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Phytogeographical Notes on the Brazilian Amazon *

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“Ainda não existe, nem existirá tão cedo, sôbre a mata amazônica, um trabalho de conjunto, que seja capaz de dar uma boa idéia não só dos seus aspectos variados, como também da sua composição florística, das fases de sua vida e da sua importância como fator econômico. Muito já se tem escrito sôbre um ou outro destes assuntos, mas geralmente sem as bases suficientes de observação ou de conhecimentos científicos. O presente trabalho, apesar de baseado sôbre uma experiência de 14 anos e sôbre estudos seguidos em viagens e no gabinete, é apenas um modesto ensaio, um pródromo dum estudo mais completo e mais aprofundado que só depois de muitos anos de trabalho assíduo poderá ser tentado. A nossa mata equatorial é um mundo por si, cuja organização e vida íntima só por diversas gerações de investigadores poderá ser desvendada. A vida dum homem mal chegaria para ter uma idéia exata da composição dum quilômetro quadrado de mata virgem, quanto menos duma área mais de três milhões de vezes maior”. J. HUBER (1909), *Bol. Mus. Goeldi*, VI, 91.

The Hylaea of Humboldt and Bonpland is the great equatorial rain forest of South America covering most of the Amazon basin, the basin of the upper Orinoco, the Guianas, and the basins of the lower Tocantins

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including the Rio Pará and the small rivers of the Atlantic drainage eastwards to the Rio Turiassú in the State of Maranhão. The upper Mamoré and Guaporé, the upper Rio Branco valley and the upper Andine valleys as well as the arenitic plateaus and table mountains of the Guianas are excluded from the hylaea. The immense forest is nearly continuous in its Western half but it is dotted with relatively small patches of open savannahs with a non-hylaeian flora in the Eastern parts (chiefly along the coastal belt). The only natural limits of the hylaea are the Atlantic and the Andes; on the North and on the South extremes, the hylaea (rain) forest is gradually replaced by the flora of the drier neighboring countries. In such conditions, it may be convenient to take for limits of the hylaea those of the geographic area of some genus of forest trees proper to the country, well studied by botanists, and well known to everyone for its economic importance. No genus seems better suited for this purpose than *Hevea*, the genus of the most important rubber trees.

In Brazil, the area of *Hevea* covers the whole State of Amazonas; the State of Pará with the very probable exception of the Rio Araguaia; all of the Territories of Acre and Amapá; the Northwestern part of the State of Maranhão; the North of the State of Mato Grosso and of the Territory of Guaporé; the Southern half of the Territory of the Rio Branco. Outside the boundaries of Brazil, *Hevea* has been observed in the Guianas, Venezuela, Colombia, Ecuador, Perú and Bolivia, in forests contiguous with and not essentially different from those of the Brazilian Amazon. The northernmost localities for *Hevea* are the upper Orinoco and the lower Essequibo, about five to six degrees North latitude (1); the southernmost station, Subandine Eastern Bolivia about 16 degrees South. Besides *Hevea*, there are many other genera of forest trees typical of the hylaea, but none of these is so universally known as *Hevea*. The famed Brazil nut (*Bertholletia excelsa*) is absent from the Guianas except the extreme South, as well as in all the Western hylaea (at least in spontaneous growth). The ornamental *Ravenala guianensis* and the six American *Gnetum* are very characteristic for the entire hylaea, reaching however beyond the limit of *Hevea* in Maranhão. The arboreous *Leguminosae*, chiefly the *Caesalpinioideae Amherstiaeae*, reach their best development for the Americas in the hylaea, only being equaled by the flora of Equatorial West Africa. Nineteen of

(1) The forest country of British Guiana extends more Northwest and seems to unite with that of the Orinoco delta, Territory of Amacuro, Venezuela. But, very little is known about this flora, where up to now *Hevea* has not been found.

