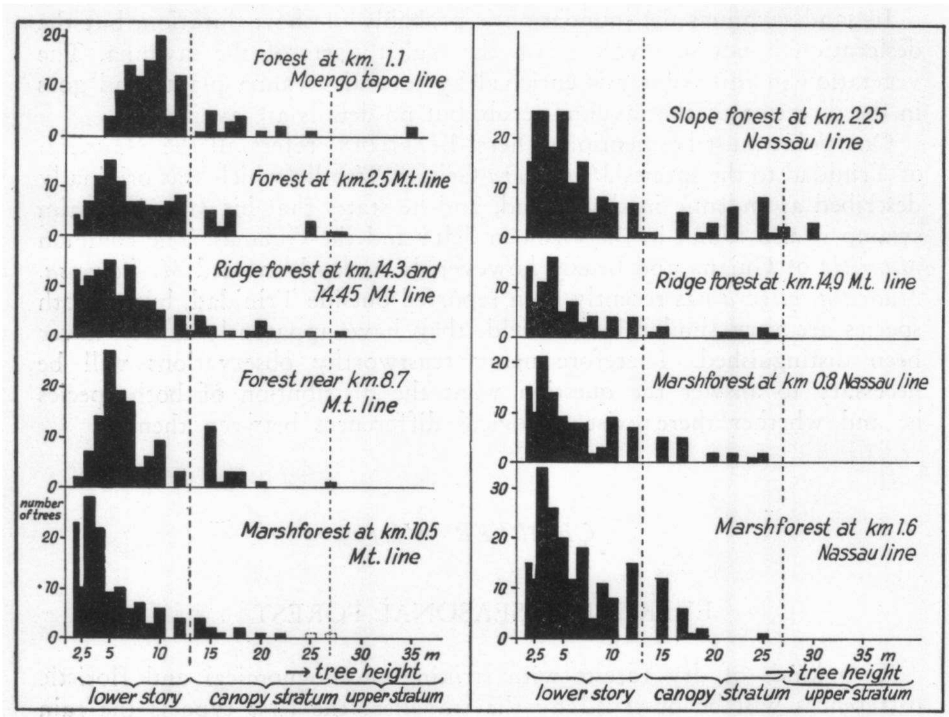


Fig. IV. Height-class distribution of the trees in some forests. In the first example the treelets under 5 m were not counted.

Outside the ridge area this forest is found on various soil types, provided the drainage is moderate to good, in the lowlands, on the hills and in the mountains up to at least 550 m (altitude of Nassau Mts). Our sample plots on and around the bauxite hills North of Moengo tapoe, near the Tibiti savanna and in the Nassau mountains show in the floristic composition a good agreement with each other and with the ridge forests in the Wiawia transect which demonstrate a very good developmental series from the poorly developed wood near the seacoast to the rich forest on the oldest ridges.

The flora of the evergreen seasonal forest is very difficult to characterize as a result of the large number of species represented in each stand and the comparative rarity of many of them. Therefore, in the small sample plots we were obliged to use, one will often miss species that are present in the neighbourhood, and the number of species that are really present remains a matter of conjecture.

Comparison shows that but few species that were not present in a sample plot were noted in the strip survey within 100 m from the plot, and the majority of the commoner species therefore are represented in an area of 400 square m (4 quadrats of 10 m square each). Conversely many species were noted in the sample plots and not in the strip survey; this were not only herbs and small trees, but also young individuals of the taller species.

The usual opinion is that in the mixed tropical forest the heterogeneity is so great that the individuals of most tree species are growing very far apart. This certainly holds true if one looks only at full-grown trees, but when all individuals in a sample plot are taken into account, the mean distance between the individuals diminishes. On our experience I venture to express the opinion that even for the richest forests in Suriname and probably elsewhere the characteristic combination of species is represented in a relatively small area, say according to the type of forest in a quadrat between 100 and 1000 square m.

As stated above we do not know the total number of species present in the investigated forests.

However, the records of DAVIS and RICHARDS (71) obtained from forests in British Guiana give some indications for the estimation of this number. They counted all trees with stems over 10 cm in diameter in sample plots of 1.5 ha and all smaller trees that were over 4.5 m high in 2 strips covering together 1/8 of the surface of the plots. In their mixed forest association and *greenheart* consociation they met resp. 91 and 95 tree species but only 55 and 63 of these occurred in more than 1 or 2 individuals. If we compare the last-named figures with those we obtained from our plots of 4 × 100 sq. m combined with the data of the survey of the nearest 200 m of the line we see a good agreement.

record number	69	70	73	74	76	77	83
number of tree species	51	62	68	51	50	44	51

Record no 75 of 6 × 100 sq. m plus 600 m line survey yielded 74 species, the records of smaller plots, however, less than 35 species.

For a uniform stand of typical evergreen seasonal forest, therefore, a number of about 100 tree species seems to be a fair estimate.

As I have pointed out earlier in this paper it often happens that the species to which a tree belongs could not be determined and that only a choice can be given between 2 or more species. As it is improbable that these species will have the same ecological amplitude, heterogeneous elements come under one heading, and such a unit may show a much wider range than each of its components will possess. Instructive examples are *swietiboontje, Inga* sp. div. and *spikrihoedoe, Mouriria* sp. div.

Some of the species probably are restricted to this forest type, but as all names that were recorded many times show a wider distribution, these species must be looked for in the group with low frequency, represented in table II by a small number of findings and this makes it impossible to draw conclusions with regard to the fidelity and constancy of these species from the available material.

For this reason only negative characters are left at present, namely the more or less complete absence of swamp- and marsh-forest species on one hand and of savanna-forest elements on the other hand.

Species with a high presence, 60% or more, are: *Parinari campestris* [47], *Tapirira guyanensis* [48], *Duroia eriopila* [52], *Oenocarpus* [50] probably more than one species, probably *Protium heptaphyllum* [49], and from the herbs *warimbo*, *Ischnosiphon gracilis* and *obliquus* [151], and *bos-ananas* [152], a large terrestrial Bromeliacea.

Marsh- and swamp-forest species that are entirely absent or represented only by an occasional individual are: *Triplaris, Pterocarpus officinalis, Genipa, Simaba multiflora, Tabebuia insignis*-group, *Licania macrophylla, Cordia tetrandra, Chrysobalanus* and *Mauritia.*

Savanna-forest species that are nearly completely missing are: *Swartzia bannia, Clusia nemorosa* and *fockeana, Humiria balsamifera* and *floribunda, Bombax flaviflorum, Ormosia costulata, Licania incana, Conomorpha magnoliifolia, Dimorphandra conjugata.*

Many species occur more or less locally and on this account it is possible to make a subdivision. The limits, however, are not sharp. I draw attention to this subdivision as the limits of the vegetation units coincide in part with geographical limits.

1. Cereus ridge wood.

In the Wiawia transect the first change occurs between the 6th and 7th ridge at km 2.5 and the second coincides with the division between the marsh-forest types at km 9.5. The three subtypes located in this way are bound to different phases in the formation of the ridges.

From the 2nd up to the 6th ridge we find forest or wood of one subtype. The first ridge belongs genetically to the same series, but it is as we have seen so small and so soaked with salt water that it bears a fully different vegetation. In habit this subtype comes close to BEARD's littoral woodland (48), which is not found in Suriname as nowhere along the present coast important amounts of sand are deposited, and as no dunes of any extent are formed. In the past during the time the larger ridges were formed littoral woodland may have been present.

As in this subtype the trees form no continuous canopy, much light penetrates to the ground and allows the development of many herbs. No stories are discernable, and many trees are stunted and show burn-scars, which proves that swamp fires occasionally sweep through the ridge forest too.

Important species on these young ridges are *Astrocaryum segregatum* [37], *Eugenia wullschlaegeliana* [95], *Protium cf. heptaphyllum* [49], *Inga* probable mainly *ingoides* [19], and on the higher and broader 4th and 6th ridge vigorous trees of *Hymenaea courbaril* [38] and *Plumeria* [96]. The first and last-named couple of species have their optimum here and disappear on the ridges to the South. Restricted to this subtype is an enormous *Cereus* species [97] reaching a height of 10 m and provided with stems that become woody in the lower parts.

On the 2nd and 4th ridge the usually epiphytic Aracea *Monstera sagotiana* creeps over the ground and covers considerable areas. The occurrence of *Ximenia americana* on the second ridge is also interesting. This species has frequently been reported as an inhabitant of strand wood in the Caribbean but in Suriname it was collected only a few times, twice near Paramaribo and by us also near Albina on a sandy terrace of the Marowijne River.

Species we found only in the subgrowth of the 4th, 5th and 6th ridge, but there abundant, are *Cyperus chalaranthus,* a slender sedge met elsewhere in secondary growth, and the shrubby *Solanum asperum.*

The second subtype belongs to the vast 7th and 8th ridge complexes and to some single ridges South of them to km 9.5. In this subtype several species make their appearance, some as important elements, others as scattered individuals. With the last-named group we have to be somewhat cautious, for the fact that we have not met them on the first six ridges does not necessarily mean that they are completely absent; we have only made observations along the line, thus covering only a small strip of these narrow ridges. In regard to this it may be instructive that of the 23 tree species we recorded on the 200 m wide 4th ridge 4 were met only there and later on the 7th and 8th ridge; the other ridges, which are 100 m or less wide yielded only 9 to 12 species each. On the other hand the vegetation of the 4th ridge came closest to a real forest and it is therefore probable that it is really richer in species than the open wood on the smaller ridges.

II. Intermediate ridge forest.

The forests of the second subtype have a closed canopy at 14—25 m and a more or less well-developed lower story and subgrowth. Common species are *Inga sp. div.* [19], *Protium heptaphyllum* a.o. [49], *Parinari* [47], *Oenocarpus* [50], *Tapirira* [48] (often abundant), *Manilkara* [51], *Simarouba* [64] and *Caryocar microcarpum* [21] (always in small numbers).

Astrocaryum segregatum, Eugenia wullschlaegeliana, Hymenaea and *Plumeria* disappear gradually.

In the lower story *Duroia eriopila* [52] comes into prominence, and in the subgrowth *Ischnosiphon, warimbo* [151], and *bosananas* [152].

III. Parinari ridge forest.

The forest on the old ridges is dominated by *Parinari campestris* [47] in the canopy; *Duroia eriopila* [52] and *Ravenala* [59] take nearly everywhere the first place in the lower story, as *warimbo* [151] does in the subgrowth. *Euterpe* [17] and several Melastomataceae [70] are usually present in the lower story. This variant grows on sand where leaching has produced a podsol profile with a discontinuous iron pan.

IV. Typical evergreen seasonal forest.

In the fourth subtype all the lowland and upland forests are brought together. This subtype is richest in species and only here the stories are well differentiated, especially in the upland forest. As common species we find here once more *Inga sp. div.* [19], *Parinari* [47], *Oenocarpus* [50], *Protium heptaphyllum* a.o. [49]. New in this subtype are *Iryanthera vs. hostmanni* [63], *Licania sp. div.* [67—69]. In the undergrowth we find the same species as in the third subtype.

The topographical designation of lowland and upland forest only partly coincides with differences in the physiognomy and composition of the vegetation. Such differences are probably in the main correlated with the water household, which in forest at a higher altitude need not be less favourable than in the lowland. In this respect I think 2 variants can be recognized:

A. A variant rich in palms: *Euterpe, Oenocarpus, Maximiliana maripa, Astrocaryum sp. div.* on soil with a good watersupply all the year round.
B. A variant with only scattered and poorly developed individuals of the palms occurring in the former variant; it is found on soils that are too well drained to retain enough moisture in the dry season.

North of Moengo tapoe we met the two variants one besides the other, the dry one on the bauxite hills and the moist variant in the valleys between the hills where under ± 1 m clay an impermeable kaolin layer prohibits free drainage. In the rainy season the ground may be more or less waterlogged for some time, and the top soil is so thick that it stores enough water to last through the dry season. At the lowest spot where the waterlogging lasts longest a few marsh-forest trees *(Licania macrophylla)* appear but the composition as a whole is still that of evergreen seasonal forest.

V. Forest of the ridges near Coronie.

The forest on the drier parts of the ridge complex along the Coronie road near our camp differs in composition from that on the ridges in the Wiawia transect. The northernmost part of the ridge complex on which the Coronie road has been built, consists of an almost pure, several meters thick deposit of shells, but the greater part of it is formed of fine sand with an admixture of shell fragments which varies greatly both in vertical and horizontal direction; it contains also a fair amount of mica. The ground water in the ridge complex was more or less brackish with the exception of the water in the shell beds which proved to be completely fresh. In the second line values from 140 mg Cl/l (at km 1.10) up to 6700 mg at km 0.36 and 6600 mg at km 1.35 were measured but no correlation between the variations and the topography could be found. As the ridge complex we visited lies rather isolated in extensive swamps, and as we do not have records from other shell ridges, we are as yet unable to say whether the shell ridges sensu lato bear a distinct forest community or not. At present we must confine ourselves to the remark that some species like *Couroupita guianensis* [116] and *Trichilia trinitensis* [119], which proved to be frequent near our Coronie camp, were not found on the poor sand ridges. On the other hand all species encountered in the forest of the Coronie ridge occur also outside the the shell-ridge area.

CHAPTER IX

SAVANNA FOREST AND SAVANNA

I. Savanna forest.

Savanna forest is a community with a well defined composition occurring on white sand or on clay with a bad structure, i.e. on soils that are exposed to serious desiccation in the dry season. Physiognomically it is very variable, in the best developed form it is a forest with a continuous canopy layer at 10—18 m consisting of a remarkably large number of thin trees overtopped by a few bigger ones. A lower story is hardly recognizable, the young trees being very slender. The ground flora consists of herbs and small ferns, and lianas and epiphytes are not numerous. Most trees have micro- to mesophyllous leathery leaves.

Where conditions are more adverse, the vegetation is lower and we meet äll gradations from wood, scrubwood and scrub to an open savanna with groups of scattered shrubs sometimes not more than 2 m high. Many of the species occurring in this sequence pass from regular trees to small shrubs, but some, e.g. *Bombax flaviflorum,* retain their tree form, however small they may become.

Characteristic species for the woody savanna vegetation in all its forms are: *Clusia nemorosa* and *fockeana* [86], *Humiria floribunda* and *balsamifera* [132], *Ormosia costulata* [135], *Licania incana* [134], *Bombax flaviflorum* [133], *Conomorpha magnoliifolia* [137] and *Dimorphandra conjugata* [136]. *Swartzia bannia* [85] occurs mainly in the forest and is there often abundant. In the forest we also meet species that are just as well found in other types, e.g. *Parinari, Tapirira, Protium cf. heptaphyllum* and *Oenocarpus. Miconia myriantha, Calycolpus revolutus* and *Marlierea montana* prefer savanna forest, but are found elsewhere too.

Differential species for the savanna scrub are: *Bactris aff. savannarum, Retiniphyllum schomburgkii* and probably *Ternstroemia punctata* and the herbs *Scleria cyperina* and *Lycopodium cernuum. Chrysobalanus* and *Mauritia* belong also to this group but indicate low spots in the savanna where the ground water remains within reach of the deeply penetrating palm roots.

In its normal composition the savanna forest s.l. occurs on strongly leached sands with an iron pan at varying depth, sometimes at 1—1.30 m as on the savannas on the oldest ridges in the Moengo tapoe transect; but near the Tibiti savanna it was not yet reached at 2.50 m. It is found also on kaolinic soils, e.g. along the railway between km 80 and 110.

We met a deviating variant on the clay savannas North of the Wane creek where shallow clay (40—70 cm) with very bad polygone structure and a hogwallow surface overlies impermeable kaolin.

These savannas are very flat and lower than the surrounding country, even actually beneath the level of the Great Swaying Swamp, which is separated from them by the oldest ridges. The hogwallow structure indicates that these savannas are inundated in the wet season, probably for a considerable time, but at the time of our visit in September and October the ground was bone-dry. The scrub on these savannas contains besides a majority of savanna-forest species a number of marsh plants like *Symphonia, Tabebuia insignis* and *Aulomyrcia pyrifolia. Chrysobalanus* is frequent and *Mauritia* scattered but locally abundant.

These savannas show resemblance to the Aripo savannas of Trinidad and are the only ones which are marsh formations in the sense of BEARD (48).

Facies formation is a common feature in savanna forest. In the Wiawia-transect between km 10 and 13 *Swartzia bannia* is by far the most abundant species. Near the Tibiti we met nearly pure stands of *Dimorphandra* which had been badly damaged by fire. All trees had been killed to the base of the stem and had formed from it a number of new stems. In one of the largest of these secondary stems I counted 21 annual rings; this makes it very probable that the forest was destroyed in the excessively dry year 1926.

HELSTONE told me that this facies is extremely inflammable. The trees produce much dead leaves which catch fire very easily in the dry season.

In general we meet in savanna forest a considerable layer of litter, which may change downwards into a loose forest peat ("Rohhumus"). In a dense savanna wood at Suhosa (middle Suriname River) I saw a litter and forest-peat layer some 20 cm thick lying free like a springy matras on the white sand. According to GONGGRIJP and BURGER (34) the inflammability of the forest is mainly due to this dry litter.

The savanna forest gradually merges into savanna under natural conditions. The savanna observations made during the expedition will be published later on by LANJOUW.

II. Wallaba forest.

An economically important facies is the *wallaba* forest where in the timber tree *Eperua falcata, (sand) wallaba,* may exhibit absolute dominance in the canopy stratum. We met this forest only near the Tibiti savanna in narrow strips, not in the coastal region. Westwards in British Guiana it is common on the white sands. It occurs on leached sands in which the rain water rapidly sinks to a great depth. An iron pan may be present, but only at a depth of 2 m or more. This forest is obviously in all respects intermediate between the normal evergreen seasonal forest and the savanna forest.

BEARD (47) supposes that the *wallaba* forest of British Guiana may belong to his dry evergreen forest formation, and the description of this type fits the Suriname savanna forest rather well. This is in complete contrast to the opinion of GONGGRIJP and BURGER (34) who did not recognize xerophytic rain forest and placed high *wallaba* stands under seasonal evergreen forest and the dense thin-stemmed *wallaba* woods together with the typical savanna forests under transitional vegetations modified under the influence of man by fires. In my opinion the savanna forest is a distinct edaphic type, independent of burning; it is modified by fire in the same direction as by more adverse conditions of the habitat.

CHAPTER X

SUCCESSION

In this chapter I will try to give a general picture of the development of the vegetation. From the data that are available at present, only a limited number of steps in the succession can be traced with certainty. Several of the connections given here are more or less hypothetical and will have to be verified afterwards by observations in the field. For this work it will be necessary to establish as soon as possible a series of well-marked permanent quadrats, which can be investigated in different seasons and during many years in succession without disturbance from outside.

Several seres can be recognized according to the habitats in which they start. Theoretically it is easy to define primary and secondary seres, but in practise, even in a country like Suriname with large uninhabited areas, it is difficult to say where the realm of nature ends and the influence of man begins. The most important factor by which man from very early times to the present day has affected his surroundings, is fire, and in exceptionally dry years this can extend its devastating influence over vast areas. Therefore we must always be on the look-out for deviations or for a retardation of the primary succession, even where not a single sign of a previous fire can be found. How great and longlasting the effect of one severe fire can be, is illustrated by an example reported by BEEBE (cited by MYERS 98). He writes that near the Abary River in British Guiana where now an open swamp with grass and reeds stretches almost to the horizon, once a densely wooded jungle was found with *mora* trees, *eta* palms *(Mauritia flexuosa)*, etc. In 1837 during a period of extreme drought the whole vegetation became dry as chips. Then a fire broke out which swept the whole region, and destroyed the forest. Afterwards floods broke through the weakened barrier and transformed the area into one large swamp.

The common opinion is that all fires in Guiana are man-made. Lightning can be excluded as cause as thunderstorms are in these regions always accompanied by heavy rain. Even in the wooden town Paramaribo, where no lightning-rods are found, we have no records of a fire caused by lightning.

However, I should like to draw the attention to another source of natural fires, viz. the self-combustion of drying litter. The latter may be heated to the critical point under the action of bacteria in the same way as in our country a hay stack may catch fire. This process has been reported to occur in the swamps in the North American coastal plain when in dry years the water evaporates and the peat is exposed to the air and dries out. In very dry years the same phenomenon might occur here and there in the pegasse which covers the soil in the swamps of Suriname. Once started, a fire can doubtless run for miles and miles.

Successions on clay soil.

Halosere starting on growing mud flat along the coast.

A halosere starts on a growing mud flat in the uppermost part of the tidal zone. It begins with the establishment of *Avicennia* and *Laguncularia* or, where the sedimentation is very active, with *Spartina brasiliensis.* A preceding submersed community consisting of different kinds of seagrass (mainly *Thalassia testudinum* (Sol.) Konig and *Cymodocea manatorum* Asch.) and confined to the lower part of the mud flat has been described from many localities in the Caribbean, but has never been reported from the coast of Guiana. However, this does not prove that is does nowhere occur, and we should therefore be on the look-out for it in the future. As the mud flat rises, the pioneer mangrove scrub gradually develops into a mature *Avicennia* forest. What happens to this forest, is a problem that is very intimately connected with the morphogenesis of the coastal region as a whole.

RICHARDS (14) draws the attention to the sequence of the vegetation belts described from Porto Rico (77) and other regions, and suggests that the *Avicennia* forest would disappear simply by lack of rejuvenation and would be replaced by swamp herbs.

For this development it is necessary that the front of the coast belt gradually increases in height and that the older part is at the same time converted in a shallow basin which fills itself with brackish water. It is unknown whether the formation of such a basin is possible under constant external conditions or can only be the result of a relative rise of the sea level. JENMAN (87) keeps to the first possibility and states that a barrier will be formed along the front of a mud flat when the latter has become so large and shallow that the flood water covers it so slowly that it looses most of its silt already at the seaward side. We have, however, no facts to support this theory. Therefore it is impossible to tell whether such a development is normal or not. In any case we find in the western part of Suriname a coastal barrier grown with *parwa* forest which merges gradually into a brackish swamp. As said on p. 44 the germination of *Avicennia* seems to be impossible under water and where the inundation of the *parwa* becomes permanent it is therefore a question of time until the trees die, and are succeeded by *Typha-Cyperus articulatus* swamp. When the *parwa* forest is destroyed by fire or cutting, the succession may be accelerated, but only where the soil is permanently inundated. Where the soil is more or less regularly exposed to the air, a secondary succession takes place which leads to a new *parwa* forest. In the very salt swamps behind the Wiawia offshore bar *Sesuvium*, *Sporobolus* and *Eleocharis mutata* are the pioneers which precede the reestablishment of *parwa*. On levees along the lower part of the rivers *Acrostichum aureum* often forms dense pioneer stands. The herbs decline again as soon as the *Avicennias* begin to overshade them. The *Typha-Cyperus articulatus* swamp can be succeeded by a swamp wood as we saw North of our Coronie camp. I think that this is the normal development when no disturbance occurs, and that peat formation and consequently a rise of the soil level will pave the way for the development of marsh forest. This theory implies that all my other swamp types must be due to deviations of the primary succession sere.

On account of the observed sequence of the types in the visited areas I suppose that the *Typha-Cyperus articulatus* vegetation of shallow swamps can, when the salinity decreases and tree growth is suppressed by occasional fires, be succeeded by a *Leersia hexandra* stage and this stage by a *Cyperus giganteus* vegetation. In deeper water the *Typha* swamp probably develops into the typical *Cyperus giganteus-Typha-Scleria* community. This in turn changes into the variant with abundant fern growth, which fills the swamp by the formation of pegasse. The important rôle of the ferns *(Blechnum indicum* and *Dryopteris gongylodes)* has already been stressed by JENMAN (87). Often in these swamps tree groups and small woods are found, which seem to be remarkably stable. In aerial photographs taken respectively in 1939 and in 1948 I could find no differences in form or extent in the swamp woods over a considerable area between the Corantine and the Nickerie River. This stability is probably not the result of light superficial swamp fires which affect the mainly geophytic and chamaephytic herbaceous vegetation and the trees but slightly, but by which tree seedlings would be killed. Then one would expect that at the leeward side of the woods locally seedlings would survive and in that case the woods would change in form. A possible reason, however, might be that for the establishment of trees in a swamp a series of conditions is required which are fulfilled but once in several years and then only locally. At present we have no indications for the occurrence of fire cycles comparable to those described by EGLER from the saline Everglades in Florida (73).

The swamps of the 5th and 6th type with a floating peat layer have probably been formed by catastrophes which cleared the area completely and left it as a body of rather deep open water. A very important pioneer for the formation of a floating mat is *Polygonum acuminatum*, often together with *Panicum mertensii*, as we could observe in the small swamp behind our Coronie camp where *Ipomoea tiliacea* too was abundant. In the Nanni creek *Polygonum* and *Panicum* occupied the margin of the floating islets and of the floating belts along the levees. These observations confirm the supposition of LANJOUW (35) on the rôle of *Polygonum acuminatum*.

Each swamp type has the potency to develop via a swamp wood towards marsh forest which I regard with RICHARDS (14) as the edaphic climax of all hydroseres.

The dominance of a single species in a large swamp area, as we have observed in the Wiawia transect, is probably promoted by a separation of the swamps by ridges. Where ridges are absent we find much more variation within the various swamp types.

Sere starting in brackish water.

Where an inroad of the sea has produced an open lagoon, a brackish sere may start. I have seen a fine example of the latter in the Bigie pan. The first pioneer is *Ruppia maritima*. When the salinity has decreased to oligohalinous a *Nymphaea ampla* community can establish itself with *Ceratophyllum demersum, Lemna perpusilla, Wolfiella lingulata* and *algae*. *Limnobium stoloniferum* forms a distinct final stage; it forms by vegetative propagation floating disks. After some time the plants in the centre die and are succeeded by *Eleocharis mutata* or *Paspalum vaginatum*, which root in the mud that has accumulated on the clay soil. As *Limnobium* is a free-floating plant I see as possibility that *Eleocharis* and *Paspalum* germinate between the dead *Limnobium* shoots and obtain in a second phase a hold in the soil, after which they grow rapidly out to large clumps. Soon the associates *Jussieua decurrens, Torulinium* and *Acnida* come in. The groups of *Eleocharis* have just time to coalesce before the invasion of *Typha* begins. This represents a stage in the succession with considerable stability. From now on the sere develops in the same way as the halosere.

Hydroseres in fresh water.

Very little can be said at present with regard to successions starting in fresh water. In swamps of the 2nd to 4th type sometimes small open locks are met which must have been formed by some unknown agency. Man-made ditches offer a similar habitat. The pioneers are here floating aquatics, *Nymphaea spp., Utricularia foliosa, Hydrocleys, Limnobium, Pistia, Azolla, Salvinia* and *Lemnaceae*. This community is widely distributed in tropical America and very closely related to the association of *Pistia stratiotes* and *Lemna paucicostata* from tropical Africa with which it has in common the name-giving species and *Spirodela polyrrhiza* whereas *Nymphaea* and *Azolla* are represented by different species.

The second stage consists often of *Eleocharis interstincta, E. mutata* or *Leersia hexandra,* sometimes *Cyperus haspan* or other species play a part. After that the surrounding swamp vegetation occupies the seat once more. Small locks may probably directly be colonized by this vegetation. In locks in the swaying swamps *Nymphaea odorata* and *Mayaca longipes* are the pioneers. Then *Eleocharis interstincta, Rhynchospora triflora,* etc. penetrate from the border and form a floating mat. In the margin green algae and *Drosera capillaris* flourish, in the next phase often *Lycopodium meridionale.* After a peat layer has been formed, the other species of the *Lagenocarpus* vegetation come in.

Large stands of *Eleocharis interstincta* have been reported by GEIJSKES (30) from swamps near Republiek and by BENOIST (53) from quiet river bends in French Guiana. I suppose that they represent an early stage in the succession.

Succession on sand, psammosere.

Where sand or shells are deposited along the coast, a psammosere can start, and this can be traced with fair certainty to the end. Where an offshore bar is deposited on bare mud, as soon as the sand bar rises above normal high tide the *Ipomoea-Canavalia* community will establish itself. Is the sand supply small, than mangrove shrubs come in together with *Cordia macrostachya* and *Caesalpinia bonduc.* Where much sand is deposited and this is raised by the aid of the sea wind to a low dune ridge the herbaceous strand community is apparently directly succeeded by the same *Hibiscus tiliaceus* scrub which follows on the strand mangrove. This point can also be reached in another way, viz. by the interruption of a halosere. Every offshore bar must start either from a fixed point of the coast where the sand is deposited in the margin of a *parwa* forest, or else on a part of the coast which is in regression, but the bar itself is formed on a growing part of the coast. Such offshore bars are straight or slightly curved. Where a mud coast retreats, we often see that sand or shells are deposited by high tides in the *parwa* forest on top of the cliff. When the pneumatophores of *Avicennia* are burried in the sand and the latter is heated by the sun, they are killed and the trees consequently die. This has been observed by HUBER (83) on the Brazilian coast near Dunas, where between the dead trees strand plants had established themselves. On similar small sand bars along the Suriname coast we have observed strand mangrove, which I suppose to be the next stage, and this is in its turn bound to disappear when the abrasion of the coast continues. However, when the chances turn and the coast begins to grow again, these bars are sometimes preserved in the form of small winding ridges. These can be found on the aerial photographs in many places near the coast (see map I). They show clearly the scallops of the former abrasion coast. In this case the strand mangrove is replaced by *Hibiscus tiliaceus* scrub.

By continued accrescence of the coast the influence of the sea slowly diminishes and the succession can develop in the same tempo.

On the higher ridges, in which soon a body of fresh ground water is formed, the scrub probably develops rather fast into the mixed wood that we have found on the youngest ridges in the Wiawia transect. This is a poor variant of the lowland forest differentiated by a few littoral species. Whether the still higher old ridges in the Wiawia transect have borne in this stage a real littoral woodland, is not known. It is not improbable that the lower rainfall near the coast, and the very free drainage to great depth in the sand may have produced suitable conditions for the development of a xerophytic woodland similar to that found on dunes in the Caribbean.

On the small low ridges and along the borders of the higher ones the *Hibiscus* scrub has a much longer life because the ground water here remains brackish for a long time, and we have observed this vegetation at considerable distances from the present coast. Only after the water in the surrounding swamps has decreased in salinity to oligohalinous, the succession can go on. As the drainage of the coastal swamps is extremely bad, the water level will rise in the rainy season above high-tide level and the lowest parts of the ridges will be inundated. At these places therefore the *Hibiscus* scrub will not proceed towards evergreen seasonal forest but towards *Triplaris* marsh forest.

On the higher ridges the wood changes apparently in the course of centuries via the intermediate ridge forest in the forest on the old ridges which is dominated by *Parinari.* On the highest parts of the ridge which may have born in their youth a littoral woodland the conditions become adverse again in their old age by serious leaching of the soil, and then the ridge forest gives way first to savanna forest and later on to savanna as we see clearly on the ridges North and South of the Great Swaying swamp. Whether the last step is conditioned or only accelerated by fire, I cannot say, but there is no doubt that fires can have reached almost every spot North of the Wane creek. In the ridge-forest in the Wiawia line burn scars probably dating from the very dry year 1926 were found from km 1 to 4.2, at km 5.4 in the centre of the 8th ridge complex, from km 10.3 to 11.9 and from km 12.6 to 13.

CHAPTER XI

AUTECOLOGICAL REMARKS

This chapter contains a list of all the species mentioned in the preceding chapters unless they were of minor importance. The Pteridophyta have been separated from the Spermatophyta, but within each group the species have been arranged alphabetically according to family, genus and species. After the accepted scientific name follow the synonyms met with in the cited literature, the vernacular names collected by us and references to the place in the tables I and II, the area of distribution and the life form.

As most vernacular names are Surinam ones, these are given without indication; they are separated from names in other languages by a semicolon, and to the latter is added (Ar.) for Arawak, (Car.) for Caraib and (Hind.) for Hindustani.

The abbreviations used for the area of distribution have the following meaning:

Car	Caribbean, including the coastal regions in and around the Caribbean sea and in Guiana; the distribution of some of the species extends southeastwards as far as the Amazone estuary.
cosm	cosmopolitan.
End	endemic in Suriname.
BG	only known from Suriname and British Guiana.
FG	only known from Suriname and French Guiana.
Gui	in Guiana and N. Brazil, also in the eastern part of Venezuela and in Trinidad.
NSA	in the northern part of South America.
pt	pantropic.
pts	pantropic and subtropic.
tA	in tropical America from Mexico and S. Florida southward.
tsA	in tropical and subtropical America.
tSA	in tropical South America.
tSCA	in tropical South and Central America.
tAA	in tropical America and Africa.
tAWA	in tropical America and West Afrika.

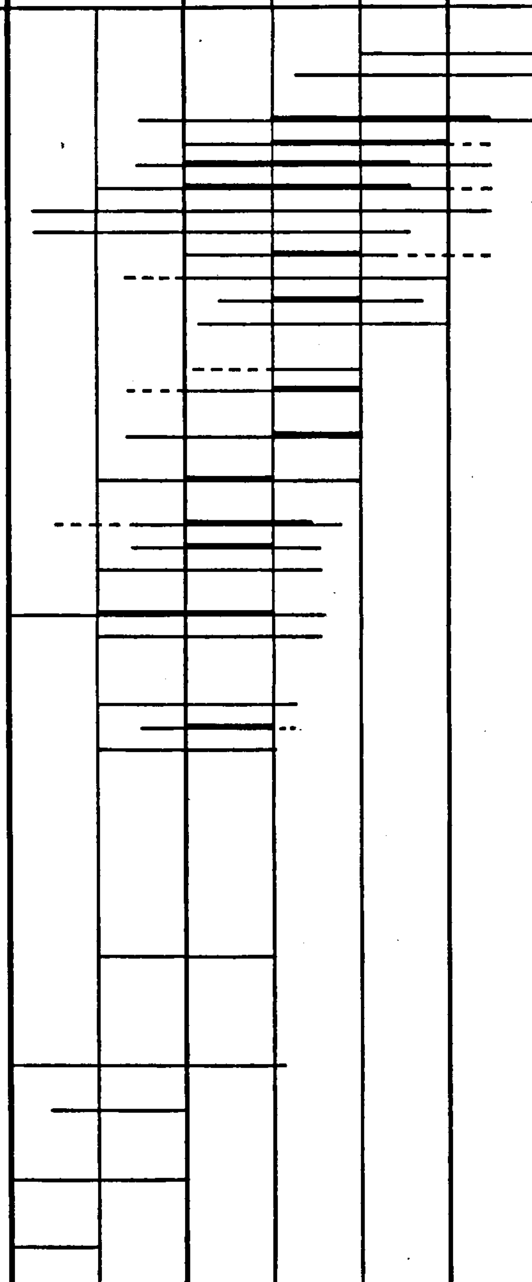
For the life forms I have followed the system of RAUNKIAER, although this gives difficulties in certain classes of herbs. This is a consequence of the absence with many species of a resting period, whereas the way this resting period is passed is the key to RAUNKIAER's system. On the other hand we can often substitute for it the way in which the plants survive when they are accidentily deprived of their assimilating parts. A number of species I was unable to classify and several more I have classified with some doubt, as we have but little information at present on the life cycles of most species. Herbarium specimens very often miss the basal and subterranean parts of the plant, and our field observations are limited. The only way to acquire a good knowledge of the life forms will be to make regular observations on the plants in a series of field stations established in various habitats.

For the life forms the following abbreviations have been used:

MM	mega- and mesophanerophytes, trees of more than 8 m high.
M	microphanerophytes, trees and shrubs of 2—8 m high.
N	nanophanerophytes, shrubby plants of 0.3—2 m high.
PH	phanerophytic herbs.
S	stem succulents.
L	lianas with distinctly woody stems.
Ch	chamaephytes.
V	vines: twiners and climbers with not or only slightly woody stems.
H	hemicryptophytes.
G	geophytes; rG, rhizome geophytes.
Hy	hydrophytes.
Th	therophytes.

Table IV. Salt tolerance of the more important swamp and moisture-loving species.

fresh		brackish			salt
oligo-trophic	eutrophic	oligo-halinous	meso-halinous	poly-halinous	eu- and hyperhal.
< 100 mg Cl/l		100-1000 mg Cl/l	1000-10.000 mg Cl/l	10,000-17,000 mg	> 17,000 mg Cl/l



Iresine verm., Batis mar.
Sporobolus virg., Sesuvium port., Fimbristylis spath.
Avicennia nitida, Eleocharis mutata
Laguncularia racemosa
Rhizophora mangle
Cyperus articulatus
Mariscus ligularis
Cyperus polystachyos
Acnida cuspidata
Acrostichum aureum
Fimbristylis ferrug. and spad.
Ruppia mar., Paspalum vag., Brachypteris ov., Rhabdadenia bifl.
Rosenbergiodendron formosum
Hibiscus til., Paspalidium gem., Phragmites comm.
Machaerium lun., Torulinium fer., Scirpus cub.
Typha ang., Jussieua lept., Mikania micr., Cissus park.
Leersia hexandra
Neptunia plena
Cydista aequ., Eclipta alba, Ipomoea til., Canna glauca
Montrichardia arborescens
Panicum mert., Solanun stram., Entada pol., Ceiba pent., Coccoloba lat., Crataeva tap.
Sacciolepis stri., Phaseolus trich.
Hura crep., Annona glabra
Cyperus gig., Thalia gen., Aeschynomene sens., Jussieua aff., dec., er. and suffr., Luziola spruc., Cissus sic., Paullinia pinn., Ipomoea park. and subrev., Azolla car., Salvinia aur., Pistia strat., Nymphaea ampla and rudg., Hydrocotyle umb., Nymphoides humb.
Andira iner., Triplaris sur., Erythrina glauca, Cordia tetr., Bactris, Inga ing., Diospyros gui., Cecropia pelt., Spondias momb., Couroupita gui., Tabebuia aqu.
Blechnum ind., Heliconia psitt., Chrysobalanus icaco
Dryopteris gong., prot. and serr., Nephrolepis bis., Pityrogramme cal., Cyperus haspan
Fuirena umb., Rhynchospora cyp., cor. and gig., Eleocharis interst., Jussieua nerv.
Lagenocarpus gui., Eleocharis plic., Rhynchospora trifl.

Table IV shows the salt tolerance of the more important swamp and moisture-loving species, as it could be deduced from the available data.

One half of the about 450 species in the list are trees or large shrubs. For the six swamp types I have calculated from table I the biological spectra. For each type 2 spectra are given in table V, a bruto one based on the species alone, and a balanced one made with the method of TÜXEN and ELLENBERG. The latter takes into account the degree of cover for each species and shows the real part each life form plays in the vegetation. In table V vines and lianas are included in the nano-phanerophytes.

	MM,M	N	Ch	G	Hy	Th	?	number of species
Eleocharis mutata		15		35	35	15		6 bruto
swamp		1		93	5	1		balanced
Typha-Cyperus articulatus		46	10	27	7		10	30 bruto
swamp		3	5	90	1		1	balanced
Leersia hexandra	3	29	11	33	9	6	9	36 bruto
swamp	1	3	83	8	$1\frac{1}{2}$	3	$\frac{1}{2}$	balanced
Cyperus giganteus-Typha-Scleria	5	28	10	40	11	4	2	53 bruto
swamp	2	1	10	86	1	—	—	balanced
Rhynchospora corymbosa	17	17	11	40	9		6	35 bruto
swamp	20	1	19	60	—		—	balanced
Lagenocarpus guianensis	21	9	4	45	4	9	8	24 bruto
swamp	1	3	—	95	—	1	—	balanced

Table V. Biological spectra of the swamp types.

Annotated list of species.

PTERIDOPHYTA

HYMENOPHYLLACEAE.

Trichomanes hostmannianum (Kl.) Kze. In marsh forest along creeks. Other species like *T. arbuscula* Desv. and *T. pinnatum* Hedw. in dry to moist forests.

LYCOPODIACEAE.

Lycopodium meridionale Underw. et Lloyd; I 71, tA, Ch. Creeping in savannas, very abundant in the floating savanna in the Great Swaying swamp where the peat is thin and loose.

Lycopodium cernuum L., pratilobie; pt. Optimal in savanna scrub, there up to 1.2 m high, occasionally in savannas, even in the floating one in the Great Swaying swamp.

POLYPODIACEAE.

Acrostichum aureum L., payuli (Car.); I 2, II 144, pts, rG. Gigantic halophytic fern, common as scattered clumps. Where parwa forest is destroyed it often forms dense stands.

Blechnum indicum Burm. (B. serrulatum Rich.); I 17, II 143, pt, rG. Very common fern in fresh-water swamps, one of the principal producers of pegasse in oligotrophic water. Also in marshlets in savannas.

Ceratopteris deltoidea R. C. Benedict and *C. pteridoides* (Hook.) Hieron.; Hy. Occasionally floating in fresh or oligohalinous swamps.
Dryopteris gongylodes (Schkuhr) Kze; I 18, pt, rG. Very common in fresh-water swamps, one of the principal producers of pegasse.
Dryopteris protensa (Afzelius) C. Chr. var. funesta (Kunze) C. Chr.; tSA, rG. Widely distributed in marsh and rain forest.
Dryopteris serrata (Cav.) C. Chr.; tSA, rG. Widely distributed in fresh-water swamps and marsh forest.
Lindsaya stricta Dryand. In marshy spots in savannas.
Nephrolepis biserrata (Sw.) Schott; I 19, pt, rG. Occasional in fern swamps.
Pityrogramme calomelanos (L.) Link (Ceropteris cal. (L.) Underwood); pt, rG. Widely distributed in swamps, marsh and moist forest.

SALVINIACEAE.
Azolla caroliniana Willd.; I 81, tsA, Hy. Floating everywhere on eutrophic or oligohalinous stagnant water in the open or under light shade.
Salvinia auriculata Aubl.; I 80, tA, Hy. The same.

SPERMATOPHYTA

ACANTHACEAE.
Dianthera obtusifolia (Nees) Brem. (Justicia obt. (Nees) Lindau); tsA, Ch. Herb with decumbent shoots rooting at the base, in swamps and along ditches.
Trichanthera gigantea (H. et B.) Steud., tapokai (Car.); tsCA, M. Tree of low river banks.

AIZOACEAE.
Mollugo verticillata L.; tsA, Th. Pioneer on open sandy spots, strand, sand flats in rivers and fields.
Sesuvium portulacastrum L., zwamp porselein; pts, Ch. Succulent halophyte. Common along the coast both on clay and sand.

ALISMATACEAE.
Echinodorus grandiflorus (Cham. et Schltr.) Micheli. 2.5 m tall herb in swamps, rare.
Sagittaria lancifolia L.; I 65, tsA, rG. Occasional in fresh-water swamps.

AMARANTACEAE.
Acnida cuspidata Bert. ex Spreng.; I 3, Car, Th? Tall herb with a very thick hollow stem in brackish swamps, characteristic of my second type.
Alternanthera ficoidea (L.) R. et S.; tsA, Ch? On strand and ruderal places.
Alternanthera philoxeroides (Mart.) Gris. (Achyranthes phil. Mart.); ptA, Ch? Along riverbanks (a.o. in mangrove in fresh water) and ditches.
Alternanthera sessilis (L.) R. Br.; pts. Pioneer in wet or moist open spots.
Iresine vermicularis (L.) Moq. (Philoxerus verm. (L.) R. Br.); tAA, Ch. Succulent halophyte, common along the coast more on clay than on sand.

ANACARDIACEAE.
Loxopterygium sagotii Hook. f., *slangenbout;* tSA, MM. Valuable timber tree of rain forest.
Spondias mombin L. (S. lutea L.), *moppé;* II 12, tAWA, MM or M. Moisture-loving deciduous tree, with delicious plum-like fruits, common on the younger ridges.
Tapirira guyanensis Aubl., *witte hoedoe; tapiriri* or *atapriri* (Car.); warimia (Ar.); II 48, tSA, MM. Common in rain and savanna forest, also in marsh forest.