the 20 American species of *Parkia* are present in the hylaea, of these only two occur elsewhere; some are very striking elements of the landscape. The great majority of the species of the genera *Dimorphandra*, *Hymenobium* and *Coumarouna* is proper to the hylaea, where they rank among the largest of the forest trees. The American center of distribution of the *Palmae* lies in the hylaea, here very rich in species, but, excepting the Amazon estuary, far less abundant in individuals and less characteristic for the landscape than in several other tropical countries. Of the two centers of distribution of the beautiful *Vochysiaceae*, one lies in the hylaea and the other in Central Brazil. The arboreal *Linaceae* (*Humiriaceae*) have their world center of distribution in the hylaea. Other characteristic features of the hylaea are: the very large number of species and individuals of *Moraceae* everywhere; the frequency of *Rosaceae* *Chrysobalanoideae* and *Lecythydaceae*, and the relative frequency of representatives of the families *Olaceae*, *Dichapetalaceae* and *Icacinaceae*, of arboreal *Tiliaceae* and of the genera *Sloanea*, *Buchenavia* and *Diospyros*. The four wild species of the genus *Bixa* are restricted to the hylaea. The genus *Theobroma* has its center of dispersion in the Amazon and plays an important part here; like many other genera, it reaches far North but hardly exceeds the limit of *Hevea* in Maranhão. In the hylaea, *Lauraceae*, *Anonaceae* and *Burseraceae* are probably more numerous in species than in any other part of America, in virgin forest as well as in secondary forest; *Melastomataceae* and *Myrtaceae* are much less important than in Tropical and Subtropical Southeastern Brazil, in spite of their great frequency in secondary growth. The *Myristicaceae* are very rich in species in Western Amazonia, their center of dispersion for America. Large-leaved herbaceous *Monocotyledoneae* are abundant in the constantly humid Western hylaea and the Amazon estuary, but less so in the lower Amazon, Tocantins and other regions with a dry summer; in frequency, the *Scitamineae* are the most important. The *Gramineae*, largest family of the campo-flora, are relatively scarce in rain forest but represented by some characteristic genera with broad leaves, for example *Pariana*. Abundance of scandent shrubs ("bushropes") or lianas is very striking for the rain forests of all tropical countries, but no other region seems to exceed the hylaea in species of large woody climbers. Among the latter, the *Leguminosae* are the best represented; most of the species of *Bauhinia* with scalariform stems are hylaeal, while everywhere else erect plants form the majority of species of this large pantropical genus; scandent species of *Acacia*, *Piptadenia* and *Entada* and thick vines of *Dioclea*

are common; some *Machaerium* have flattened stems like the scandent species of *Bauhinia* but never scalariform. *Bignoniaceae* of many genera are commonest among the high climbing lianas, followed by *Menispermaceae*, *Dilleniaceae*, *Hippocrateaceae*, *Convolvulaceae* (of the genera *Maripa* and *Dicranostyles*) and *Malpighiaceae* (more frequent in secondary growth). The genus *Strychnos* abound in species and individuals and has its American center of distribution here. The three species of *Lophostoma* are noteworthy. Among the woody Dicotyledoneous epiphytes, large tree-strangling species of *Ficus* and *Clusia* are common and very conspicuous; some of these *Ficus* often become trees of enormous size. Noteworthy is the frequency of species and individuals, of the large epiphytic shrubs of the genera *Coussapoa* and *Moutabea*, both occurring sometimes in the form of trees, and the abundance of the *Marcgraviaceae*, epiphytic climbers whose most common and most conspicuous species is the beautiful *Norantea guianensis* with crimson bracts. The hylaea is the center of dispersion of the curious *Bignoniaceae* — genus *Schlegelia*, represented here by several scandent epiphytes of various sizes, none of them frequent. Epiphytic *Monocotyledoneae* are not so abundant in species and individuals in the hylaea, at least in the high forest, as for example in the forests of Rio de Janeiro and São Paulo; however, the *Cyclanthaceae* are remarkably frequent. Epiphytic *Araceae*, *Bromeliaceae* and *Orchidaceae* sometimes abound in more open forests (chiefly in igapó) or on campinas.

The relative scarcity of some families well represented in the rain forests of other Tropical American countries, chiefly *Polypodiaceae* and *Compositae*, is characteristic for the hylaea. *Cactaceae* are very scarce in the rain forests of the hylaea and even the epiphytic species which abound in Tropical Southeastern Brazil are rare here (most remarkable is *Strophocactus Wittii*, endemic in the middle Amazon); the non-epiphytic species occur with frequency on the hill campos of Monte Alegre, with non-hylaeal flora. The *Passifloraceae* are frequent in the primary forests and abundant (at least in individuals) in the secondary growth, but much less numerous in species than in all other rain forest regions of Tropical America (2). A small genus, *Dilkea*, is however endemic in the hylaea.

(2) Killip, in his excellent monograph, cites among the 355 American species only 30 native to the Brazilian Amazonia, not including 6 others present in the non-typical hylaeal Upper Rio Branco basin.

The extreme frequency and variety of myrmecophilous plants is certainly one of the most striking characteristics of the hylaea (3). Most remarkable among them are the epiphytes growing on the nests of certain tree-inhabiting ants, as *Camponotus femoratus* ("tracua") and several *Azteca*; according to Huber, they have never been observed elsewhere. A good description was made by E. ULE (Epiphyten des Amazonasgebietes, in Vegetationsbilder series 2 fascicle 1) who gave them the name "Ameisengarten". These epiphytes belong to several families (chiefly *Polypodiaceae*, *Araceae*, *Bromeliaceae*, *Orchidaceae*, *Piperaceae*, *Cactaceae*, *Solanaceae* and *Gesneriaceae*) represented by many species; some *Ectozoma*, *Marckea*, *Codonanthe* and *Coryanthes* seem unable to live in other conditions; others may survive after the destruction of the nest or even occur without the presence of ants. Myrmecophilous trees or shrubs abound everywhere in the hylaea and are for the greater part restricted to this region; the only ones occurring in Extra-Amazonian Brazil are some *Cecropia*. The myrmecophilous species of the genera *Pourouma*, *Triplaris*, *Hirtella*, *Inga*, *Tachigalia*, *Sclerolobium*, *Pterocarpus*, *Picrolemma*, *Tococa*, *Myrmidone*, *Clidemia*, *Mayeta*, *Tachia*, *Remijia*, *Gleasonia* and *Duroia* seem to be exclusively hylaeans.

When the primary forest of the hylaea is destroyed by whatever means, it is succeeded like that of other countries, by a secondary growth, in Brazil called "capoeira". If the virgin forest has been cleared away by cutting alone, without burning, this "capoeira" is first composed of herbs, small shrubs and treelets belonging to widespread heliophilous plants

(3) SYNOPSIS OF THE MYRMECOPHILOUS PLANTS OBSERVED IN THE BRAZILIAN AMAZONIA:

- A: Epiphytes on the nests of ants.
- a: Never living without ants: *Coryanthes* sp. sp., *Epidendrum* sp. sp., *Marckea camponoti*, *M. formicarum*, *M. sessiliflora*, *Ectozoma Ulei* and *Codonanthe* sp.
 - b: Originated in ant nests but surviving after the destruction of the nest: *Marckea coccinea* and *Codonanthe* sp. sp.
 - c: Often on ant nests but not necessarily: certain *Araceae*, *Bromeliaceae*, *Orchidaceae*, *Peperomia* and *Gesneriaceae*, *Phyllocactus* and a dwarf *Ficus* (*F. paraensis?*).
- B: Trees or shrubs inhabited by ants.
- a: Provided with special accommodations for these ants.
 - I With hollow stems or branches: *Cecropia* sp. sp., *Triplaris* sp. sp., *Picrolemma* and *Tachia*.
 - II With inflated hollow tips of branchlets: *Cordia nodosa* and *Duroia* sp. sp.
 - III With pockets on the extremities of the petioles: species of *Pourouma*, *Hirtella*, *Tococa*, *Myrmidone*, *Clidemia*, *Mayeta* and *Duroia*.
 - IV With stipules sheltering ants: *Remijia glomerata* and *Gleasonia uaupensis*.
 - b: With cavities hollowed out by the ants and later becoming inflated.
 - I With hollowed twigs: *Inga cinnamomea*, *Tachigalia* sp. sp. and *Sclerolobium* sp. sp.
 - II With hollowed peduncles or axes of inflorescences: *Pterocarpus Ulei*, *Platymiscium Ulei* and *Sapium* sp.