ANNONACEAE.
Annona glabra L. (A. palustris L.), *zwamp zuurzak;* arast'urang (Car.), pakaturupo (Car.); II 4, tAWA, MM. Small tree, common in mixed swamp wood in oligohalinous water.
Annona montana Macfad., *boszuurzak;* rusulu or urusuru (Car.); II 115, MM. In ridge forest.
Xylopia spp., *pegrekoe;* arara (Ar.); II 72, M. *X. amazonica* R. E. Fr., *X. aromatica* (Lam.) Mart. and *X. discreta* Sprague et Sandw., (called also *pegrekoe pisie)*. In the lower story of rain forest.

APOCYNACEAE.

Allamanda cathartica L; tA, L. In strand scrub, savanna, along river banks, etc.

Ambelania acida Aubl. (A. sagotii Müll. Arg.), *batbatti* (Sur, Ar.); II 80, FG, MM. In rain forest, never found in the coastal region.

Aspidosperma spp.; II 130, MM. *A. album* (Vahl) R. Ben., *marcgravianum* Woods. (A. nitidum Benth.), *oblongum* A. DC., a.o. The significance of the vernacular names *parelhout (wit* and *zwart)* or *parihoedoe* and *kromantikopie* is not yet cleared; jaroro (Ar.); apukut'a (Car.) seems to hold for all species.

Bonafousia tetrastachya (H. B. K.) Mgf. (Tabernaemontana repanda E. Mey.), *kapoeatikie;* yamorodang (Ar.); wako (Car.); II 142, Gui, M. Common, mainly in the lowest parts, in Triplaris marsh forest.

Bonafousia undulata (Vahl) DC., *mirkitikie;* II 124, Gui, MM. In rain forest.

Couma guyanensis Aubl., *mappa;* II 60 p.p., Gui, MM. In rain forest.

Macoubea guyanensis Aubl., *mappa;* II 60 p.p., Gui, MM. The name mappa, in use with the Forest Service, was not known for this species from older collections. In marsh, rain and savanna forest.

Parahancornia amapa (Hub.) Ducke, *mappa;* II 60 p.p.?, Gui, MM.

Himatanthus articulatus (Vahl) Woods. *(Plumeria art.* Vahl and sucuuba R. Spruce ex Müll. Arg. in Flora of Suriname), *savannebolletrie; mabwa* (Ar., Sur.); anahi (Car.); II 96, Gui, MM. In rain and savanna forest. Common on the younger ridges in the Wiawia transect, where a specimen of *H. lancifolius* (Müll. Arg.) Woods. was collected too. The true *Plumeria sucuuba* R. Spruce ex Müll. Arg. = *Himatanthus suc.* (Spruce) Woods. is an Amazonian species not known from Suriname or British Guiana.

Rhabdadenia biflora (Jacq.) Müll. Arg. (Echites bifl. Jacq.), V. A common twiner in the salt and distinctly brackish coastal zone of tropical America. It is not clear whether this species is specifically different from *R. paludosa* (Vahl) Miers. Britton and Millspaugh in the Flora of Bahama separate the two, but they cite four authorities combining them. In the former case the two species are vicariants, *R. paludosa* being found in the Greater Antilles, Bahamas, S. Florida and W. tropical America, *R. biflora* in the Lesser Antilles and along the Atlantic coast of S. America.

Rhabdadenia macrostoma (Benth.) Müll. Arg. (Echites macr. Benth.); I 31, tSA, V. Rare twiner in fresh-water swamps.

AQUIFOLIACEAE.

Ilex guianensis (Aubl.) O.K.; Car, M. in swamp wood, strand and savanna scrub.

Ilex martiniana D. Don.; Gui, M. In marsh forest in the old coastal region.

ARACEAE.

Monstera sagotiana Engl., kleine donké. Usually epiphytic, on the youngest ridges in the Wiawia line creeping over the ground.

Montrichardia arborescens Schott (M. aculeata Schott), *mokomoko;* I 20, II 141, tA, rG. Very common in oligotrophic to mesohalinous swamps, often gregarious along ridge borders and river banks in the tidal zone.

Pistia stratiotes L.; I 83, pt, Hy. Floating in stagnant water.

ARALIACEAE.

Didymopanax morototoni (Aubl.) Dcne et Planch., *kassavehout, kasabahoedoe;* II 90 p.p., tA, MM. In rain forest, on sand and clay.

ASCLEPIADACEAE.

Funastrum clausum (Jacq.) Schltr.; I 29, tA, L. In swamps and along river banks.

BALANOPHORACEAE.

Helosis cayennensis (Sw.) Spreng.; tSA, W. Ind. Parasitic herb on tree roots in marsh and moist forest.

BATIDACEAE.

Batis maritima L.; tsA, Ch or N. Succulent halophyte, sun-loving, tolerating very high salt concentrations. Common along the coast on open or lightly shaded spots mainly on clay.

BIGNONIACEAE.

Cydista aequinoctialis (L.) Miers; I 27, tA, V. Very common climber along river banks and in swamps.

Jacaranda copaia D. Don., *goebaja;* futé (Ar.); kupaya (Car.); II 61, tSCA, MM. In rain forest.

Jacaranda rhombifolia G. F. W. Mey.; NSA, MM. Common on low river banks.

Tabebuia insignis-group, *zwamppanta;* walukuli (Ar.); pandra (Car.); I 90, II 3. *T. aquatilis* (E. Mey.) Sprague et Sandw. (Couralia fluviatilis Aubl.); NSA, M, and *T. insignis* (Miq.) Sandw. var. *monophylla* Sandw. (T. longipes Baker); BG, M. In swamp and marsh forest. *T. insignis* (Miq.) Sandw., *zwarte panta;* Gui, M. In marsh forest and scrub in seasonally inundated clay savanna in Moengo tapoe line.

Tabebuia capitata (Bur. et K. Schum.) Sandw., *makkagrieng;* arawanni (Car.); Gui, MM. Deciduous, in rain forest on sandy soil.

Tabebuia serratifolia (Vahl) Nicholson, *groenhart,* grienharti; *(k)wassiba* (Ar.); tSA, MM. Deciduous, in rain forest, avoids wet soil, often on poor sand.

BOMBACACEAE.

Bombax aquaticum Schum. (Pachira aqu. Aubl.), *watercacao;* tA, MM. Very common along river banks in fresh water.

Bombax flaviflorum Pulle, *savannekatoen,* -kapok; itèmè (Ar.); krikrimaururu (Car.); II 133, BG, MM or M. Characteristic tree in savanna forest and -scrub.

Bombax globosum Aubl., *boskatoen,* parakatoen; krikrimaururu (Car.); II 62, Gui, MM. In rain, marsh and savanna forest.

Bombax spectabile Ulbrich (Pachira insignis Sw.), *bosmomow;* II 44, NSA, W. Ind., MM. Tall moisture-loving tree.

Catostemma sp., *barmanni;* wanaballi (Ar.); II 35, MM. Common in rain and marsh forest.

Ceiba pentandra (L.) Gaertn., *kankantrie;* II 13, tAWA, MM. Very large buttressed, deciduous tree, on ridges and sandy river banks; stands a fair amount of soil water and salt.

Quararibaea guyanensis Aubl., lèlè; Gui, M. On low river banks.

BORAGINACEAE.

Cordia macrostachya (Jacq.) R. et S.; Car, N. Along the coast on strand and in cultivated areas on sand and clay common.

Cordia tetrandra Aubl.; II 9, NSA, M or MM. The names *tafra (bong), tafelhout; alatruka* (Car.) are used for all arboreous *Cordia* species. *C. tetrandra* is common in swamp and marsh forest in the coastal region, other species in sec. growth.

Heliotropium curassavicum L.; tsA, Ch. Common perennial along the coast of tropical America, mainly on sand; apparently reaching its eastern limit on the mainland near Nickerie.

BROMELIACEAE.

bosananas; II 152. Forms rosettes of thick, sharply toothed leaves one m and more long, in wet to dry forests.

BURSERACEAE.

This family is very insufficiently known in Sur., and the vernacular names are confuse, see salie, witte salie and tiengimonnie.

Protium glabrescens Sw., *witte salie;* II 58 p.p., Gui, MM. In rain forest.

Protium heptaphyllum (Aubl.) March, *tiengimonnie;* hajawa (Ar.); *sipio* (Car.); II 49 p.p., NSA, MM. Probably the commonest species in Guiana and Amazonia.

Protium hostmannii (Miq.) Engl., *tiengimonnie;* hajawa (Ar.); Gui, MM. Common in rain forest.
Protium insigne (Tr. et Pl.) Engl., *tiengimonnie;* olo (Ar.); tSA, MM. In rain forest.
Protium sagotianum March., *witte salie;* II 58 p.p., NSA, MM. In rain forest.
Trattinickia rhoifolia Willd., *tiengimonnie, awaloe pisie;* olo (Ar.); *ajawa* (Car.); Gui, MM.

BUTOMACEAE.
Hydrocleys nymphoides (Willd.) Buch.; I 82, tSA, Hy. Floating in eutrophic swamps and ditches, common.

CACTACEAE.
Cereus sp., II 97, S. Arborescent up to 10 m high cactus, common on the youngest ridges in the East, even in strand mangrove.

CAMPANULACEAE.
Sphenoclea zeylanica Gaertn. Originating from the Old World, but now widely distributed in tropical America on wet spots, in Sur. found only near Nickerie.

CANNACEAE.
Canna glauca L.; tSA, G. Gregarious along border of eutropic swamps.

CAPPARIDACEAE.
Crataeva tapia L., kuleru (Car.); II 99, tA, M or MM. On the youngest ridges and sand flats in rivers; stands a fair amount of soil water and salt.

CARYOCARACEAE.
Caryocar glabrum (Aubl.) Pers., *sopohoedoe* (glad), with smooth cortex; alukumarirang (Car.); NSA, W. Ind., MM. Not common in rain forest.
Caryocar microcarpum Ducke, *sopohoedoe* (ruw), with rough cortex; kula (Ar.); II 21, tSA?, MM. Moisture-loving, wide-spread in marsh forest and on the lower ridges.
Caryocar nuciferum L., *sawarie;* Gui, MM. In rain forest.

CELASTRACEAE.
Goupia glabra Aubl., *kopie;* kopi-i (Car.); II 104, Gui, MM. Timber tree, in rain forest locally dominant.

CERATOPHYLLACEAE.
Ceratophyllum demersum L. var. *cristatum* K. Sch.; Hy. In stagnant open water.

COMBRETACEAE.
Conocarpus erecta L.; tsAWA, M. At the landside of mangrove, very rare in Sur.
Laguncularia racemosa (L.) Gaertn. f., *akira;* tsAWA, M. Gregarious along river banks in brackish water, scattered in mangrove forest.
Terminalia catappa L., *amandel,* M. Introduced from Asia, at present naturalized along strand coasts in tropical America.
Terminalia dichotoma G. F. W. Mey (T. tanibouca Smith), kalebashout, sansanhoedoe; Gui, MM. In marsh and rain forest.

COMPOSITAE.
Eclipta alba (L.) Hassk. (Verbesina alba L.); I 37, pt, Th. Common in swamps, along river banks and as weed.
Erechtites hieracifolia (L.) Raf. ex DC.; Car, Th. Occasional in swamps, common weed.
Mikania congesta DC. (M. micrantha var. congesta (DC.) Robinson); tA, V. Twiner along river banks and in swamps.
Pacourina edulis Aubl.; NSA, Th? Occasional in fresh to mesohalinous swamps.
Pluchea odorata (L.) Cass.; Car, N. In Sur. near Nickerie only, in moist to wet soil.

CONVOLVULACEAE.

Cuscuta umbellata H.B.K.; Car. Twining parasite, in Sur. found only on *Sesuvium portulacastrum,* on the W. Indian islands also on other coastal plants.

Ipomoea parkeri Choisy; I 23, Gui, V. In eutrophic and oligohalinous swamps.

Ipomoea pes-caprae (L.) Sweet (I. biloba Forsk), kumatara (Car.); pts, Ch. Very common strand plant.

Ipomoea stolonifera (Cyrill.) Poir. (I. littoralis Boiss., I. carnosa R. Br.); pts, Ch. Strand plant.

Ipomoea subrevoluta Choisy; I 24, Gui, V. In eutrophic swamps.

Ipomoea tiliacea (Willd.) Choisy, halitsiballi (Ar.); bawar (Hind.); I 22, tA, V. Common in eutrophic to mesohalinous swamps, along river banks and in sec. growth.

Ipomoea tuba (Schlecht.) G. Don. (Calonyction tuba (Schlecht.) Colla); pt, V. Strand plant.

Jacquemontia velutina Choisy; I 32, V. Found only in the swamp S. of the Coronie ridges.

CYPERACEAE.

Becquerelia tuberculata Pfeiff.; I 70, Gui, rG. Abundant in shallow parts of the Great Swaying swamp and in bogs on savanna, occasional in forests.

Cladium mariscus Pohl (C. jamaicense Crantz, Mariscus jamaicensis (Crantz) Britton); I 58, cosm, rG, not in NSA, where similar habitats are occupied by *Cyperus giganteus.* In Gatun Lake in Panama both species meet each other.

Cyperus articulatus L., biesbisi; bioro (Ar.); kupas'idang (Car.); I 6, pts, rG. Characteristic of my 2nd swamp type, associate of the 3d and 4th type.

Cyperus chalaranthus Presl.; II 160, tSA, rG. Common in light shade, in wood on the youngest ridges and sec. growth.

Cyperus comosus Poir.; tA, rG. Closely resembling *C. giganteus,* but smaller. Collected in ditches and on muddy banks of the lower rivers.

Cyperus digitatus Roxb.; pts, rG. Rare in swamps.

Cyperus elegans L.; I 61, Car, without NSA?, in swamps.

Cyperus giganteus Vahl, *papajagras;* I 16, tA, rG. Characteristic of my 4th swamp type. Small specimens may be confused with *C. comosus.*

Cyperus haspan L.; I 50, pts, rG. In swamps and elsewhere in wet or moist spots.

Cyperus luzulae (L.) Retz.; tA, rG. Rare in swamps, common in sec. growth.

Cyperus polystachyos Rottb. (Pycreus pol. (Rottb.) Beauv., C. odoratus L.), motha (Hind.); pts, Th. In moist to wet ground, often in sec. growth, salt-tolerant.

Cyperus surinamensis Rottb.; tsA, rG. In moist to wet ground.

Diplasia karataefolia L. C. Rich.; II 158, Gui, rG. In marsh and rain forest and on savanna. Gigantic sedge with rosettes of up to 3.5 m long, sharply toothed, leathery leaves.

Eleocharis caribaea (Rottb.) Blake; pts, Th. Small tender plant on clayey river banks in the tidal zone.

Eleocharis geniculata R. Br.; tA, rG. Along river banks in completely fresh water.

Eleocharis interstincta (Vahl) R. et S.; I 43, tsA, rG. Common pioneer in stagnant fresh water, associate in swamps.

Eleocharis mutata R. et S.; I 1, tA, rG. Forms almost pure pioneer stands in hyperhalinous to fresh-water swamps.

Eleocharis plicarhachis (Gris.) Svenson; I 57, tA, rG. In oligotrophic swamps of the 5th and 6th type.

Fimbristylis annua (All.) R. et S. (F. diphylla (Retz.) Vahl); pts, Th. On moist to wet open ground.

Fimbristylis ferruginea (L.) Vahl; pts, Ch. Locally abundant on wet brackish sand or clay.

Fimbristylis miliacea Vahl; I 55, pts. Th. In fresh-water swamps, open swamp wood and moist sec. growth.

Fimbristylis spadicea (L.) Vahl; tsA, Ch or rG. On salt clay, submersed by high floods.

Fuirena robusta Kunth; I 45, tA, rG. In fresh or oligohalinous swamps.

Fuirena umbellata Rottb.; I 44, pts, rG. In fresh-water swamps and wet spots in savannas.

Hypolythrum longifolium Nees var. *sylvaticum* (Poepp. et Kunth) Uitt.; II 156, tSA, rG. In marsh and moist forest along creeks.

Hypolythrum pulchrum (Rudge) Pfeiff., NSA, rG. Very common in sand and clay savannas, stands shade and permanently wet soil.
Kyllinga pungens Link; tsAA, very rare in E. Asia, rG. In Sur. on savanna and as weed, in the Caribbean also on strand.
Lagenocarpus guianensis Nees; I 69, tA, rG. Dominant in the swaying swamps, occasionally in savannas.
Lagenocarpus tremulus Nees; tA, rG. Common in savannas.
Mariscus ligularis (L.) Urb. (Cyperus lig. L.); tAA, rG. On strand, and savanna, also a common weed.
Remirea maritima Aubl.; pt, rG. Characteristic strand plant, in Sur. but once collected.
Rhynchospora corymbosa (L.) Britton (R. aurea Vahl); I 56, pt. rG. Characteristic of my 5th swamp type, occasionally in the 4th type.
Rhynchospora cyperoides (Sw.) Mart.; I 67, tAA, rG. Common in wet spots in savannas, also in oligotrophic swamps.
Rhynchospora gigantea Link; I 66, tA, rG. In oligotrophic swamps; resembles closely *R. corymbosa* but seems to be ecologically different.
Rhynchospora micrantha Vahl; I 63, tAWA, not in Guiana.
Rhynchospora stellata (Lam.) Gris. (Dichromena colorata (L.) Hitchc.); I 64, Car, without NSA.
Rhynchospora triflora Vahl; I 68, pt, rG. Characteristic of my 6th swamp type, most frequent in the initial phase.
Scirpus cubensis Poepp. et Kunth; I 36, tAA, rG. In mesohalinous to eutrophic swamps, prefers rather deep and open spots.
Scleria cyperina Willd.; Gui, rG. Common on savannas in and around scrub groups.
Scleria eggersiana Boeck.; I 48, Car, rG. Locally abundant in dense groups in my 4th swamp type.
Scleria flagellum-nigrorum Berg, *baboennefie;* II 162 p.p., tA?, V. Forms with its sharp-edged branches and leaves an almost impenetrable tangle in swamp wood and sec. growth.
Scleria macrophylla Presl. (S. paludosa Kunth); tSCA, rG. In swamp wood.
Scleria microcarpa Nees; I 49, tA, rG. Locally in groups in swamps of the 4th and 5th type.
Scleria secans (L.) Urb.; *baboennefie;* II 162 p.p., tA, V. Forms almost impenetrable tangles in swamp wood and sec. growth, just like *S. flagellum-nigrorum.*
Torulinium ferax (L.C. Rich.) Urb. (Cyperus ferax L.C. Rich.), piripiri (Car.); I 9, pt, G. In brackish swamps, along river banks and as weed on moist soil.

DILLENIACEAE.

Curatella americana L.; tA, M. Stunted treelet in orchard savanna.
Tetracera asperula Miq., *(savanne) kautêté;* II 154, Gui, L. The vernacular names point to two forms of the species, in rain forest it is a liana, in and around savanna scrub a low trailing shrub.

DROSERACEAE.

Drosera capillaris Poir.; I 72, tA. On wet spots in savanna and in the Great Swaying swamp.

EBENACEAE.

Diospyros guianensis (Aubl.) Gürke, *blaka oema; barabara* (Ar.); tarara (Car.); II 27, Gui, M. Small tree, common in marsh forest and moist rain forest.

EUPHORBIACEAE.

Aparisthmium cordatum (Juss.) Baill., *bradiliefie;* mababalli (Ar.); sawranani (Car.); tSA, MM. In rain forest.
Amanoa guyanensis Aubl., *zwampgujave;* II 25, Gui, MM. Moisture-loving tree, abundant in scrub wood along creeks on peaty mud.
Caperonia palustris (L.) St. Hil.; tAA, Th. In fresh-water swamps and as weed.
Hura crepitans L, *possentrie,* possem; warayua (Ar.); kumakara (Car.); II 121, tA, MM.

Locally dominant in marshy, usually brackish spots on and along ridges, in the eastern part only a few stunted trees have been found.

Omphalea diandra L., *baboennoot;* idaballi (Ar.); sitio (Car.); tA, L. Wide-spread in moist and wet woods and forest margins.

Phyllanthus acidus (L.) Skeels (Cicca disticha L.), *goesberie;* II 7, M; probably introduced from India, at present widely distributed in tA in moist to wet woods.

Phyllanthus nobilis (L.f.) Müll. Arg., *boskoffie;* tA, M. In moist to wet woods.

Sapium klotzschianum (Müll. Arg.) Hub.; Sur, S. Brazil, MM. Moisture-loving tree.

Sapium obtusilobium Müll. Arg., mirkiehoedoe; II 117, MM. Found only on the Coronie ridges.

FLACOURTIACEAE.

Casearia macrophylla Vahl, *boskoffie;* II 123, NSA, MM. In rain forest.

Homalium guianense (Aubl.) Warb. and *racemosum* Jacq., *bietahoedoe;* II 101, Gui, MM. Common along river banks, moisture-loving.

Laetia procera (Poepp. et Endl.) Eichl., *pientokopie;* II 89, NSA, W. Ind., MM. In rain forest.

GENTIANACEAE.

Lisianthus alatus Aubl.; Gui, N. Mainly in oligotrophic swamps, rare. Other species in savannas.

GRAMINEAE.

Acroceras zizanoides (H.B.K.) Dandy (Panicum ziz. H.B.K.); pt, Ch, with creeping base. In moist to wet woods and sec. growth.

Andropogon bicornis L.; I 54, tA, Ch. In fresh-water swamp, on fire savanna and waste places.

Cenchrus echinatus L., pratatai (Car.); pt, Th. On strand and waste places.

Echinochloa polystachya (H.B.K.) Hitchc., *paragras;* I 13, tA, Ch. Culms ascend from a creeping base. Common in moist grassland and swamps; it can also play a part in the formation of floating mats.

Gynerium sagittatum (Aubl.) Beauv., *pijlriet;* tA, rG. According to SPLITGERBER not rare, especially in the coastal region; seen by us only in dense groups on river banks near villages where it probably has been planted. In other countries it grows also in swamps.

Hymenanche amplexicaulis (Rudge) Nees (Panicum ampl. Rudge); I 47, tA, Ch, creeping at the base. In fresh and oligohalinous swamps; plays sometimes a part in the formation of floating mats.

Leersia hexandra Sw. (Homalocenchrus hex. (Sw.) Kuntze), *warapagras;* I 15, pt, Ch. Dominant in swamps of the 3d type, common in the 4th type, in Trinidad found even in wet spots in savanna. RIDLEY in Flora of the Malay Peninsula states that it is one of the best fodder grasses, but to exploit the Leersia swamps for this purpose a special method must be developed. An effective control of the water supply will be necessary and trampling of the vulnerable mat must be avoided.

Luziola spruceana Benth. ex Doell.; I 46, tA, rG. In fresh-water swamps.

Olyra latifolia L., pinpin; II 157, tAA, G. Tall erect or climbing forest grass, very euryoecious.

Oryza latifolia Desv., boesihalesie; pt. rG. Sometimes confused with *O. sativa.* Moisture-loving.

Panicum grande Hitchc. et Chase; I 53, tA, Ch with creeping or floating stolons. In fresh-water swamp and swamp wood; forms sometimes floating mats.

Panicum laxum Sw.; tA, Ch. On open, moist or wet sand or clay soil.

Panicum mertensii Roth. (P. megiston Schult.); I 10, tA. Tall, not gregarious grass in fresh to mesohalinous swamps, and along river banks; stands shade.

Panicum pilosum Sw.; tA, Ch. Moisture-loving.

Paspalidium geminatum (Forsk) Stapf (Panicum gem. Forsk, P. appressum Lam.); I 5, pts, Ch. Usually on wet brackish clay.

Paspalum densum Poir., baboen grassie; tA, caespitose Ch. On moist and wet clay soil.

Paspalum distichum L.; I 62, pts, creeping Ch. In moist or wet, fresh or brackish ground.
Paspalum repens Berg.; pts, Ch, creeping at the base. Rare in swamps.
Paspalum vaginatum Sw.; pts, Ch, creeping at the base and stoloniferous. Forms dense patches in brackish swamps.
Pharus latifolius L.; tA. Broad-leaved grass of rain and marsh forest.
Phragmites communis Trin., tamakus'idang (Car.); I 40, cosm, rG. In Sur. rather rare in brackish swamps.
Sacciolepis striata (L.) Nash; I 14, Car, Ch. Common in fresh to mesohalinous swamps.
Spartina brasiliensis Raddi; NSA, rG. Pioneer on mud in the tidal zone along the coast and in the lower part of the rivers.
Sporobolus virginicus (L.) Kunth; pts, rG. Very common and locally dominant on saline clay or sand, not on permanently inundated soil.
Stenotaphrum secundatum (Walt.) Kuntze (S. americanum Schrank); tsAWA, G or Ch. Common on strand.

GUTTIFERAE.
Calophyllum brasiliense Camb., koelarie; kurara (Sur., Ar.); kulahara (Car.); tSA, MM. Moisture-loving tree, common in marsh forest.
Caraipa densifolia Mart., *laksirie, alakasirie;* alakusèrĭ (Ar.); Gui, MM. Moisture-loving tree.
Clusia fockeana Miq., *savanne mangro;* mataburi (Ar.); kunapolan (Car.); II 86 p.p., Gui, MM or M. Characteristic of savanna forest.
Clusia nemorosa G.F.W. Mey., *savanne mangro;* mataburi (Ar.); kunapolan (Car.); II 86 p.p., Gui, MM or M. Characteristic of savanna forest, grows also in Mauritia-Chrysobalanus association and rarely in swamp of the 6th type. This species is very variable and only experimentally can be proved in how far these forms have a genetic base and hybrids with related species e.g. *C. fockeana* occur.
Clusia purpurea (Splitg.) Engl.; End?. Hemi-epiphytic tree in mangrove (on *parwa)* and in bank forest along Upper Saramacca River.
Platonia insignis Mart.; Gui, MM. In marsh forest.
Rheedia benthamiana Pl. et Tr., *pakoelie;* pakuli (Car.); II 82, BG, MM. In rain forest.
Rheedia kappleri Eyma, *zwamppakoelie;* asas'i (Ar.); II 34, FG, MM. Moisture-loving tree, optimum in Symphonia marsh forest.
Symphonia globulifera L.f., *(hoogland) matakki; mani* (Ar.); II 30, tAA, MM. Timbertree with knee-shaped pneumatophores. Frequent to very abundant in my 2nd type of marsh forest, stands permanent inundation, rare in rain forest.
Vismia cayennensis (Jacq.) Pers., *oema pienja;* waràja (Ar.); II 106 p.p., NSA, M. Common in woods, very tolerant as to soil and soil moisture.
Vismia confertiflora Spruce, *oema pienja;* firoberobana waràja (Ar.); II 106 p.p., Gui, M. Like the former.
Vismia guianensis (Aubl.) Choisy, *reddibakka pienja;* iyaro waràja (Ar.); swinani (Car.), tSA, M. Like the former.

HUMIRIACEAE.
Humiria balsamifera (Aubl.) St. Hil. and *floribunda* Mart., *blakaberie;* meri (Car.); II 132, tSA, M or MM. Characteristic of savanna forest. The 2 species are both very variable and they are connected by intermediate forms. Experiments must show whether these are hybrids or the 2 species must be reduced to one wide species.
Sacoglottis guianensis Benth. var. *sphaerocarpa* Ducke, *bofrohoedoe,* kwattasirie; II 91, Gui, MM. In rain forest.

HIPPOCRATEACEAE.
Hippocratea volubilis L.; tA, L. In strand scrub and along river banks.

HYDROCHARITACEAE.
Limnobium stoloniferum (G.F.W. Mey.) Gris., bomagrassie; opono payulidĕ (Car.); tA, Hy. In stagnant, fresh or oligohalinous open water.

HYDROPHYLLACEAE.

Hydrolea spinosa L.; tA. On moist to wet places.

LAURACEAE.

Cassytha filiformis L. (C. americana Nees); I 75, pt. Twining parasite, very euryoecious as well to host as to habitat, common in strand, swamp and savanna vegetation.

Licaria canella (Meissn.) Kosterm.; Gui, and L. *cayennensis* (Meissn.) Kosterm.; FG, ***kaneelhart, kaneriehoedoe;*** MM. In rain and high savanna forest.

Licaria guianensis Aubl., ***kaneelpisie;*** II 73, FG, MM. In rain forest.

Ocotea rubra Mez, *wana, wane;* Gui, MM. Valuable timber tree, in rain forest.

Many other *Ocotea* spp. and also species of other genera, mainly *Nectandra* are combined under the name *pisie;* II 74. They form a very heterogeneous and confuse group.

LECYTHIDACEAE.

Couratari spp., *iengipipa;* II 75, MM. The species of this genus are still very insufficiently known, although they are well recognizable in the forest. Very large trees with broad crowns, widely distributed but rare.

Couroupita guianensis Aubl., *boskalebas;* kaupě (Car.); II 116, Gui, MM, deciduous. In dry to marshy forest, probably on rich soil only, not on ridges of poor sand.

Eschweilera longipes (Poit.) Miers, *manbarklak;* II 32, Gui, MM. Valuable timber tree, in rain and Symphonia marsh forest.

Eschweilera corrugata (Poit.) Miers; Gui, MM, and *E. floribunda* Eyma; Sur., MM; *oema-barklak;* II 76, also *E. amara* (Aubl.) Ndz. and *E. chartacea* (Berg.) Eyma have been collected in the past under this name. The genus as a whole is inadequately known and the vernacular names are rather confuse, therefore unidentified *barklak* specimens are combined under II 33; kakaralli (Ar.); kwatĕrĕ (Car.).

Gustavia augusta Alm sensu Berg, *watramamabobbie;* lanaballi or wanaballi (Ar.); arepawana (Car.); II 57, NSA, MM. In rain and marsh forest.

LEMNACEAE.

Lemna perpusilla Torr. (L. paucicostata Hegelm. ex Engelm.); pts, Hy. Floating in stagnant fresh or oligohalinous water.

Spirodela polyrrhiza (L.) Schleiden; cosm, Hy. Floating in stagnant water.

Wolffiella lingulata (Hegelm.) Hegelm; Hy. Floating in stagnant fresh or oligohalinous water.

LENTIBULARIACEAE.

Biovularia olivacea (Wright) Kam. (B. minima (Warm.) Kuhlm.); Hy. Minute, almost colourless floating plant in oligotrophic water.

Utricularia angulosa Poir.; Th. In floating savanna in Great Swaying swamp.

Utricularia foliosa L. (U. oligosperma St. Hil.); I 84, tA, Hy. In stagnant fresh open water.

Utricularia guyanensis A. DC.; I 73 p.p., Th. In sand and floating savanna.

LOGANIACEAE.

Antonia ovata Pohl, *(savanne) soekroehoedoe,* likahoedoe; turara (Ar.); II 129, Gui, MM. In rain and savanna forest.

LYTHRACEAE.

Crenea maritima Aubl. (Cren(a)ea repens G. F. W. Mey.); akiraĕ (Car.); NSA, N. In the margin of mangrove.

MALPIGHIACEAE.

Brachypteris ovata (Car.) Small (B. borealis Juss.); I 4, Car, N or L. In brackish swamps and mangrove scrub very common.

Byrsonima coriacea (Sw.) Kunth var. *spicata* (Cav.) Ndz., *lontoekassie;* mulĕi (Car.);

II 94, tA, MM. Common on the younger ridges and in savanna forest, rare in rain-forest.

Byrsonima crassifolia (L.) Rich., mulèi (Car.); tA, M. Stunted fireproof treelet, common in orchard savannas.

MALVACEAE.

Hibiscus bifurcatus Cav., jorka okro; haimiara mĕnkararĕ (Car.); I 52, tSCA, N. Common in fresh or oligohalinous swamps, along rivers and in marsh wood.

Hibiscus furcellatus Desr. in Lam.; tsA, N. Rare in wet spots.

Hibiscus sororius L. f.; tA, N. Occasional in fresh-water swamps.

Hibiscus tiliaceus L. (Pariti(um) til. (L.) St. Hil.), *maho, tjawassie;* kayèsè (Car.); II 41, pt, M. Characteristic of strand scrub, also in dense stands along river banks in brackish water.

Pavonia racemosa Sw.; Sur, W. Ind., M. In brackish mangrove belt along lower rivers.

Pavonia scabra (B. Vogel) Stehlé (Malache sc. B. Vogel); tA, M. Like the former, but not in Sur.

MARANTACEAE.

Ischnosiphon gracilis (Rudge) Koern. and *obliquus* (Rudge) Koern., *warimbo;* II 151, NSA, G. Very common tall herbs, often in large groups in marsh and moist rain forest.

Monotagma plurispicatum (Koern.) K. Schum., *kleine warimbo;* II 159, G. In rain forest.

Thalia geniculata L.; I 41, tsAA, rG. Locally abundant in fresh or oligohalinous swamps.

MAYACACEAE.

Mayaca longipes Mart. ex Seubert; Gui, Hy. Submersed in locks in the swaying swamps and in clear creeks.

MELASTOMATACEAE.

Miconia myriantha Benth., *pikientikie,* bojohoedoe; kabuyakoro (Ar.); kumète (Car.); II 55, tSA, M or MM. In wet to dry forests, not in deep shade.

Many other species of *Miconia* and *Henriettea* in rain and savanna forest are given the name *mispel;* II 70, M, MM.

Mouriria spp., *spikrihoedoe;* alasuaba (Ar.), komotori (Ar.); II 26, MM. In marsh and rain forest, a.o. *M. guianensis* Aubl.; NSA, *M. plasschaerti* Pulle; End, *M. princeps* Naud.; Gui.

Nepsera aquatica (Aubl.) Naud.; Car, N. In swamp, savanna and dry to wet forests.

Rhynchanthera grandiflora (Aubl.) DC.; NSA, N. In clay savanna and swamps of the 6th type.

Tococa guianensis Aubl.; II 108, NSA, N or M. In dry to wet forests.

MELIACEAE.

Carapa guianensis Aubl.; NSCA, MM.

Carapa procera DC., *krappa; karapa* (Car.); II 28, FG and trop. Africa. In Sur. much commoner than the closely related *C. guianensis,* with which it may easily be confused. In the literature I found only the latter, this is mentioned for many forest types, whereas *C. procera* in Sur. is a distinctly moisture-loving tree.

Guarea guara (Jacq.) Wils., *doifiesirie;* karababalli (Ar.); atuwaĕ (Car.), kuleku (Car.); II 102, MM. On the younger ridges, in rain and sometimes in savanna forest.

Trichilia trinitensis Juss., kabowasitoko (Ar.); marakatano (Car.); II 119, Gui, M. Probably restricted to the shell-ridge areas and rain forest in the interior.

MIMOSACEAE.

Entada polystachya (L.) DC.; II 147, tA, L. On moist to wet sand or clay, stands meso-halinous ground water.

Inga alba (Sw.) Willd., *prokonie;* II 88, Gui, MM. In rain forest.

Inga ingoides (Rich.) Willd., *swietiboontje; karoto* (Ar.); warapotĕrĕ (Car.), *want'i*

(Car.); II 19 p.p., Car., M or MM. Moisture-loving tree, common in the coastal region, penetrating in swamps and tolerating some salt. Many other species occur under the same names in the forests and fall under one heading II 19 with the first species.

Inga lateriflora Miq.; Gui and *heterophylla* Willd.; tSA, W. Ind., turiri (Car.); tulèli (Ar.); MM. In rain forest.

Neptunia plena (L.) Benth., samasamari (Ar.); I 35, tA, N? In eutrophic to mesohalinous swamps.

Neptunia prostrata (Lam.) Baill.; pt, Hy. Creeping herb, floating on the water surface on its inflated stems.

Parkia nitida Miq., *agrobigie;* II 128, FG, MM. Large tree in rain forest.

Pentaclethra macroloba (Willd.) Kze ; tSCA, MM. On low river banks.

Pithecellobium jupunba (Willd.) Urb. (Abarema jup. (Willd.) Britton et Killip) *zwamp-, bostamarin;* hurwasa (Ar.); uya (Car.), kraipiĕ (Car.); II 56, Car, MM. Grows in all forest types.

Zygia cauliflora (Willd.) Killip and *glomerata* (Vell.) Pittier, *moeserkie* or *moesirtjie; alekoyo* (Ar.); Gui, M or MM. Common on low river banks.

MENYANTHACEAE.

Nymphoides humboldtianum (H.B.K.) O.K. (Limnanthemum humb. (H.B.K.) Gris.); I 79, tA, Hy. In fresh to mesohalinous swamps.

MONIMIACEAE.

Siparuna guianensis Aubl., *fajapau;* muneridang (Ar.); yarakopi or ir(i)akopi (Car.); II 84, tSA, M. Common shrub in rain forest.

MORACEAE.

Cecropia peltata L., *bospapaja; boroma* (Ar.); *yarayara* (Car.); II 10, MM. *C. peltata* is the commonest species in the coastal region and a differential of the Triplaris marsh forest, but other species occur under the same vernacular names a.o. *C. palmata* Willd.

Ficus spp.; I 88, II 6, MM. Material not yet determined. *Kwassini* (Car.), common in the marsh forest in the Coronie area probably indicates one species, it has a broad crown and large buttresses.

MUSACEAE.

Heliconia psittacorum L.f., *papegaaientong,* popokaitongo; kulewako anuru (Car.), konosarang (Car.); I 11, II 163, tSA, rG. Common on moist to wet soil, along swamp borders, in woods and in savannas in marshlets and on ant hills.

Heliconia, kleine paloeloe; II 145, PH. One or more tall species, in marsh forest and penetrating in swamp wood.

Ravenala guyanensis (L.C. Rich.) Benth., *paloeloe;* II 59, Gui, PH. Often in large groups in moist or marshy forest.

MYRISTICACEAE.

Iryanthera hostmanni Warb., *s(a)rébèbé;* kirikawa (Ar.), at'iballi (Ar.), kassalerodang (Ar.); II 63, Gui, MM. In marsh and rain forest.

Iryanthera sagotiana Warb., *bloedhout, broedoehoedoe;* marakaipo (Car.); Gui, MM. In rain forest.

Virola sebifera Aubl., *hooglandbaboen;* warolo (Car.); II 105, Gui, MM. In rain forest.

Virola surinamensis (Rol.) Warb., *baboen;* dalli (Ar.); warusi (Car.); II 18, Car, MM. More of less buttressed moisture-loving tree. Very common in marsh and moist rain forest, in the latter less abundant.

MYRSINACEAE.

Conomorpha magnoliifolia Mez, teteruma(balli) (Ar.), sabana wanaballi (Ar.); II 137, BG, M. Common in savanna scrub.

MYRTACEAE.

Aulomyrcia pyrifolia (Desv.) Berg, *zwamp gujave, banda;* bandè (Ar.), mariaba (Ar.); II 24, Gui, M or MM. Common in marsh and moist rain forest, in scrub wood along creeks very abundant.

Calycolpus revolutus (Schauer) Berg, *kwakkoe,* savanne gujave; mariaba (Ar.); FG, M or MM. In savanna forest.

Eugenia wullschlaegeliana Amsh., *ololi,* apiwenai (Car.); II 95, Gui, MM. Common on young ridges, only near the coast.

Marlierea montana (Aubl.) Amsh., *kwakkoe;* II 93, Gui, MM or M. Characteristic of savanna forest, sometimes in swamps of the 6th type.

Myrcia sylvatica (Mey.) DC.; Gui, and *splendens* (Sw.) DC., Gui, W. Ind., *bosgujave;* ibibanaro (Ar.); II 109 p.p., MM. In rain and savanna forest.

Myrciaria floribunda (West ex Willd.) Berg, *bosgujave;* II 109 p.p., Gui, W. Ind; MM. In rain forest.

NYCTAGINACEAE.

Pisonia olfersiana Link, Klotzsch et Otto; II 98, MM. On young ridges near the coast and in savanna forest.

NYMPHAEACEAE.

Nymphaea amazonum Mart. et Zucc.; I 78 p.p., tSA, Hy. In stagnant fresh water.

Nymphaea ampla (Salisb.) DC.; I 77, tA, Hy. Mainly in open oligohalinous lagoons.

Nymphaea odorata Ait.; Hy. This species known from S.U.S. and Cuba was found in open locks in the swaying swamps.

Nymphaea rudgeana G.F.W. Mey.; I 78 p.p., tSCA, Hy. In fresh and oligohalinous swamps and sluggishly flowing creeks.

OCHNACEAE.

Ouratea polygyna Engl., kassibon, basrawana; II 131, tSA, M. In rain forest and savanna scrub.

Ouratea surinamensis (Planch.) Wehlburg, *kassihoedoe;* II 110, End, M. In marsh forest and savanna scrub.

OENOTHERACEAE.

Jussieua affinis DC.; I 38, tA, Th? In fresh to slightly mesohalinous swamps and swamp wood and along river banks.

Jussieua decurrens (Walt.) DC.; tsA, Th?. In fresh and oligohalinous swamps.

Jussieua erecta L.; tsAA, N. In fresh water.

Jussieua leptocarpa Nutt.; I 8, tsAA, N? In and along fresh to mesohalinous swamps.

Jussieua nervosa Poir.; I 39, tSCA, N. In fresh-water swamps and wet spots in savanna.

Jussieua suffruticosa L. (J. angustifolia Lam.); tAA or pt, N. In wet places and in sec. growth.

Oocarpon torulosum (Arn.) Urb.; tA. Rare in swamps.

OLACACEAE.

Chaunochiton kappleri (Sagot) Ducke, *patakoana;* II 65 p.p., Gui, MM. In rain forest.

Minquartia guianensis Aubl., *alattahout;* Gui, MM. Stem with deep growth holes, used for poles. In rain forest.

Ximenia americana L., *Fransman moppé;* pt, M. Thorny shrub or low tree in wood on the youngest ridges.

ORCHIDACEAE.

Cyrtopera longifolia Reich. f.; tAWA, G. Tall orchid, the inflorescence up to 3 m high, rare in fresh-water swamps.

PALMAE.

This family is in great need of a special study, therefore only a few species can be named at present with reasonable certainty.

Astrocaryum paramacca Mart., *paramakka;* II 111, Gui, M. Common in moist rain forest outside the coastal region.

Astrocaryum segregatum Drude, *awarra* (Sur., Ar., Car.); II 37, Gui, M. Very common on the younger ridges, also in marsh and rain forest.

Astrocaryum cf. *sciophilum* (Miq.) Pulle, *boegroemakka;* II 112, M. STAHEL (39) gives the name *A. murumuru* Mart.; the exact name could not be ascertained as no material was collected. Common in rain forest in the interior.

Bactris spp., *kiskismakka* or *kaumakka;* II 14, M. Several large-leaved species are moisture-loving and grow in marsh forest and along swamp borders.

Bactris sp., *nanaimakka,* small stemless palm with long needle-like spines.

Desmoncus spp., *bambamakka;* alakulè (Car.); II 8, *D. horridus* Splitg. et Mart., a really horrible climbing palm with sharp hooks on the leaf tips, is certainly rather common in the coastal region in marsh forest and swamp wood.

Euterpe oleracea Mart., *pina,* palissade, prasara; wasé (Car.); II 17, NSCA, MM. Moisture-loving palm; at its optimum in marsh forest it forms clumps and dominates completely the understory. Whether *E. edulis* Mart. reported from the other Guianas and Brazil occurs in Suriname I do not know.

Geonoma spp., *tas;* II 150, N. In marsh and moist rain forest.

Jessenia bataua (Mart.) Burret (Oenocarpus bat. Mart.), *patawa (koemboe);* II 50 p.p., Gui, MM.