of the genera *Solanum*, *Piper*, *Cassia*, *Croton*, *Myrcia*, *Eugenia*, *Vismia*, *Casearia*, *Miconia*, *Clidemia*, *Mimosa*, *Byrsonima*, *Trema*, etc. After a few years, these plants are dominated by large shrubs and fast growing trees originating from shoots of trunks, seedlings and seeds from the primary forest, and seeds proceeding from neighbor forests. This category of "capoeira" resembles the primary forest more and more, but never entirely succeeds in becoming real virgin forest. Typically hylaeen species are always well represented in this kind of "capoeira", but for many species the percentage of the individuals will never be the same as in the virgin forest, nor will the proportion of the trees with a straight bole equal that of the virgin forest. Such an old, well developed "capoeira" receives the name "capoeirão" (augmentative of "capoeira").

Another type of "capoeira" appears after the burning of the primary forest, when all seedlings and most of the trunks and of the seeds have been killed and the soil has been sterilized or unfavorably modified by the fire. This category of "capoeira" is composed of a far smaller number of species, most of them not being hylaeen but widely distributed outside of this region. Repeated fires gradually reduce the number of the species, until very few survive, as for example *Byrsonima lancifolia*, *Vismia* sp., *Davilla rugosa*, *Myrcia* spp. and some small *Melastomataceae*; the several other species of *Byrsonima* and *Vismia* which abound in the neighboring forests are always absent. Near Manaus where rain is scarce from July to September, this reduction is more accentuated than in rainy Belem; on silica, more than on compact clay-loam. Wastland of nearly bare sand or laterite occupies at present, in the suburbs of Manaus, wide stretches formerly covered by rain forest.

The forest of the periodically flooded varzea is more rapidly renewed than the upland forest, even though it has been burned; the sediments of the annual flood waters renew the soil and bring seeds of many plants from virgin forests. Hylaeen species prevail among the trees.

Many plants common in the "capoeiras" are also present in small clearings formed by falling trees in virgin forest.

In the State of Maranhão, the genuine hylaeen flora is restricted to a narrow zone of true rain forest between the river Gurupi (boundary of the State of Pará) and the Turiassú and upper Pindaré (4); most of that State belongs to the dryer "zona dos cocais" (palm zone) of A. Sampaio,

(4) According to the collections of R. L. Froes, the only botanist who has worked in that very inaccessible region.

characterized by the abundance of "babassú" (*Orbignya Martiana*) which often is found in nearly pure stands. Here, floristic elements of the hylaea are mixed with others of Northeast or Central Brazilian origin; near Cururupú, for example, the Amazonian *Theobroma speciosum* grows along with the Northeast Brazilian *Caesalpinia bracteosa*. Near São Luiz, hylaeal species may constitute three quarters of the ligneous plants of the uplands; *Hevea*, *Bertholletia*, *Euxylophora*, *Parkia*, *Vouacapoua*, *Coumarouna odorata*, *Manilkara Huberi* and other very representative forest trees of Pará are, however, lacking (5). The swampy or inundable banks of rivulets reproduce the true aspect of the igapó of Pará with its abundance of *Mauritia flexuosa*, *Euterpe oleracea*, *Ravenala guianensis* and the presence of *Gnetum nodosum* etc. This difference between the flooded and the non-flooded woods might possibly have originated from increasing drought (five months with less than 100 mm of rainfall per month, four of them under 50 mm) which might have caused the extinction of certain species. Very few hylaeal plants reach eastwards to Parnaíba or southwards to Codó; none has been found near Caxias, where, as in the entire Southern part of Maranhão, the flora is related to that of Central Brazil.