Manicaria saccifera Gaertn., *truli;* NSCA, MM. Common on low banks of the lower rivers.

Mauritia flexuosa L.f., *maurisie;* I 92, II 20, NSA, MM. Very abundant along the border of oligohalinous swamps, on low river banks and on low spots in savannas. Whether this is the only species in Sur. is unknown (see p. 83).

Maximiliana maripa (Mart.) Drude, *maripa;* II 29, Gui, MM. Common in marsh and moist rain forest.

Oenocarpus spp., *koemboe;* lo (Ar.); kumu (Car.); II 50, MM. See *Jessenia;* the only collected specimen may belong to *O. bacaba* Mart.. Very common in marsh and moist rain forest.

PAPILIONACEAE.

Aeschynomene sensitiva Sw.; I 33, tAA, N. Common in fresh to slightly mesohalinous swamps.

Alexa wachenheimii R. Ben., *nekoehoedoe,* FG, MM. In rain forest .

Andira coriacea Pulle, *reddie* or *rode kabbes;* kuraru (Ar.); II 16 p.p., FG, MM. In rain and savanna forest.

Andira inermis (Wright) H.B.K., *reddie* or *rode kabbes,* zwampkabissie; kuraru (Ar.); ereyuru (Car.); II 16 p.p., tAWA, MM. In dry to wet forest, but prefering a marshy habitat.

Caesalpinia bonduc (L.) Roxb. (C. bonducella Flem., Guilandina crista (L.) Small); pts, N. Common shrub on high strand and in dune scrub.

Canavalia maritima (Aubl.) Thou. (C. obtusilobia DC.), zeeboon; kumatara (Car.); pts, Ch. Very common creeping strand herb.

Cassia alata L., srabritie; pt, N. In moist to wet places, river banks, etc..

Copaifera guianensis Desf., *hoepel,* okro-oli; kupaiwa (Ar.); apa-ua (Car.); II 36, Gui, MM. Common in marsh and rain forest.

Crudia glaberrima (Steud.) Macbr., *watrabirie;* atapa (Car.); Gui, MM. Common on low river banks.

Cynometra hostmanniana Tul., *makraka;* sakaballi (Ar.); II 43, Gui, MM. On low river banks.

Dalbergia ecastophyllum (L.) Taub. (Ecastophyllum brownei Pers.), akaleroai (Car.); tsAWA, M. In strand scrub and along ridge borders near the coast and river banks.

Dalbergia monetaria L.f.; tsA, M. Along river banks.

Dicorynia guianensis Amsh., *basralokus;* II 78, FG, MM. Timber tree, in rain forest outside the coastal region.

Dimorphandra conjugata (Splitg.) Sandw., *dakama* (Sur., Ar.); akayoran (Car.); II 136, Gui, M. Characteristic of savanna forest, locally dominant in a wood facies.

Dipteryx odorata Willd., *tonka;* kumaru (Ar.); Gui, MM. In rain forest.

Eperua falcata Aubl., *(zand) wallaba;* II 79, Gui, MM. Widely distributed in forests, locally dominant on poor, but well-drained sand.

Eperua jenmani Oliv., *(oever) wallaba,* MM. according to GONGGRIJP and BURGER (34) common on low sandy river banks. It should be easily recognizable by its brown pods. I doubt strongly the specific name as *E. jenmani* has been collected only twice in Suriname without pods and also in British Guiana this species is rare. On the other hand *E. rubiginosa* Miq. with rusty brown pods has been collected many times along rivers.

Erythrina glauca Willd., *koffiemama;* as'iakara (Car.); I 87, tA, MM. Very common in eutrophic and oligohalinous swamps in the eastern and western part of the young coastal region. It forms almost pure stands of sometimes great extent. Also in marsh forest along the upper rivers.

Hymenaea courbaril L., *lokus;* kawanali (Ar.); II 38, tA, MM. In rain forest and on low river banks. According to MARSHALL (94) on well drained sands and clays, preferring not to much rain; 1900—2150 mm a year seems best. This might be a reason for its abundance on the younger ridges in the Wiawia transect and its disappearance landinward.

Machaerium lunatum (L.) Ducke (Drepanocarpus lun. Mey.), *brantimakka;* akarirowai (Car.), atulia (Car.); I 86, tAWA, M. Very common in almost pure stands in oligo- and mesohalinous swamps and along the lower rivers.

Macrolobium bifolium (Aubl.) Pers. (M. hymenaeoides Willd.), waratappa; II 42, Gui, MM. Common on low river banks. Other species like *M. chrysostachyum* (Miq.) Benth, *M. multijugum* (DC.) Benth. and *M. acaciaefolium* Benth. grow in the same places.

Mora excelsa Benth., *mora;* parakuwa (Car.); II 39, NSA, MM. Dominant on low river banks in the western half of Suriname, valuable timber tree.

Muellera moniliformis L.f. (M. frutescens (Aubl.) Standl., Coublandia frutescens Aubl.); NSCA, N. Along the coast on sand and clay and along river banks in the brackish area.

Ormosia spp., *kokriki,* among others *O. coccinea* Jacks.; Gui, MM. In rain forest.

Ormosia costulata (Miq.) Kleinh., *kokriki;* ibikoro barakaro (Ar.); kunakoko (Car.); II 135, BG, MM of M. Characteristic tree or shrub of savanna forest.

Peltogyne venosa (Vahl) Benth., *purperhart;* Gui, MM. In rain forest.

cf. *Pera glabrata* Poepp., peprehoedoe; atsiballi (Ar.); II 126, MM.

Phaseolus campestris Mart. ex Benth.; Gui, V. In fresh and oligohalinous swamps and along river banks.

Phaseolus trichocarpus Wright; I 28, tA?, V. In fresh to mesohalinous swamps and along river banks.

Pterocarpus officinalis Jacq. (P. draco L., P. belizensis Standl.), *waterbébé;* itikibolo (Ar.); mutusi (Car.); I 91, II 2, Car, MM. Very common and abundant in marsh and swamp forest, with large sinuous buttresses.

Pterocarpus rohrii Vahl, *hooglandbébé;* mutusirang (Car.); NSA, MM. In rain forest. MARSHALL (94) says, that it is in Trinidad essentially a swamp tree in Carapa-Bactris forest, similar to *P. officinalis.* In Suriname on the contrary as far as we know it avoids wet soil.

Rhynchosia minima (L.) DC.; pt, V. On sand at or near the coast.

Sesbania exasperata H.B.K.; tA, N. In fresh or oligohalinous swamps.

Sclerolobium melinonii Harms, *djaditja;* II 46, FG, MM. Moisture-loving tree.

Swartzia bannia Sandw., *savanneijzerhart;* II 85, MM. Characteristic of savanna forest.

Swartzia spp., *gandoe;* II 113, MM, probably *S. benthamiana* Miq., *S. tomentosa* DC. and *S. prouacensis* (Aub.) Amsh. In rain forest.

Tephrosia cinerea (L.) Britt. var. *littoralis* (Jacq.) Benth.; tA, Th. On sand at or near the coast.

Vigna luteola (Jacq.) Benth. (V. repens (L.) Kze); pts, V. On strand and on waste places in the young coastal region.

PLUMBAGINACEAE.

Plumbago scandens L.; tA. In wood on the youngest ridges.

POLYGONACEAE.

Coccoloba latifolia Lam., *bradiliefie;* padura (Car.); II 11, Gui, M or MM. Moisture-loving tree, common in the coastal region. (HUBER states the same for Brazil).

Coccoloba uvifera (L.) Jacq.; Car, N or M. Very common in strand scrub, but not occurring in Sur.

Many other species grow in forest and clayey savannas, *bradiliefie; matura* (Ar.).

Polygonum acuminatum H.B.K.; I 42, tAA, rG. Common in fresh or almost fresh swamps, along open water sometimes abundant, and with a highly constructive value in the formation of floating mats.

Polygonum hydropiperoides Michx. (Persicaria hydr. (Michx.) Small); S.U.S. and Peru, rG. Rare in fresh-water swamps.

Polygonum punctatum Elliot (Persicaria punc. (Ell.) Small); tsA, rG. In moist to wet places.

Triplaris surinamensis Cham., *mierenhout, mierahoedoe;* yèkuna (Ar.); I 89, II 1, Gui, MM. Abundant in swamp and marsh forest in the young coastal region, also common in sec. growth, especially on river banks.

PONTEDERIACEAE.

Eichhornia crassipes (Mart.) Solms (Piaropus crass. (Mart.) Britton); tsA, Hy. Very common along river banks, in dead loops and bends often covering large areas.

Pontederia rotundifolia L.; tsSA, rG? Along river banks and rarely in swamps.

POTAMOGETONACEAE.

Ruppia maritima L., sewar (Hind.); cosm, Hy. In open brackish lagoons.

RHIZOPHORACEAE.

Rhizophora mangle L., *mangro;* tAWA, MM. Forms pure belts along the lower rivers, single trees occur in permanently fresh water. Rare along the coast.

ROSACEAE.

Chrysobalanus icaco L., *pruim;* kulimiro (Ar.); I 93, II 5, tAWA, M. Very tolerant as to soil moisture, in strand scrub (in Sur. only along the lower Marowijne R.), in swamp wood, marsh forest and low spots in savannas. Characteristic of *Mauritia-Chrysobalanus* association. Often in the literature C. *pellocarpus* G. F. W. Mey. is mentioned which in the Flora of Suriname has been reduced to a variety of *C. icaco* with smaller fruits. I doubt whether is has any significance at all and is not merely a form. I have often seen that the fruits were shrivelled and dry. In a group of shrubs usually but a few well developed plums are found.

Hirtella paniculata Sw., *witte foengoe, kolethoedoe;* II 92. Gui, M. In rain and savanna forest.

Licania apetala (E. Mey.) Fritsch, *kwepie; kwepi* (Car.); II 69, Gui, MM. In rain and savanna forest.

Licania heteromorpha Benth., *anaura;* II 67, Gui, MM. From marsh to savanna forest. Very common and frequent on the older ridges.

Licania incana Aubl., *savanne foengoe;* onit'at'a (Ar.), marisiballi (Ar.); II 134, Gui, M or MM. Characteristic of savanna forest.

Licania leptostachya Benth., *savanne foengoe;* onit'at'a (Ar.); II 114, Gui, MM. In rain forest.

Licania macrophylla Benth., *sponshout;* II 31, Gui, MM. In Symphonia marsh forest.

Licania divaricata Benth., *savanne anaura;* boroboroli (Ar.); anaura (Car.); BG, MM. In savanna forest.

Licania micrantha Miq., *zwarte foengoe, blaka foengoe;* marisiballi (Ar.); II 68, Gui, MM. In rain forest, common on the older ridges.

Parinari campestris Aubl., *foengoe;* kupesini (Car.); II 47, NSAWA, MM. Very tolerant as to soil and soil-moisture, dominant on the old ridges.

RUBIACEAE.

Amajoua guianensis Aubl., *marmeldoosje;* II 53, Gui, M. In rain forest.
Cephaelis spp., *bofroekasaba;* II 155, N. Among others *C. pubescens* Hoffmans ex Willd., *C. tomentosa* (Aubl.) Vahl and *C. violacea* (Aubl.) Sw. In rain and savanna forest.
Coussarea paniculata (Vahl) Standley and *racemosa* A. Rich.; koffiballi (Ar.) koffirang (Car.); II 83, MM. In rain forest.
Duroia eriopila L.f., *marmeldoosje;* kumaramara (Ar.); II 52, Gui, M. In rain and savanna forest common, especially frequent in ridge forest.
Genipa americana L., (hoogland) *taproepa,* tapurupo (Car.); lana (Ar.); II 22, tA, M or MM. In marsh forest, often abundant. This is quite different from the statement of MARSHALL (94) that on Trinidad it seems to prefer well-drained clay and less than 1900 mm rain a year.
Isertia coccinea (Aubl.) Gmel., *pinpin, kandrahoedoe;* NSA, M. In rain forest and sec. growth.
Isertia parviflora Vahl, *kandrahoedoe;* Gui, M. In savanna and rain forest.
Mapouria fockeana (Miq.) Brem., akamikunare (Car.); II 120, BG, N. In forest and moist sec. growth.
Palicourea crocea (Sw.) DC., *bofroekasaba;* adatekorong (Ar.); akamikunare (Car.); I 94, II 164, tSCA, N or M. Extremely euryoecious, from swamp to savanna.
Palicourea guianensis Aubl., *pinpin;* kamadang (Ar.); NSA, M. In rain forest and sec. growth.
Posoqueria latifolia (Rudge) R. et S., pipahoedoe; kalokodang (Ar.); pipiatamĕr (Car.); II 66, tSCA, MM. Usually in rain forest.
Retiniphyllum schomburgkii (Benth.) Müll. Arg., *kayakayadang* (Ar.); NSA, N. Common in savanna scrub.
Rosenbergiodendron formosum (Jacq.) F. Fagerl. (Randia form. (Jacq.) K. Schum.), konotopotrĕ (Car.); II 40, tSCA, M. In scrub and wood on brackish, often moist sand. Often together with *Hibiscus tiliaceus.*

RUTACEAE.

Fagara pentandra Aubl., *pritijari;* alemikirang (Car.); II 103 p.p., MM. On ridges.

SAPINDACEAE.

Cupania scrobiculata L. C. Rich., *gauetrie;* kulisiri (Ar.); tonoropio (Car.); II 54 p.p., tSCA, M. In rain and savanna forest.
Dodonaea viscosa (L.) Jacq. var. *vulgaris* Benth.; pts, N. On strand.
Matayba arborescens (Aubl.) Radlk. and *opaca* Radlk., *gauetrie;* tonoropio (Car.); II 54 p.p., Gui, M. In rain and savanna forest.
Paullinia pinnata L., *fijfifingrie, boter melk en kaas;* I 30, II 148, tAA, L. In scrub or low woods in swamp and on moist soil.
Talisia megaphylla Sagot, *kraskrastikie;* turisi (Car.); II 122, Gui, MM. In rain forest.

SAPOTACEAE.

This family is still very insufficiently known in Sur. and most vernacular names are used for more than one species. Often they cover each other in part.
Ecclinusa guianensis Eyma, *bata(m)balli* (Sur., Ar.); II 77, Gui, MM. In rain forest.
Manilkara bidentata (A. DC.) Chev., *bolletrie;* buruwĕ (Ar.); II 51, Gui, MM. Balata. Common in rain forest and on low river banks.
Micropholis guyanensis (A. DC.) Pierre, *wit* (or zwart) *riemhout;* FG, MM. In rain forest.
Pouteria caimito (R. et P.) Radlk., *jan snijder;* tSA, MM.
Pouteria engleri Eyma, *zwart riemhout;* Gui, MM.
Pouteria guianensis Aubl., *jan snijder, pientobolletrie;* Gui, MM.
Pouteria robusta (Mart. et Eichl.) Eyma var. *longifolia* Eyma, *djoebolletrie, kiemboto;* MM.
Pouteria trigonosperma Eyma, *djoebolletrie;* End, MM.

SCROPHULARIACEAE.

Bramia monnieri (L.) Drake (Bacopa monn. (L.) Wettst.); I 60, pt. In swamps, not known from. Sur.

Capraria biflora L.; tA, Ch? On moist often saline sand and clay.

SIMAROUBACEAE.

Quassia amara L., *kwassibita;* k'erapu (Car.); II 153, Gui?, L. In marsh and rain forest.

Simaba multiflora A. Juss., *noianjang;* guyari (Car.); II 23, Gui, M of MM. Common in marsh forest and along river banks.

Simarouba amara Aubl., *soemarouba* or *simarouba,* II 64, Gui and S.W. Ind., MM. In rain forest.

SOLANACEAE.

Solanum asperum Rich.; II 161, M.

Solanum stramonifolium Jacq.; boboro (Ar.); kwas'is'i (Car.), paremuru or polemuru (Car); I 12. Common along the youngest ridges and in sec. growth, stands salt and inundation.

STERCULIACEAE.

Melochia lanceolata Benth.; Gui, N. In fresh-water swamps.

Sterculia pruriens Schum., basraboskatoen, okrohoedoe; yahoballi (Ar.), kuyètsi (Ar.) Gui, MM. In marshy and rain forest.

THEACEAE.

Laplacea fruticosa (Schrad.) Kobuski (L. semiserrata (Nees) Camb.), *patako(e)ana;* warimiri (Ar.); II 65 p.p.?, tSCA, MM. In rain forest.

Ternstroemia punctata (Aubl.) Sw., kayakayadang (Ar.); Gui, M. Characteristic of savanna wood and scrub.

TYPHACEAE.

Typha angustifolia L. (T. domingensis Pers.), *langa grassie;* I 7, cosm, rG. Locally dominant in mesohalinous to eutrophic swamps of the 2nd and 4th type.

UMBELLIFERAE.

Hydrocotyle umbellata L.; I 34, tsA. In fresh and oligohalinous swamps.

Hydrocotyle verticillata Thunb.; I 59, S.U.S., Great Antilles, S. Brazil. In swamps.

VERBENACEAE.

Avicennia nitida Jacq. (including A. tomentosa L.), *parwa;* koroda (Ar.); apaliu (Car.); tAWA, MM. Forms an extensive forest belt along the coast and the estuaries of the rivers.

Vitex spp., *kalebashout;* kwairan (Car.); II 45, MM. Among others *V. compressa* Turcz.; NSA and *V. orinocensis* H.B.K. var. *multiflora* (Miq.) Huber; NSA. In rain forest.

VIOLACEAE.

Corynostylis arborea (L.) Blake; II 149, tSA, L. In swamp wood and along river banks.

Paypayrola guianensis Aubl., *tajahoedoe; cacaoballi* (Ar.); *cacaorang* (Car.); Gui, M. In rain forest.

Rinorea spp., *lèlè (tikie);* baririkuti (Ar.); II 107, M. In rain forest.

VITACEAE.

Cissus parkeri (Baker) Planch.; I 25, Gui, L. In fresh to mesohalinous swamps.

Cissus sicyoides L.; I 26, tA, L. In swamps, along river banks and in moist forest margins.

VOCHYSIACEAE.

Qualea coerulea Aubl., gronfoeloe; muneridang (Ar.); gronfulu (Car.), ir(i)akopi (Car.); II 100, Gui, MM. In rain and marshy forest.

XYRIDACEAE.
Xyris dolichosperma Lanj.; I 74, Sur. In wet spots in savanna and in swamps.

ZINGIBERACEAE.
Costus spp., *sangrafoe;* II 146, rG. *Witte sangrafoe* is at least for a large part *C. niveus* G.F.W. Mey., *rode sangrafoe* are several red flowered species. In wet or marshy forest.
Renealmia spp., *masoesa; masùsa* (Ar.). Among others *R. exaltata* L.f.. In moist and marshy forest.

SELECTED LIST OF VERNACULAR NAMES:

agrobigie — Parkia nitida (Mim.)
ajawa (Car.) — Trattinickia rhoifolia (Burs.)
akira — Laguncularia racemosa (Comb.)
alakasirie — Caraipa densifolia (Gutt.)
anaura — Licania heteromorpha (a.o.?) (Ros.), in older collections also Couepia versicolor R. Ben. (Ros.)
awarra — Astrocaryum segregatum (Palm.)

baboen — Virola surinamensis (Myri.)
baboennefie — Scleria flagellum-nigrorum, secans (a.o.?). (Cyp.)
bambamakka — Desmoncus horridus a.o. (Palm.)
banda — Aulomyrcia pyrifolia (Myrt.)
barklak — Eschweilera spp. (Lec.)
barmanni — Catostemma sp. (Bom.)
basralokus — Dicorynia guianensis (Pap.)
bata(m)balli (Sur., Ar.) — Ecclinusa guianensis (Sapo.)
batbatti (Sur., Ar.) — Ambelania acida (Apo.)
bietahoedoe — Homalium guyanense and racemosum (Flac.)
blakaberie — Humiria floribunda and balsamifera (Hum.)
blakafoengoe — Licania micrantha (a.o.?) (Ros.)
blakaoema — Diospyros guianensis (Eben.)
boegroemakka — Astrocaryum cf. sciophilum (Palm.)
bofrohoedoe — among others Sacoglottis guianensis var. sphaerocarpa (Hum.)
bofroekasaba — Cephaelis violacea, glabrescens, also Nonatelia racemosa Aubl., Palicourea longiflora (Aubl.) A. Rich. (Rub.)
bolletrie — Manilkara bidentata (Sapo.)
bosgujave — Myrcia sylvatica and splendens, Myrciaria floribunda (Myrt.)
boskatoen — Bombax globosum, in the interior also B. nervosum Uitt. (Bom.)
boskoffie — Casearia macrophylla (Flac.), Phyllanthus nobilis (Euph.)
bospapaja — Cecropia peltata a.o., Coussapoa spp., Pourouma spp. (Mor.)
boszuurzak — usually Annona montana (Ann.), sometimes Rollinia exsucca (Dun.) A.DC. with small fruit.
bradiliefie — Coccoloba spp. (Poly.), sometimes Aparisthmium cordatum (Juss.) Baill. or Conceveiba guyanensis Aubl. (Euph.)
brantimakka — Machaerium lunatum (Pap.)

dakama (Sur., Ar.) — Dimorphandra conjugata (Pap.)
djaditja — Sclerolobium melinonii (Pap.)
djedoe — several trees with soft worthless wood and compound leaves: Sclerolobium spp. (Pap.), Thyrsodium sp. (Anac.), Cupania hirsuta Radlk. (Sapi.)
djoebolletrie — Pouteria robusta and trigonosperma, also Chrysophyllum prieurii A.DC. (Sapo.)
doifiesirie — Guarea guara (Meli.)
dukali (Ar.) — among others Pouteria sp. (Sapo.)

fajapau — Siparuna guianensis (Mon.)
foengoe — Parinari campestris (Ros.)

gauetrie — Cupania scrobiculata, Matayba arborescens and opaca (Sapi.)

goebaja — Jacaranda copaia (Big.)
goesberie — Phyllanthus acidus (Euph.)
groenhart — Tabebuia serratifolia (Big.)

hajawa (Ar.) — Protium heptaphyllum and hostmannii (Burs.)
hoepel — Copaifera guianensis (Pap.)
hooglandbaboen — Virola sebifera (Myri.)
hooglandbébé — usually Pterocarpus rohrii (Pap.), also Alchorneopsis trimera (Euph.), the latter may be wrongly named.

iengipipa — Couratari spp. (Lec.)
ir(i)akopie (Car.)) — Siparuna guianensis (Mon.), sometimes Qualea
jarakopie) coerulea (Voch.)
jan snijder — Pouteria guianensis and caimito (Sapo.)

kalebashout — Vitex orinocensis, compressa a.o. (Verb.)
kalokodang (Ar.) — Posoqueria latifolia (Rub.)
kaneelhart — Licaria cayennensis and canella (Laur.)
kaneelpisie — Licaria guianensis (Laur.)
kapoeatikie — Bonafousia tetrastachya (Apo.)
kasabahoedoe) — B.B.S.: Didymopanax morototoni (Aral.); also Alchornea
kassavehout) triplinervia (Spreng.) Müll. Arg., Alchorneopsis trimera Lanj. (Euph.)
kassihoedoe — Ouratea surinamensis (Och.)
kayakayadang (Ar.) — Retiniphyllum schomburgkii (Rub.), sometimes Ternstroemia punctata (The.)
kiemboto — among others Pouteria robusta and surinamensis Eyma (Sapo.)
kiskismakka — Bactris spp. (Palm.)
koemboe — Oenocarpus spp. and Jessenia bataua (Palm.)
koffiemama — Erythrina glauca (Pap.)
kokriki — in savannas Ormosia costulata, in forest Ormosia spp. (Pap.)
kopie — Goupia glabra (Cel.)
krappa — Carapa procera (Meli.)
kraskrastikie — probably Talisia megaphylla (Sapi.)
kromantiekopie — usually Aspidosperma spp. (Apo.)
kwakkoe — mostly Marlierea montana, also other Myrt.
kwassiba — usually written without k: Tabebuia serratifolia (Big.); sometimes with prefix a: Pouteria sp. (Sapo.)
kwepie — Licania apetala, also other Ros.

laksirie = alakasirie — Caraipa densifolia (Gutt.)
lèlètikie — usually Rinorea sp. (Viol.)
likahoedoe — Antonia ovata (Log.)
lokus — Hymenaea courbaril (Pap.)
lontoekassie — Byrsonima coriacea var. spicata (Malp.)

mabwa (Sur., Ar.) — Himatanthus (Plumeria) articulatus (a.o.?) (Apo.)
maho — Hibiscus tiliaceus (Malv.)
manbarklak — Eschweilera longipes (a.o.?) (Lec.)
mangro — Rhizophora mangle (Rhiz.)
mappa — Couma guyanensis, Macoubea guianensis, Parahancornia amapa (Apo.)
maripa — Maximiliana maripa (Palm.)
marmeldoosje — usually Duroia eriopila, also Amajoua guianensis (Rub.)
masoesa — Renealmia spp. (Zing.)
matakki — Symphonia globulifera (Gutt.)
maurisie — Mauritia flexuosa (Palm.)

mierahoedoe, mierenhout — Triplaris surinamensis (Poly.)
mispel — Miconia spp., Henriettea spp. (Mela.)
mokomoko — Montrichardia arborescens (Arac.)
moppé — Spondias mombin (Anac.)
muneridang (Ar.) — Siparuna guianensis (Mon.) and Qualea coerulea and rosea Aubl. (Voch.)

nanaimakka — Bactris sp. (Palm.)
nekoehoedoe, nikkoehout — Alexa wachenheimii, Poecilanthe Hostmanni (Benth.) Amsh., Lonchocarpus latifolius (Willd.) H.B.K. (Pap.), old also Conceveiba guyanensis Aubl. (Euph.), Clathrotropis brachypetala (Pap.)
noianjang — Simaba multiflora (Sim.)

obé — cf. Acrocomia sp. (Palm.); according to STAHEL (39) Elaeis melanococca Gaertn. (Palm.)
oemabarklak — Eschweilera corrugata, floribunda, a.o. (Lec.)

pakoelie — Rheedia benthamiana (Gutt.)
paloeloe — Ravenala guyanensis, kleine paloeloe (small kind) Heliconia one or more spp. (Mus.)
panta — Fusaea longifolia (Aubl.) Saff., Duguetia sp. (Ann.); also = zwamppanta
papaja gras — Cyperus giganteus (Cyp.)
paramakka — Astrocaryum paramacca (Palm.)
parelhout, parihoedoe — Aspidosperma marcgravianum a.o. (Apo.)
parwa — Avicennia nitida (Verb.)
patako(e)ana — Chaunochiton kappleri (Olac.), Laplacea fruticosa (The.)
pegrekoe — Xylopia discreta, amazonica, aromatica, a.o. (Ann.)
pienja — Vismia spp. (Gutt.); man pienja V. angusta, oema pienja V. confertiflora and V. cayennensis.
pientobolletrie — Pouteria a.o. guianensis (Sapo.)
pientokopie — usually Laetia procera (Flac.)
pikientikie — usually Miconia myriantha (Mela.), sometimes Maprounea sp. (Euph.)
pina — Euterpe oleracea (Palm.)
pinpin — Isertia coccinea, Palicourea guianensis (Rub.), also Olyra latifolia (Gram.)
pipahoedoe — Posoqueria latifolia (Rub.)
pisie — many Ocotea and Nectandra spp., sometimes other Laur.
pritijari — Fagara pentandra, Zanthoxylum sp. (Rut.); also spp. of other fam.?
prokonie — usually Inga alba, sometimes I. pezizifera Benth. (Mim.)

reddie or rode kabbes — Andira inermis, sometimes A. coriacea (Pap.)

salie — Tetragastris spp., also Protium altsonii Sandw. (Burs.) sometimes erroneously used for Meli.
sangrafoe — Costus spp. (Zing.)
savannefoengoe — usually Licania incana, sometimes L. leptostachya (Ros.)
savannemangro — Clusia nemorosa and fockeana; in forest other Gutt.?
savannekatoen — Bombax flaviflorum (Bom.)
savanneijzerhart — Swartzia bannia (Pap.)
simaroeba or soemaroeba — Simarouba amara (Sim.)
sipio (Car.) — Protium heptaphyllum (Burs.)
snijgras — many Cyp. with hard, sharply toothed leaves.
soekroehoedoe, (savanne-) — Antonia ovata (Log.)
sopohoedoe — Caryocar microcarpum and glabrum (Car.), sometimes Pithecellobium jupunba (Mim.)
spikrihoedoe — Mouriria spp. (Mela.) among others guianensis, princeps, plasschaerti
sponshout — Licania macrophylla (Ros.)
srebébé — Iryanthera hostmanni (Myri.); also other spp.?
swietiboontje — many Inga spp., (Mim.) near the coast and in wet places mainly I. ingoides.

tafelhout, tafelboom) — Cordia, the arboreous spp., (Bor.) in the coastal region
tafra) C. tetrandra.
tapiriri (Car.) — Tapirira guyanensis (Anac.)
taproepa) — Genipa americana (Rub.)
tapurupo (Car.))
teteruma (-balli) (Ar.) — Conomorpha magnoliifolia (Myrs.)
tiengimonnie — Protium heptaphyllum a.o., Trattinickia rhoifolia (Burs.)
tjawassi — Hibiscus tiliaceus (Malv.)

watrabébé — Pterocarpus officinalis (Pap.)
witte salie — Protium glabrescens, sagotianum a.o.? (Burs.)
witte foengoe — Hirtella paniculata (Ros.)
witte hoedoe — Tapirira guyanensis (Anac.)
wit parelhout — Aspidosperma marcgravianum a.o. (Apo.)
wit riemhout — Micropholis guyanensis, Pouteria spp. (Sapo.)

zwampgujave — Aulomyrcia pyrifolia (Myrt.), Amanoa guyanensis (Euph.)
zwamppakoelie — Rheedia kappleri (Gutt.), sometimes not distinguished from pakoelie.
zwamppanta — Tabebuia aquatilis, insignis and insignis var. monophylla (Big.)
zwampzuurzak — Annona glabra (Ann.)
zwarte foengoe — Licania micrantha (Ros.)
zwart riemhout — Pouteria engleri, a.o. (Sapo.)

ADDITIONS TO TABLES I AND II

After each species the family and the area of its distribution are indicated. In the list on p. 99 remarks on the species may be found. Vernacular names are printed in italics, and may be compared with the list on p. 117.

Figures placed in parentheses indicate that the species was met outside the sample plot.

In those cases where the species was identified, but where the entry in general refers to several species of one genus, the first one or two letters of the specific epithet are indicated with superior types. For example: Inga f[i] means that Inga ingoides was frequent in that plot. Nota bene: ° indicates reduced vitality.

In the additions trees are given first and they are separated from the names of herbs, shrubs and lianas by a dash.

(?) after a name indicates that this name is a "nomen nudum". In case the species is not yet identified the collecting number is given in italics.

Additions to the swamp records of table I

Where the coverage is not indicated, it is about 100%.

1. 5 May 1949. ± 10 cm water, soil grey clay covered by 10 cm pegasse.
   Ceratopteris deltoidea + 1.
2. 5 May 1949. 10—20 cm water, soil grey clay covered by ± 10 cm pegasse.
   Ceratopteris deltoidea + 1, *Sesbania exasperata* + 1.
3. 4 May 1949. ± 40 cm water, soil grey clay, pegasse layer not measured.
4 and 5. 13 Nov. 1948. Soil wet clay, groundwater at + 3 to — 25 cm, pH 5.8—6. Peaty rootlayer only a few cm. Under *Acrostichum* group pH 4.8.
6. Lanjouw 1933 (35).
7. 21 Dec. 1948. 30—40 cm water; soil grey clay. *Typha* ± 2 m high.
8. 21 Dec. 1948. 20—30 cm water, soil grey clay covered by some pegasse.
9 and 10. 13 Nov. 1948. ± 5 m broad transition zone fringing the ridge; sandy soil, upper 10 cm peaty, inundated in rainy season.
11. 16 Nov. 1948. swamp strip affected by fire, along border many dead branches from burned shrubs; 0—10 cm water; coverage 80%.

12. 16 Nov. 1948. ± 5 cm water, grass carpet ± 60 cm high.
13. 16 Nov. 1948. ± 5 cm water, upper clay layer very rich in humus.
14. 16 Nov. 1948. Remnants of burnt *brantimakka* scrub heaped up ± 50 cm high and overgrown by climbers, coverage 80%; groundwater below the surface; top layer black clay, rich in humus; 15—75 cm grey clay with brown spots.
Pacourina edulis + 1.
15. 16 Nov. 1948. Groundwater ± 5 cm below the surface; soil 0—5 cm pegasse; 5—100 cm grey clay with brown spots.
16. 18 Nov. 1948. Soil soggy, profile at km 2.10: 0—10 cm pegasse; 10—100 cm tough grey clay with brown spots; at km 2.17: 0—25 cm pegasse; 25—50 cm grey clay with brown and red spots; 50—150 cm tough grey clay. Around *Erythrina* groups a fringe of *Montrichardia* and clumps of *Cyperus giganteus*. Near border *Luffa operculata* (L.) Cogn. + 1.
17. 18 Nov. 1948. 20—50 cm water; soil 0—10 cm pegasse; 10—150 cm tough grey clay with brown spots.
Pacourina edulis + 1.
18. 7 May 1949. ± 30 cm water, grass carpet ± 60 cm high.
Melochia lanceolata + 1, *Echinodorus grandiflorus* + 1.
19. 7 May 1949. 20—30 cm water.
Ceratopteris pteridoides + 1, *Pluchea odorata* 1·1, *Sphenoclea zeylanica* + 1, *Panicum laxum* + 2.
20. 7 May 1949. Dense meadow, only occasionally crossed by cattle; grass and *Fimbristylis* ± 50 cm high.
Pluchea odorata 1·1, *Panicum laxum* 2·2, *Cyperus polystachos* + 2, *Echinodorus grandiflorus* + 1, *Sphenoclea zeylanica* + 1, *Phyllanthus niruri* L. + 1, *Caperonia palustris* + 1, *Jussieua suffruticosa* + 1.
Groups of *Cassia alata* shrubs and small scattered trees and shrubs, see table II record 6.
21. 7 May 1949. Vegetation badly trampled by cattle, coverage ± 35%; highest bumps at water level, holes 20—30 cm deep with aquatic plants a.o. *Chara hydropitys* Reichenb. var. *majuscula* Nordst. 1·2; grass ± 20 cm high.
Neptunia prostrata + 1, *Alternanthera sessilis* + 1, *Cassia alata* in scattered groups.
22. 17 May 1949. Soggy meadow, slightly pastured.
23. 19 Nov. 1948. ± 5 cm water.
24. 19 Nov. 1948. 20—40 cm water; soil profile at km 3.6: 0—20 cm clayey mould; 20—120 cm tough grey clay with brown spots.
Habenaria sp. (1169) 1·1.
25. 19 Nov. 1948. 40—80 cm water.
26. 28 Nov. 1948. 0—10 cm water; soil 0—10 cm pegasse; 10—105 cm alternating layers of clay and coarse sand with mica; 105—255 cm blue-grey sand with mica.
27. 22 Nov. 1948. 0—20 cm water, root and pegasse layer ± 20 cm.
28. 23—24 Nov. 1948. The same.
Odontocarya paupera + 1.
29. 23—24 Nov. 1948. 20—50 cm water, pegasse layer 30 cm or more.
30. 22 Nov. 1948. 20—50 cm water; soil 0—10 cm pegasse; 10—380 cm grey clay.
Oocarpon torulosum + 1.
31. 8 May 1949. ± 60 cm water; soil clay; tall herb stratum 90% coverage, 2 m high, low herb stratum 100%, 1 m high.
Polygonum hydropiperoides + 1.
32. 8 May 1949. 60—70 cm water, holes in pegasse layer to 1 m deep, clay at ± 1.10 m.
33. 8 May 1949. 40—50 cm water, deep pegasse layer with a few locks in it forming open pools several meters across and 1—1.20 m deep and grown with *Cyperus haspan* and *Utricularia foliosa*, except one which was covered by a floating mat of *Leersia hexandra*.
34. 7 May 1949. 20—30 cm water, 30—80 cm pegasse; vegetation ± 2.5 m high.
35. 7 May 1949. 50 cm water with deeper holes to 70 cm; clay soil covered by some pegasse; vegetation 2.5 m high.

36. 15 May 1949. 25 cm water; tree stratum ± 70%, 5—8 m high, herb layer 90%. *Phyllanthus acidus* 3·1, *Cecropia peltata* + 1, — *Heliconia sp.* 2·1, *Scleria flagellum-nigrorum* + 2, *Costus vs. niveus* + 1, *Dianthera obtusifolia* + 1.
37. 15 May 1949. 30—40 cm water; several small trees, half killed by a fire. *Inga ingoides* + 1, *Heliconia sp.* 1·1, *Phyllanthus acidus* + 1.
38. 15 May 1949. ± 50 cm water; few small trees up to 5 m high. *Annona glabra* + 1, vs. *Pithecellobium jupunba* + 1, — *Phaseolus campestris* + 1, *Dianthera obtusifolia* + 1.
39. 15 May 1949. ± 30 cm water; vegetation 2—2.5 m high, but not very dense.
40. 17 May 1949. *Cyperus giganteus* dominant, 1.5—2 m high. *Canna glauca* + 1.
41. Lanjouw 1933 (35). *Cyperus digitatus* ×, *Sesbania exasperata* ×, *Mikania congesta* ×.
42. Lanjouw 1933 (35).
43. Lundell 1937 (91). *Dryopteris serrata* 2·3, *Erechtites hieracifolia* + 1, *Habenaria pringlei* Robins. +, Bletia tuberosa (L.) Ames +, *Begonia tovarensis* Klotzsch +, *Vigna luteola* +, *Echinodorus tenellus* (Mart.) Buch. (*Helianthium tenellum* (Mart.) Britton) +.
44. Lundell 1937 (91). *Nymphaea ampla* dominant; *Polygonum acuminatum* important in the border zone.
45. Kenoyer 1929 (88). *Cyperus luzulae* ×, *Scleria macrophylla* ×, *Gynerium sagittatum* ×, *Dryopteris serrata* ×, *Jussieua suffruticosa* ×.
46. Gleason and Cook 1926 (77). Almost fresh water. *Mikania congesta* ×, *Pluchea odorata* ×.
47. The same, Yauco-Boquérón-valley, water up to 80 cm. Around *Typha* groups floating mats of *Sporobolus* are mentioned, this is highly improbable; as no species is indicated the grass was apparently sterile and may have been confounded with *Leersia hexandra*. *Polygonum punctatum* 1·1, *Sesban emerus* (Aubl.) Urb. +. In open water *Ceratophyllum demersum, Lemna perpusilla, Nymphaea ampla.*
48. Stehlé 1935 (116). Vegetation 2 m high, behind the mangrove, therefore probably in oligohalinous water.
49. Stehlé 1937 (117). Soil laterite or alluvial clay. *Scleria lithosperma* Sw. ×, *Cyperus polystachyos* ×, *Cyperus acicularis* With. ×, *Fimbristylis spadicea* ×.
50. 10 May 1949. Peat layer ± 60 cm, compact and strong enough to bear the weight of a man. *Nepsera aquatica* 1·1, *Hibiscus furcellatus* + 1, *Cyrtopera longifolia* + 1, *Lisianthus alatus* + 1, *Mandevilla hirsuta* (Rich.) K. Schum. + 1.
51. 16 Dec. 1948. ± 50 cm water, thick layer of pegasse on clay; at km 1.9 grey-blue clay with pH 5.1 and 0.08% Cl; shrubs 4—7 m, coverage 40%, beyond km 1.8 *Mauritia* up to 10 m high, duckweed, liana *Connarus punctatus* Planch.
52. 16 Dec. 1948. 70—80 cm water, thick layer of pegasse on clay.
53. 20 Dec. 1948. 40—50 cm water, thick layer of pegasse on clay; at km 2.15 grey clay with pH 6.9 and 0.12% Cl. Before km 2 *Chrysobalanus* abundant, beyond *Rhynchospora corymbosa.*
54. 20 Dec. 1948. ± 80 cm water, thick layer of pegasse. *Pityrogramme calomelanos* + 1, *Lisianthus alatus* + 1.
55. Lanjouw 1933 (35). *Erechtites hieracifolia* ×, *Limnobium stoloniferum* ×, *Hibiscus sororius* ×.
56. 27 Nov. 1948. 2—5 m water, floating peat 1—2 m thick. Vegetation 2 m high, dense.
57. 27 Nov. 1948. 2—3 m water, floating peat 1—2 m thick. Vegetation 1.6—1.8 m high, dense.
58. 22 Oct. 1948. The same. Interrupted by an undeep zone without floating peat, sandy clay at 50—70 cm depth; *maurisie* palms and some shrubs of *Chrysobalanus, Clusia nemorosa* and *Marlierea montana;* herb layer with much *Rhynchospora corymbosa* and *Becquerelia tuberculata.*

59. 22 Oct. 1948. 1—2 m water, floating peat ± 50 cm thick, rather loose. Small herbs bordering open pools a.o. *Utricularia angulosa* Poir.

56—59. Scattered small open pools with *Nymphaea odorata* and *Mayaca longipes*.

60 and 61. 21 Oct. 1948. 30—50 cm water; soil 0—50 cm dark-grey clay; 50—120 cm grey sandy clay with brown and some red spots.

62. 18 Oct. 1948. 40—50 cm water, soil clay.
Biovularia olivacea + 3, *Mayaca longipes* + 1.

63. 18 Oct. 1948. 20—40 cm water, soil clay.
Hypolythrum pulchrum 1·1, along the border *Rhynchanthera grandiflora.*

64. 11 Oct. 1948. 20—50 cm wet peat and 50—70 cm sapropelium on clay, groundwater ± 10 cm below the surface.
Lindsaya stricta Dryand. + 2, *Panicum nervosum* Lam. + 1, *Raddia nana* (Doell.) Chase + 2, *Clusia nemorosa* + 1, *Rhynchanthera grandiflora* 1·1, *Tibouchina aspera* Aubl. + 1, *Rheedia kappleri* + 1, *Vismia sp.* + 1, *Calophyllum brasiliense* + 1.

Additions to the forest records of table II

1. 18 and 21 Dec. 1948. 10—40 cm water; bushes 4—7 m high.
Ilex guianensis +, — *Fuirena robusta* f 2, *Rhabdadenia biflora* +.

2. 23 Dec. 1948. ± 40 cm water; vegetation 3—4 m high.
Machaerium lunatum a, *Phyllanthus nobilis* +.

3. LANJOUW 1933 (35). In the same wood by Prof. STAHEL in 1926 *Jussieua affinis* and *Panicum grande* were found.

4. 7 May 1949. Scrub, ± 30 cm water.

5. 7 May 1949. Scrub wood 5—6 m high, coverage 100%; 0—10 cm water; 15—25 cm pegasse on clay.
Rhabdadenia biflora ×, *Mikania micrantha* ×, *Ipomoea tiliacea* ×.

6. 7 May 1949. Scattered shrubs in the swamp; see table I record 20.

7. 14 May 1949. Tree stratum 8—12 m high, crowns not in contact, coverage ± 60%; subgrowth 2—4 m, dense.
Renealmia sp., *Heliconia sp.* and *Ischnosiphon sp.* abundant near the levee, gradually disappearing northward.
Scleria microcarpa + 2, *Fimbristylis miliacea* + 2, *Torulinium ferax* + 2, *Jussieua affinis* + 2, *Oryza latifolia* + 2, *Panicum pilosum* + 2, *Solanum stramonifolium* + 1. Climbers: *Adenocalymna bilabiatum* (Sprague) Sandw., *Heteropteris nervosa* Juss., *Pseudocalymna alliaceum* (Lam.) Sandw., *Allamanda cathartica* L., *Acroceras zizanoides*, *Mikania micrantha*, *Ipomoea tiliacea.*

8. 15 May 1949. Tree stratum 6—10 m high, coverage 70%; herb layer up to 2 m, coverage 50—80%; see table I record 36.