Very little is known of the hylaeal (Northern) part of Mato Grosso representing about one third of this State which is better explored botanically in the central part. The Southern limit of *Hevea*, according to HOEHNE, is the region which gives birth to the headwaters of the Juruena and the Paraguai, about 14 degrees South. Nothing is known about the southern limit of the hylaea in the Territory of Guaporé; we know, however, through observations made by KUHLMANN, that the flora along the Madeira-Mamoré railroad is purely Amazonian. In the Territory of Acre, the luxuriant forest is for the greatest part composed of hylaeal species but has a small percentage of characteristically Southern (extra-Amazonian) trees; *Phyllocarpus Riedelii*, *Cariniana brasiliensis* and *Gallesia integrifolia* (6) may be cited as most representative, and there is an abundance of *Bambuseae* not observed elsewhere within the hylaea.

The Western and the Northern limits of the hylaea lie beyond the frontiers of Brazil, except for the Territory of Rio Branco. Here, the true hylaea rain forest terminates with the Amazonian plain at the rapids of the river, and from here on the hill country of the "campos" (in Brazil)

(5) *Parkia pendula* and *Coumarouna odorata* reappear in the forest zone of Pernambuco.

(6) This tree, the "pau d'alto" of São Paulo and Rio de Janeiro, reaches northwards to the Purus below the mouth of the Acre river.

or "savannahs" (in British Guiana) extends Northeast to unite with that of the Rupununi, an open grass land with a high percentage of dicotyledoneous herbs, low shrubs and isolated treelets, and with "isles" of forest trees nearly all deciduous in the long dry season. This flora shows a mixture of Amazonian and extra-Amazonian elements; part of the latter may be endemic but a large part probably belongs to the very incompletely explored flora of the Lower Orinoco. Forty-six species of *Leguminosae* collected in the Brazilian part of this country have not yet been observed in other parts of the Brazilian Amazonia; on the other hand, many of the most common and widespread Amazonian plants are lacking here, including the whole genus *Hevea* (7). Therefore there can be no doubt that this flora cannot be included in the hylaea but must be considered a transitional between the latter and that of the extra-Amazonian Northern South America (8). The Northern limit of this Territory coincides with that of Brazil; it goes over the arenitic mountains which culminate in the Roraima and are clad with high savannahs and subtropical forests of no hylaeal affinity (9).

A larger number of hylaeal plants extend their Northern range reaching the Antilles or even Florida; few are found South of the State of Maranhão, and the only large virgin forest trees distributed from the hylaea to Rio de Janeiro which we know are the Moraceous *Clarisia racemosa* ("guariuba" in the Brazilian Amazonia, "oiticeira" in Rio de Janeiro) and *Helicostylis tomentosa*.

It seems worthy to mention that some plants, widely distributed North and South, occur in the hylaea only on the periphery of the region. The well known *Myroxylon balsamum* (including *M. peruiferum* which seems to be a mere form) has been observed up to now in the Territories of Acre and Rio Branco, as well as near Esperança on the mouth of the Javari

(7) The area of *Hevea* (*H. Benthamiana* in this case) ends a little below Boa Vista.

(8) The "Cisaequatoriale Savannenprovinz" of "Pflanzenreich" and other publications of German authors would include the Llanos of the Orinoco, the three Guianas, the Rio Branco and for some authors even the Rio Negro. This "province" comprises however at least four very distinct floras: 1., the Llanos; 2., the savannahs of Rio Branco and Rupununi; 3., the subtropical arenitic plateaux and table mountains; 4., the hylaea which comprises the greatest part of the Guianas and the whole Rio Negro basin except for the upper Rio Branco.