9. STAHEL and GEIJSKES 1940, swampwood situated directly behind the coastal mangrove; data taken from herbarium labels.

10. Nov. 1948. Soil soggy, 0—10 cm peaty; 10—70 cm grey-black clay with brown spots; 70—110 cm grey clay with brown spots and a thin sand layer.

11. Nov. 1948. Soil slopes gradually, at km 3.3 moist, near km 3.4 ± 10 cm under water; 0—20—25 cm black clay with much humus; 25—100 cm grey clayey sand and sandy clay with mica. Shrub *1166.*

12. Nov. 1948. Soggy ridge border.

13. Nov. 1948. Soil rather dry, marsh profile, clayey sand with mica.
Qualea dinizii Ducke +.

14. Nov. 1948. Scrub wood.
Phyllanthus nobilis ×.

15. Nov. 1948. *Renealmia sp.* ×.

17. Nov. 1948. Soil slopes ± 1 m towards the swamp. 0—35 cm grey sand; 35—50 cm yellow clay with grey spots; 50—80 cm yellow clayey sand, much mica; 80—90 cm blue-green sand.

18. Nov. 1948. 0—20 cm fine sand, much humus; 20—50 cm dark-brown sand; 50—80 cm yellow-grey, fine, clayey sand with mica; 80—95 cm yellow-grey clay.
20. Nov. 1948. Flat marsh forest belt.
22. Nov. 1948. Soil inundated.
23. Nov. 1948. Soil sloping, moist to wet.
27. Nov. 1948. 0—15 cm dark clay rich in humus; 15—40 cm grey clay, little humus; 40—95 cm tough grey clay.
28. Nov. 1948. Swampy strip with open tree stratum and subgrowth of *Cyperus giganteus* and *mokomoko.* Up to 25 cm clayey mould, deeper layers clay mixed with sand.
29. 16 Dec. 1948. 0—25 cm clayey mould; 25—75 cm fine, greenish clayey sand; 75—150 cm fine, blue-green sand with downwards increasing amount of shell fragments; 150—400 cm light-grey clay.
druifieboom (?) +.
30. 20 Dec. 1948. Ground water 10—20 cm below the surface, pH ± 6.5; 0—25 cm black-grey sand, much humus; 25—50 cm brown sand; 50—120 cm brown sand with shell fragments.
31. 20 Dec. 1948. Ground water ± at the surface, 1760—2780 mg Cl/l. Soil brown sand with much mica, 50 cm decalcinated.
32. 20 Dec. 1948. *Hura* forms closed canopy, 25—30 m high, other trees small, very little subgrowth; 10—15 cm water; soil brown sand with mica, 45 cm decalcinated.
33. 20 Dec. 1948. Slightly elevated sandy bar, 0—45 cm brown sand free of lime; 45—200 cm brown sand with shell fragments; ground water at 80 cm, 520 mg Cl/l.
34. 20 Dec. 1948. Low forest, top layer very rich in humus, lime boundary at 60—70 cm, deeper sands with clay bands.
35. 20 Dec. 1948. Shell layer at the surface, soil moist, clayey sand.
Casearia arguta H.B.K. (×), tree *1495* (×).
36. 15 Dec. 1948. Well developed ridge forest. Soil brown sand; pH increasing downwards from ± 4.2 to ± 7.
Ocotea caudata (Meissn.) Mez ×.
37. 15 Dec. 1948. The same. Soil yellow-grey sand.
Casearia arguta H.B.K. ×, *Sapindus saponaria* L. ×, *Stemmadenia grandiflora* (Jacq.) Miers ×, *Pterocarpus rohrii* ×, *Myrcia splendens* (Sw.) DC. ×, *matappitano* (Car.) (?) ×, *tekaholin* (Car.) (?) ×, — *Piper 1393* and *1399* ×.
38. 6 May 1949. Dense wood ± 9 m high with many lianas. Soil sand, in centre ± 25 cm above the clay in the surrounding. *Avicennia* forest; upper 10 cm rich in humus. Groundwater mesohalinous, at 45 cm, pH 8.
One *Ceiba* of 15 m, *Cassia chrysocarpa* Desv. ×.
39. 6 Nov. 1948. Sandy bank, flooded at very high tides. Wood 7—8 m high, partly shrubs in front.
Cordia macrostachya a, *Rhizophora mangle* ×. Many lianas: *Omphalea diandra, Combretum cacoucia* (Baill.) Exell, *Hippocratea volubilis.*
This mixed wood alternates with *Avicennia* groves with only some small *Laguncularia.*
40. 12 May 1949. Soil clayey, soggy to just under water; scrub ± 4 m high, open deeper spots with *Cyperus giganteus* and *Scirpus cubensis.*
Helosis cayennensis f.
41. 7 May 1949. Fine sandy clay soil, ± 50 cm above swamp level; light wood.
Phyllanthus nobilis ×, *Sapium klotzschianum* ×.
42. 10 May 1949. Clayey sand, ± 20 cm submersed; light wood with dense subgrowth.
Sapium klotzschianum ×, — *Panicum mertensii* + 2, *Mikania micrantha* +, *Ipomoea parkeri* +, *Jussieua affinis* + 1.
43. 12 May 1949. Fine sand.
44. 10 May 1949. Open wood; notes made in passing along the creek.
45. 11 May 1949. Rather low forest with single tall trees mostly *Hymenaea,* between the mouth and Cupido; notes made from the boat.

46. 12 May 1949. Sandy clay soil, shallow furrows keep water brought in by spring flood; canopy layer at ± 12—20 m, much shrubby subgrowth.
47. 12 May 1949. On lowest places with some shallow pools *pina* is abundant. Soil fine sand.
Trichanthera gigantea +, — some ferns.
48. 14 May 1949. Rather low and open forest, at springtide 25 cm deep flooded. Soil clay.
Crudia glaberrima f, *Jacaranda rhombifolia* ×, *Quararibaea guyanensis* ×, *Cyphomandra 3239* +; along the river bank *Bombax aquaticum* ×.
49. 15 May 1949. Forest with medium-sized trees, levee ± 10 m wide with pools left by spring flood. Soil clay.
Trichanthera gigantea ×.
50. 15 May 1949. Light wood with rather dense herb layer; 0—20 cm water. Soil clay.
Crudia glaberrima ×, *jarani (Zygia sp.)* ×, — *Acroceras zizanoides* + 2, *Cyrtopera longifolia* + 1, *Paspalum densum* 2·2, *Fimbristylis miliacea* 1·2.
51. Huber 1900 (83).
Sapium biglandulosum Müll. arg., *Hura brasiliensis* Willd.; along the bank *Muellera moniliformis, Dalbergia monetaria, Mimosa asperata* L.; many lianas.
52. Nov. 1948. Open wood with dense subgrowth. 0—50 cm black clay, very rich in humus; 50—65 cm dark-grey clay; 65—90 cm yellow-grey clayey sand.
Rhynchospora gigantea ×, *Panicum grande* ×.
53. Nov. 1948. Grey clay downwards changing into clayey sand, top layer rich in humus.
Rhynchospora gigantea ×.
54. Nov. 1948. 0—85 cm clayey mould (between 50 and 60 cm sandy); 85—95 cm sandy clay. From the swamp *Lagenocarpus guianensis* penetrates into the forest.
55. Oct. 1948. *pausander* (Ros.) ×.
56. Oct. 1948. Canopy rises very steeply to 10 m, inward gradually higher.
iengibartjie (Ros.?) ×, — *Becquerelia cymosa* Brongn. ×.
57. 13 April 1949. ± 3 km from the river, 50 cm water; trees of 10—18 m form more or less a canopy, the upper story of tall trees up to 35 m is interrupted; very little subgrowth.
58. Jan. 1949. Small creek valley filled with soggy, peaty mud.
59. 15 Jan. 1949. Moist slope of creek valley.
tamarinde (Mim.) ×, — *Crinum sp. 1981* ×.
60. 15 Jan. 1949. After several rainy days water 80—100 cm deep, soil covered with innumerable pneumatophores of *Symphonia,* the highest with their knees over the water table. 0—250 cm black-brown mould and very soft, wet clay.
watertamarinde (Mim.) f, — *waterlelie* cf. *Crinum* and *Rapatea paludosa* Aubl. ×.
61. 19 Jan. 1949. Creek valley filled with soggy, 370 cm deep, black, peaty mud.
Rapatea paludosa Aubl. f.
62. 20 Jan. 1949. *Bombax aquaticum* f, *Tabebuia serratifolia* ×, *T capitata* +, *jaifie* (Conn.?) ×, *Vochysia densiflora* Spruce ex Warm. ×.
64. 18 Jan. 1949. Levee, inundated at least at spring tides. 0— ± 45 cm grey-brown clay with brown spots in the lower part; 45—100 or 150 cm grey kaolin with red spots; 100 or 150—500 cm grey clay with plant debris.
Peltogyne venosa f, *kiemboto* f, cf. *Cassipourea guianensis* Aubl. +, *Diospyros cauliflora* Mart. +, *Pogonophora schomburgkiana* Miers ×, *Zygia cauliflora* ×, vs. *Palicourea guianensis* ×, *piboroballi* (?) +, cf. *Rapatea paludosa* Aubl. ×.
65. 18 Jan. 1949. ± 70 cm water. 0—80 cm grey-brown clay with brown spots; 80—250 cm grey clay with plant debris.
66. Oct. 1948. Periodically dry creek bed at km 12.9, Moengo tapoe line. 0—20 cm black mould; 20—60 cm soft black-grey clay rich in humus; 60—205 cm greyish sand; 205—300 cm grey-white kaolin.
67. Sept. 1948. Marshy foreland, inundated in rainy season.
Macrolobium multijugum va, *Zygia cauliflora* ×, *Aulomyrcia* cf. *divaricata* Berg ×, *Caraipa densifolia* ×, *Arthrosamanea gonggrijpii* (Kleinh.) Kleinh. ×, — *Clidemia pustulata* DC. ×, *625* ×.
68. Sept. 1948. Low wood, many trees at the base divided into several stems, many

epiphytes. 0—15 cm litter and forest peat; 15—25 cm grey-brown clay rich in humus; 25—100 cm grey clay.
Caraipa densifolia f, *Arthrosamanea gonggrijpii* (Kleinh.) Kleinh. ×, *Hevea guyanensis* Aubl. ×, *Sterculia pruriens* ×, *obé* (×), — *Trichomanes hostmannianum* a.

69. 22 Febr. 1949. Medium-high forest, canopy closed, understory open, dense subgrowth, few lianas and epiphytes; marshy clay soil. 4 × 100 sq. m.
Oxandra asbecki (Pulle) R. E. Fr. f, *Fusaea longifolia* (Aubl.) Saff. ×, cf. *Pterocarpus rohrii* ×, *Aniba hostmanniana* (Nees) Mez ×, vs. *Macrosamanea pedicellaris* (DC.) Kleinh. ×, *Tapura guianensis* Aubl. ×, *obé* ×, *Ormosia sp.* ×, *Caryocar nuciferum* ×, *Sloanea sp.* ×, *kaneelhart* ×, *Heisteria cauliflora* Smith ×, *kapoeasirie 2098* (Log.) ×, *teteihoedoe* (?) ×, *boesi awieon* (?) ×, — *Renealmia sp.* ×, *Calyptrocarya glomerulata* (Brongn.) Urb. ×, *Saxofridericia aculeata* (L. C. Rich.) Koern. ×.

70. 22 Febr. 1949. Medium-high forest, canopy closed, dense subgrowth, few lianas and epiphytes; marshy clay soil. 4 × 100 sq. m.
Vochysia sp. ×, *Tapura guianensis* Aubl. a, *Talisia* cf. *reticulata* Radlk. a, *Fusaea longifolia* (Aubl.) Saff. f, *Oxandra asbecki* (Pulle) R. E. Fr. ×, *Dipteryx odorata* ×, *Heisteria cauliflora* Smith ×, *boegoeboegoe* cf. *Swartzia schomburgkii* Benth. (×), *djedoe* ×, *Ormosia sp.* ×, *Macrolobium 2249* ×, *Apeiba sp.* ×, *Tovomita 2248* ×, *kapoeasirie* (Log.) ×, *pinpin* ×, *Heisteria* cf. *microcalyx* Sagot ×, *Piratinera sp.* (×), *Caryocar nuciferum* (×), cf. *Sterculia pruriens* (×), *Ocotea rubra* (×), *boskers* (Myrt.) ×, *2242* (Elae.) ×, *2246* (Flac.) ×, — *Saxofridericia aculeata* (L. C. Rich.) Koern. (f).

71. 12 April 1949. Medium-high forest with many small palms; the brown sandy soil slopes gradually towards a creek, at the low side ground water at 7 cm. *Dimorphandra conjugata* ×, vs. *Lacmellea (Zschokkea) aculeata* (Ducke) Monachino ×, *bergmaripa* (Palm.) a, *zwampanaura* (Ros.) ×, *kwattabobbie* (?) ×.

72. Jan. 1949. Forest; tall trees cut out some years ago. 0—70 cm grey-brown sand with humus; 70—130 cm yellow-brown sand, slightly clayey; 130—190 cm reddish clayey sand.
Trattinickia rhoifolia ×, *Ocotea guianensis* Aubl. ×, *Palicourea guianensis* ×, *Dipteryx odorata* ×, *Vouacapoua americana* Aubl. ×, *Casearia javitensis* H.B.K. ×, *Loxopterygium sagotii* ×, *Aparisthmium cordatum* (Juss.) Baill. ×, *riemhout* (Sapo.) ×, *1717* (Apoc.) ×, — *Renealmia sp.* ×, *Aciotis purpurascens* (Aubl.) Triana ×.

73. 16 Febr. 1949. Medium-high forest with few lianas and epiphytes on river terrace. 4 × 100 sq. m.
Sloanea sp. ×, *Paypayrola guianensis* Aubl. ×, *Tabebuia serratifolia* ×, cf. *Casearia javitensis* H.B.K. ×, *Heisteria cauliflora* Smith ×, *Apeiba sp.* ×, *Swartzia grandifolia* Bong. ex Benth. ×, cf. *Chimarrhis turbinata* DC. ×, *Ormosia sp.* ×, *Cordia laevifrons* Johnston ×, *Dipteryx odorata* ×, *Fusaea longifolia* (Aubl.) Saff. ×, *Eugenia coffeifolia* DC. ×, *Rollinia exsucca* (Dun.) A. DC. ×, *pikientikie (Maprounea sp.)* ×, *Inga lateriflora* or *heterophylla* ×, *2107* (Pap.) a, *2106* (Mor.) ×, *2113* (Mor.) ×, *kiskismakka 2112* (Palm.) ×, *2108* (Lacist.), *2109* (Pap.) ×, *2117* ×, *bisakapau* (?) ×, — *Piper 2110* ×, small kind of *warimbo* (Mar.) ×, *Pariana campestris* Aubl. ×, *Ichnanthus panicoides* Beauv. ×.

74. 23 Febr. 1949. High forest, understory open, little subgrowth, rather few lianas and epiphytes. 4 × 100 sq. m.
Fusaea longifolia (Aub.) Saff. a, *Oxandra asbecki* (Pulle) R. E. Fr ×, vs. *Trattinickia rhoifolia* ×, *Tapura guianensis* Aubl. ×, *Talisia* cf. *reticulata* Radlk. ×, *Peltogyne venosa* ×, *Sagotia racemosa* Baill. ×, *Lecythis davisii* Sandw. ×, *wit riemhout* ×, *Eugenia cupulata* Amsh. ×, cf. *Swartzia schomburgkii* Benth. (×), *Piratinera sp.* (×), *2261* ×, *2259* ×, *2274* ×, *2275* ×, — small kind of *warimbo* (Mar.) ×, *Olyra latifolia* ×.

75. 27 Sept. 1948. High 3-story forest, few small palms; soil slightly sloping, clay with pieces of lateritic iron-stone, on bauxite. 6 × 100 sq. m.
Paypayrola guianensis Aubl. a, *Vochysia densiflora* Spruce ex Warm., *tomentosa*

(G. F. W. Mey.) DC. and *surinamensis* Stafl. a, *Pogonophora schomburgkiana* Miers ×, *Miconia lepidota* DC. ×, *M. prasina* DC. ×, vs. *M. alternans* Naud. ×, *Anaxagorea dolichocarpa* Sprague et Sandw. ×, *Ocotea rubra* ×, *Minquartia guianensis* ×, *Calyptranthes speciosa* Sagot ×, *Qualea rosea* Aubl. ×, cf. *Parkia ulei* (Harms) Kuhlmann ×, cf. *Guatteria conspicua* R. E. Fr. ×, cf. *Buchenavia sp.* ×, *boroma (Cecropia or Coussapoa spp.)* ×, *Ocotea caudata* (Meissn.) Mez. or *glomerata* (Nees) Benth. et Hook. f. ×, *Mapouria opaca* Brem. ×, *jan snijder* ×, *Inga 497* ×, *Inga 498* ×, *mandraballi* (?) ×, *sĕkĕrĕdang* (?) ×, kayukut'idang (?) ×, *fokkofokkoboedoe* (?) ×, *pakira-ĕ* (Burs.) ×, *mano* (?) ×, lianas: *Passiflora sp.* ×, *n'ikuran* (?) ×, *494* ×.

76. 27 Sept. 1948. Rather high forest, 2 stories, understory with many palms; soil more or less waterlogged in the rainy season, impermeable subsoil of kaolin with red spots, covered by 60—80 cm grey clay or loam. 4 × 100 sq. m.
Paypayrola guianensis Aubl. a, *Calyptranthes speciosa* Sagot ×, *Minquartia guianensis* ×, *Guatteria scandens* Ducke ×, *Tovomita sp.* ×, *Apeiba sp.* ×, *kwassiba* ×, *pakira-ĕ* (Burs.) ×, *sĕkĕrĕdang* (?) ×, *krapparang* (?) ×.

77. 2 Oct. 1948. Forest with few tall trees and dense understory up to 12 m, rather little subgrowth; soil from 0—50 cm sandy clay, below 50 cm kaolin. 4 × 100 sq. m.
Caraipa densifolia ×, *Calyptranthes speciosa* Sagot ×, *Pogonophora schomburgkiana* Miers ×, *jan snijder* ×, *kwassiba* ×, *Eugenia ramiflora* Desv. ×, *krappaballi* (?) ×, *teteiboedoe* (?) ×, *watergujave* (Myrt.) ×, *mandredang* (?) ×, *640* (Sapo.) ×, — *Strychnos sp.* ×, *Trichomanes hostmannianum* ×, *Lindsaya lancea* (L.) Bedd. ×.

78. 2 Oct. 1948. Soil 0—70 cm grey-brown clayey sand; 70—140 cm yellow fine sand; below 140 cm fine-sandy kaolin.
Hevea guyanensis Aubl. ×, cf. *Pterocarpus rohrii* (×).

79. 2 Oct. 1948. Medium-high forest with much *Ravenala* in understory, rather much subgrowth; soil 0—80 cm fine-sandy clay; 80—100 cm very sandy kaolin. 2 × 100 sq. m.
Ormosia coccinea ×, *Ilex ovalifolia* Mey. sensu Loesener ×, *Casearia combaymensis* Tul. ×, *Tovomita sp.* ×.

80. 2 Oct. 1948. Shrub wood bordering clay savanna; soil 0—40 cm clayey; below 40 cm kaolin. Some terrestrial ferns.

81. 5 Oct. 1948. Soil clayey, at 30 cm already moist, roots go down to 90 cm.

82. 5 Oct. 1948. Soil 0—50 cm fine, clayey sand, pH 4.9—5.0, 50—70 cm kaolin with roots.

83. 6 Oct. 1948. Medium-high forest, canopy at 15—20 m, not fully closed, understory dense, rather little subgrowth, many lianas. Soil surface 1—1.30 m above level of Djai creek, but not flooded in rain season; soil 0—35 cm grey-brown crumbly clay; 35—80 cm kaolin. 4 × 100 sq. m.
Cupania diphylla Vahl ×, *Aulomyrcia* cf. *schaueriana* (Miq.) Amsh. f, *Ormosia coccinea* ×, vs. *Sacoglottis guianensis* ×, cf. *Trattinickia rhoifolia* ×, *Piratinera sp.* ×, *dukali 669* ×, *kromantikopie* ×, *djedoe* ×, *Pouteria caimito* ×, *olomé* (cf. *Pouteria*) ×, 677 (Til.) ×, *kirsie* (?) ×, — *Piper 666* ×, *mananesie Piper sp.* ×, *Strychnos sp.* ×, *bruinharttété* (?) ×, small Cyp. ×.

84. 6 Oct. 1948. Rather low forest, canopy at 14—18 m, rather dense subgrowth, mainly of tree seedlings, several lianas; soil 0—50 cm grey-brown crumbly clay; below 50 cm fine-sandy kaolin. 3 × 100 sq. m.
kanerieboedoe ×, *Aulomyrcia* cf. *schaueriana* (Miq.) Amsh. ×, *Eugenia sp.* ×, *Cupania diphylla* Vahl ×, *Inga lateriflora* Miq. ×, *Ormosia* cf. *coccinea* (×), *sĕkĕrĕdang* (?) ×, — *Strychnos sp.* ×.

85. 7 Oct. 1948. Marshy forest with few tall trees, understory dominated by *pina* palms, subgrowth with some shrublets and herbs. Depression in the impermeable subsoil, filled with more than 1 m fine-sandy clay, groundwater at 1 m depth, upper 50 cm rich in humus, pH 4.6—4.8. 4 × 100 sq. m.
kanerieboedoe ×, *Ilex 691* ×, *Protium sagotianum* ×, *P. glabrescens* ×, *Aulomyrcia* cf. *schaueriana* (Miq.) Amsh. ×, *kromantikopie* ×, *Pouteria caimito* ×, cf. *Inga*

lateriflora Miq. X, — *mananesie, Piper sp.* X, *Strychnos sp.* X, *Odontadenia puncticulosa* (A. Rich.) Pulle X.

86. 19 Oct. 1948. Bad forest, many trees with irregular or inclined trunks as if a storm had passed several years ago. In composition it deviates from the ridge forest by the presence of *maurisie*. Rather much lianas; soil fine-sandy clay, below 75 cm with red iron concretions. 2 X 100 sq. m. Exact locality km 16.35.
Vismia angusta X, *djedoe* X, — *mananesie Piper sp.* X, *Psychotria officinalis* (Aubl.) Raesch. f.

87. 14 Oct. 1948. Rather high forest marked by the flat crowns of *Parinari* in the canopy and by the absence of distinctly emergent trees. In the understory and in the canopy layer up to 18 m many palms; rather much lianas, many mosses on trunk bases; soil greyish sand, below 75 cm with iron concretions. 2 X 100 sq. m.
Vismia angusta X, *Isertia* cf. *parviflora* X, *Ocotea caudata* (Meissn.) Mez or *glomerata* (Nees.) Benth. et Hook.f. X, *fokkofokkohoedoe* (?) X, — *bruinhart-tété* (?) X, *Lindsaya schomburgkii* Kl. X.

88. 14 Oct. 1948. The same, many lianas, few epiphytes; soil greyish sand, below 60 cm mixed with clay, between 60 and 150 cm with red iron concretions. 2 X 100 sq. m.
Loxopterygium sagotii f, *kuseredang* (?) X, *boskers* (Myrt.) (X), *823* X, — Cyp. X.

89. 13 Oct. 1948. The same, few lianas, few epiphytes, rather dense subgrowth; soil greyish to brownish sand, between 90 and 190 cm with red spots and iron concretions. 2 X 100 sq. m.
Calophyllum brasiliense X, vs. *Sacoglottis guianensis* X, *Humiria floribunda* (X), *Clusia 969* (X), *Isertia* cf. *parviflora* X, — *Piper 898* X, *Becquerelia tuberculata* f, *tajer* (Ar.) X.

90. 21 Oct. 1948. The same, few lianas, few epiphytes, mostly Bromeliaceae. 100 sq. m.
Calophyllum brasiliense X, *kromantikopie* X, — cf. *Miconia ciliata* (L. C. Rich.) DC. X, two Cyp. X, *Lindsaya sp.* X.

91. 22 Oct. 1948. The same.
Piratinera sp. (X).

92. Nov. 1948. Soil undulating, sandy, in the lower parts somewhat clayish.
Alchorneopsis trimera Lanj. X, *Miconia alternans* Naud. X, vs. *Parkia pendula* (Willd.) Benth. X, *Minquartia guianensis* X, *Hyeronima laxiflora* (Tul.) Müll. Arg. f, *Casearia arborea* (Rich.) Urb. X, *Rollinia exsucca* (Dun.) A. DC. X, *Inga pezizifera* Benth. X, — *Piper 1256* X.

93. Nov. 1948. Soil 0—35 cm grey-brown fine sand with humus; 35—95 cm grey-brown fine sand.
pisie 1252 X.

94. Nov. 1948. Soil 0—45 cm grey to yellow-brown fine sand; 45—130 cm light-yellow sand with brown spots and mica (70—85 cm clayey layer); 130—525 cm soft grey clay. Very few palms.
Psychotria cuspidata Bredem. X.

95. Nov. 1948. Soil 0—5 cm forest peat; 5—50 cm black-grey fine sand, pH 5.3; 50—115 cm brown-black fine ferruginous sand; 115—175 cm yellowish sand with brownish spots and iron concretions. Rather few palms, few lianas.
Caryocar glabrum X.

97. Nov. 1948. Soil 0—60 cm light-grey fine sand; 60—80 cm dark-brown cemented sand; 80—95 cm ochrous sand.

100. Nov. 1948. *Caryocar nuciferum* X, *Vismia sp.* (X).

101. Nov. 1948. Lianas frequent.
Ibetralia surinamensis Brem. X, *Alchornea?* X, — *Renealmia sp.* (X).

102. Nov. 1948. Soil profile either with a greyish-white A_2-horizon reaching to a depth of 75 cm at one place to 140 cm at another and a more or less hard iron pan, or with an ochrous layer at a depth of 50 or 60 to 130 or 180 cm with yellow to white sand beneath.
Vochysia surinamensis Stafl. X, *Tabebuia capitata* X, *Qualea dinizii* Ducke (X),

Ternstroemia 1157 ×, *teteihoedoe* (?) ×, — *Piper sp.* ×, *Renealmia sp.* (×).

103. Nov. 1948. Exact locality: km 2.5—3.3. Rather open forest. Soil yellow to brownish sand, downwards becoming coarser.
cf. *Citharexylum 1154* ×, *Ternstroemia 1157* ×, *1128* (Mim.) ×, *Pisonia sp.* ×, — *Solanum surinamense* Steud. ×, *Piper sp.* ×, *Psychotria microcephala* Miq. ×, *Olyra cordifolia* H.B.K. ×, *Pharus latifolius* L. ×, *Streptogyne crinita* Beauv. ×.

104. 18 Nov. 1948. Soil 0—30 cm brown sand with humus; 30—60 cm brown-grey sand; 60—75 cm yellow sand. Open forest, many lianas and epiphytes, among others *Omphalea diandra* ×, *njamsimakka* (?) ×, *Rhipsalis sp.* and *Monstera pertusa* (L.)de Vriese, — *Renealmia sp.* (×).

105. 18 Nov. Open wood, many twiners, several dead trees. Soil 0—45 cm yellow-grey sand; 45—70 cm yellow sand.

106. 18 Nov. 1948. Open forest with dense subgrowth, many lianas. Soil profile at the highest point of the ridge: 0—5 cm litter; 5—35 cm yellowish fine sand, some humus; 35—130 cm light-yellow sand; 130—210 cm coarser sand with brown spots; 210—225 cm green-grey moist sand.
Hirtella racemosa Lam. ×, *Eugenia flavescens* DC. ×, *Pisonia sp.* ×, *Rapanea* cf. *guyanensis* Aubl. ×, *1128* (Mim.) ×, *poripo 1127* ×, — *Piper 1137* and *1139* ×, *Plumbago scandens* ×, *Monstera sagotiana* a, *Maranta arundinacea* L. ×.

107. 16 Nov. 1948. ± 9 m high, open wood; many lianas and dense subgrowth. Soil profile at the highest point: 0—5 cm sand rich in humus; 5—65 cm yellowish sand; 65—100 cm brownish-yellow coarser sand; 100—170 cm yellow, coarse wet sand; 170—200 cm clay.
Inga meissneriana Miq. f, *Croton 1111* a, — *Cestrum sp.* a, *Plumbago scandens* ×, *Dalechampia scandens* L. ×.

108. 13 Nov. 1948. ± 10 m high open wood, many lianas.
Ximenia americana ×, *Pisonia sp.* ×, *1073*[a] ×, — *Psychotria microcephala* Miq. ×, *Monstera sagotiana* va (covering the soil).

109. Nov. 1948. Low forest on the higher parts of the ridges (km 10.2—10.3, 11.5—12.1, 12.2—12.3 and 12.65— 12.95); soil white sand with an iron pan below. Soil profile at km 11.55: 0—10 cm grey sand with humus; 10—180 cm light-grey to white sand.
Calycolpus revolutus ×, *Licania incana* was frequent only near km 12.7, — *Guatteria scandens* Ducke ×.

110. 20 Oct. 1948. Canopy at 8—12 m, few emergent trees, nearly all stems inclined, many dead trunks of ± 10 cm diam. 100 sq. m.

111. Jan. 1949. Forest islets in fire savanna, varying in height from 10 to 20 m.
Byrsonima coccolobifolia Kunth ×, *Ocotea guianensis* Aubl. ×, — *Miconia rufescens* (Aubl.) DC. ×, *1736* (Lacist.) ×.

112. Jan. 1949. Open forest or wood, stems thin, between km 3.7 and 4 dominated by *Dimorphandra,* which has been burned badly in 1926. Soil grey-brown to white sand, iron pan at a depth varying from 150 to 400 cm.

113. Jan. 1949. Varying from forest to scrub-wood, the trees show numerous burn scars. Soil grey-white coarse sand, top layer with humus. Hard iron pan reached at km 3.6 at a depth of 2.85 m.
Aparisthmium cordatum (Juss.) Baill. ×, *Licania divaricata* ×, *Symplocos guyanensis* (Aubl.) Gürke ×, — *savanne dijatété* (?) ×.

114. 12 April 1949. Soil sand.
Licania divaricata ×, *pinpin* ×.

115. Oct. 1948. Marsh wood, trees with several stems; soil clay, covered by knobs overgrown with Hepatics.
Vismia guianensis ×.

116. Oct. 1948. 1.5—2 m high scrub with scattered higher shrubs and *maurisie* palms, soil with kawfoetoes, sandy clay.
Hypolythrum pulchrum a.

117. Oct. 1948. Scrub zone rising from 1.5 to 4—5 m.
Hypolythrum pulchrum a, *Lindsaya* cf. *stricta* Dryand. a.
118. Oct. 1948. ± 5 m high scrub with dense herb layer. 100 sq. m.
Hypolythrum pulchrum a, *Scleria* vs. *cyperina* ×, *Rhynchospora cyperoides* ×, *Lagenocarpus guianensis* ×, *Panicum nervosum* Lam. ×, *Isertia parviflora* ×, *Clidemia pustulata* DC. ×, *Tibouchina aspera* Aubl. ×, *Bactris* aff. *savannarum* ×, *Coccoloba excelsa* Benth. +, *Lisianthus uliginosus* Gris. ×, *Coccocypselum guianense* (Aubl.) K. Sch. ×.
119. Oct. 1948. 5 m wide belt, clay soil, water level ± at the surface.
Becquerelia tuberculata a.
122. 16 Dec. 1948. Shrubs and treelets 2.5—5 m, *maurisie* palms 5—9 m high; total coverage ± 60%, for composition of dense fern layer see table I record 52. 70—80 cm water, thick layer of pegasse.
123. 16 Dec. 1948. 40—50 cm water, total coverage of shrub layer ± 40%, see table I record 53.

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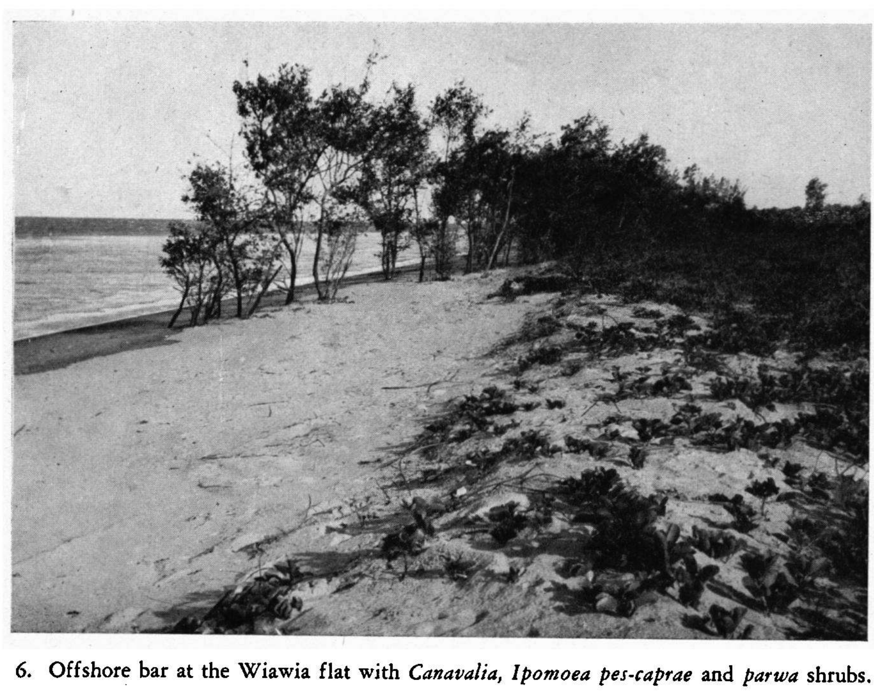
1. *Rhizophora, mangro,* at the right and *Laguncularia, akira,* at the left along Nickerie River near Paradise.

2. *Machaerium, brantimakka,* and *Montrichardia, mokomoko* belt along Cottica River near Oranje creek; marsh forest behind it with *Mauritia, maurisie* palms.

3. Abraded beach near Galibi (mouth of Marowijne River) with a group of *awara* palms, *Astrocaryum segregatum.*

4. Beach at the Wiawia flat, East of our camp; trees mainly *Avicennia, parwa.*

5. The Wiawia flat; piakkas waiting before landing for the rising tide.



6. Offshore bar at the Wiawia flat with *Canavalia, Ipomoea pes-caprae* and *parwa* shrubs.

7. First salt swamp in the Wiawia transect seen from the offshore bar; in the foreground *Sporobolus* and *Sesuvium*, in the background *parwa* trees on the small first ridge.

8. View in the *parwa* forest behind the first ridge East of our camp, the soil covered with pneumatophores.

9. Second ridge seen from the North, in the foreground the boundary line between *Eleocharis mutata* and *Sporobolus virginicus*.

10. Third swamp seen from a tree on the 2nd ridge, westwards a *parwa* grove surrounded by a *brantimakka* belt; in the foreground a *Dalbergia ecastophyllum* belt.

11. *Brantimakka* scrub seen from the *parwa* grove at the South side of the 2nd ridge; the black ball is a termite nest. In the foreground pneumatophores of *Avicennia.*

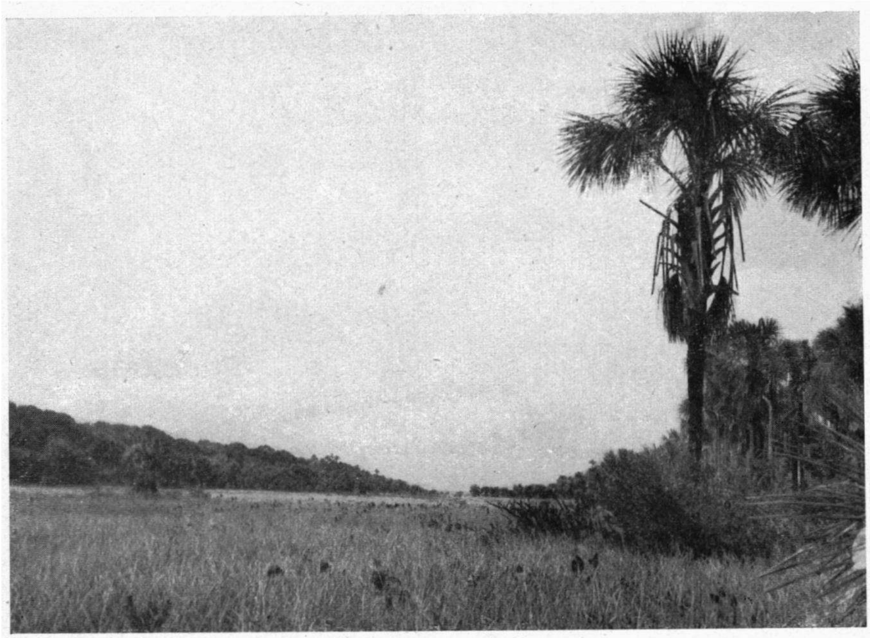
12. Fifth ridge with cacti *(Cereus)* seen from the 5th swamp; the latter with *Leersia* and *Phragmites.*

13. *Erythrina, koffiemama* groups fringed by *mokomoko* in the 6th swamp; the grass is *Leersia hexandra;* in the background a *brantimakka* scrub.

14. Two carriers crossing the 7th swamp; in the background forest on the 7th ridge.

15. Gully along ridge at km 7.35; water 1 m deep, covered by *Salvinia*. The buttressed tree is a young *waterbébé, Pterocarpus officinalis.*

16. *Cyperus giganteus* swamp with dams and islets covered by shrubs and trees, seen from a tree at km 9.2. The palms are *maurisies.*



17. Swaying swamp between km 13.1 and 13.4 seen westwards; under *maurisie* palm *Chrysobalanus* shrubs.

18. Same swamp seen Southwards from a palm; ridge fringed by a *Mauritia - Chrysobalanus* zone; in the foreground pools with waterlilies, *Nymphaea odorata,* in the *Lagenocarpus guianensis* vegetation.

19. On the way in the floating savanna towards the second island in the Great Swaying swamp.

20. Part of a forest in the clay savanna East of km 6.7, Moengo tapoe transect.

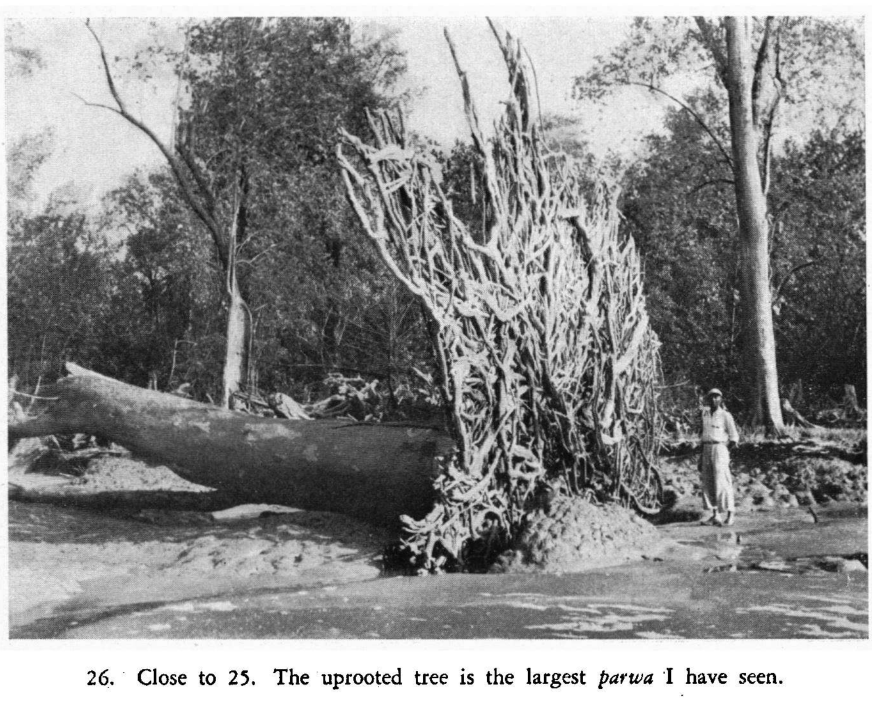
21. Marsh forest along creek near km 15.7; *Symphonia, matakki,* with knee-shaped pneumatophores, at the right a clump of *Aulomyrcia pyrifolia, swamp gujave;* the palms are *Euterpe, pina.*

22. Marshy forest at ridge border near km 15.7; sun entering through a gap formed by a dead tree; much *pina* palms; the trunk in the foreground is *Parinari, foengoe.*

23. Abrasion coast at the end of our sea line near Coronie; *parwa* forest.

24. *Typha* swamp with mixed swamp-wood groves in our sea line near Coronie at km 0.9; the ferns are *Acrostichum aureum*.

25. Abrasion of the coast in front of the sea dyke of Nickerie; in the cliff several thin sandy layers are visible; in the background mixed mangrove forest.



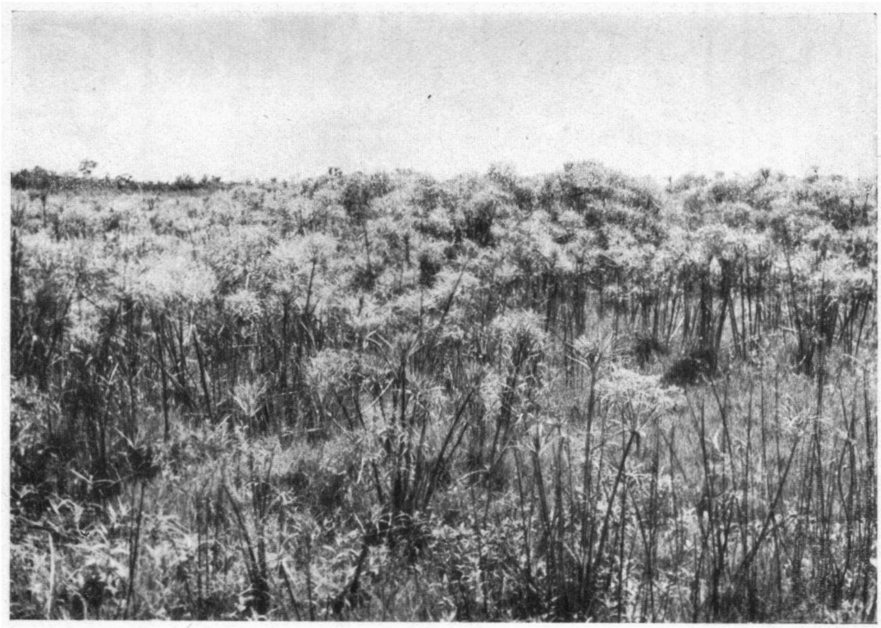
26. Close to 25. The uprooted tree is the largest *parwa* I have seen.

27. North side of Bigie pan, Nickerie; ponds in the *parwa* forest; around the trees disk-like groups of pneumatophores. In the centre a patch of *Paspalum vaginatum* and a clump of *Torulinium ferax.*

28. Succession at the South side of Bigie pan; *Nymphaea ampla,* rings of *Limnobium* and patches of *Eleocharis mutata.* The trees are *parwas.*

29. Close to 28. Some fishermen at work.

30. Swamp along the Huntley creek, Nickerie, covered with *Eleocharis mutata* and *Cyperus articulatus;* scattered groups of *parwa.*



31. Trial polder near Nickerie; *Cyperus giganteus, papajagras,* with undergrowth of *Leersia hexandra.*

32. A beautiful *Crinum* in a *Cyperus giganteus-Blechnum indicum* stand in the swamp West of the Henar polder.