(9) The extreme poverty of the *Leguminosae* and the richness in *Pteridophyta* and *Compositae* on the arenitic plateaux is in contrast with the hylaea which shows an abundance of the *Leguminosae* and relative scarcity of the two other. This flora has nothing to do with that of the non-arenitic mountains of the Upper Rio Branco and Rupununi; in the latter, the savannahs as well as every type of forest abound in *Leguminosae*. Ule has already shown, in his "Die Vegetation des Roraima", that the flora of Roraima and neighboring country has nothing in common with the rest of the Guianas and Rio Branco.

(boundary of Brazil and Perú), but never in other parts of the region. The panamerican *Tillandsia usneoides* has not yet been observed anywhere in the hylaea except Dutch Guiana and along the Rio Gurupí, border of the States of Pará and Maranhão (according to information received by J. HUBER); *Clematis dioica*, widely distributed North and South of the hylaea, was only observed in the Amazon country at the mouth of the Javari. Here and on the middle Purús the common *Caesalpinia bonducellæ* has been found, plant of the sea coast of Tropical America not occurring in any other part of the Amazon country. Of peculiar interest is the distribution of the South American mahogany, *Swietenia macrophylla* (= *S. Tessmannii* and *S. Krukoviï*). This very important timber-tree has been observed in rain forests, in Atlantic Central America, Colombia, Western Venezuela and Northwestern Ecuador, and, East of the Andes, in Amazonian Perú and Bolivia down to the upper Mamoré basin as the Southern limit (RECORD and HESS, Timbers of the New World). From Perú, this species enters Brazil by the Acre Territory (upper basins of Juruá and Purús), forming a zone which goes eastwards through the Territory of Guaporé (middle Madeira basin) to Northern Mato Grosso and Southern Pará (basins of the upper Tapajós and upper Xingú). Then it describes a curve which extends Northeast, to the middle Tocantins and the neighboring Rio Balsas (tributary of the Upper Parnaíba in the Southernmost part of the State of Maranhão) reaching, North from here, the middle course of the Rio Capim, Southeast of Belem (10).

Soil and rain are the chief factors dividing the immense hylaea into small local floras. In the uplands ("terra firme"), the forest soil of most of the region is predominantly sandy or a compact clay loam, both acid and poor; a humo-silicious soil, profound and fertile ("terra prêta"), is to be found in many places; a red brown very fertile clay loam has a spotty distribution. This latter resembles the spots of "terra roxa" of the State of São Paulo and seems to have, like those, diabasic origin; its flora is remarkably different from that of the poor soils of the neighborhood and contains several species not yet observed anywhere in the hylaea or at least up to the present moment observed only in apparently similar soils of Southern British Guiana. Like the trees which grow on "terra roxa" in São Paulo, most of the woods, here, are softer than those of the trees

(10) According to information received from the botanist R. L. Froes about his trips there. The flora of the Rio Balsas may be transitional between that of the hylaea and that of Central Brazil; the presence of *Swietenia macrophylla* indicates true rain forest conditions.

of the common (poor) upland soils. The most remarkable spots I know are situated in the basin of the small Rio Branco (with the Rio Branquinho) about 30–50km Northeast of the town of Obidos; the soil here is possibly alkaline (the water which has been analyzed by KATZER and by LE COINTE shows definite alkalinity). Spots of similar soil, of a relative importance, also exist in some places along the Lower Trombetas (near the Lago Salgado where the water is alkaline in the dry season), near Alenquer and Monte Alegre, and around Altamira on the Middle Xingú, all having species of plants nowhere else observed. The difference between the floras of silicious and of clay soil (both poor) can easily be verified along the roads leaving Manaus; silicious soil with highly acid black humus alternates here with a less acid, compact clay loam, each one with its own flora. Many of the *Hevea brasiliensis* planted here in 1929 on clay are still alive, but none survived on silicious soil where however *H. guianensis* is often native. On some places, through the entire hylaea, the common yellowish or grayish sand gives way to spots of pure white sand barely covered by a thin layer of humus. Such places usually abound in arboreal *Linaceae* (*Roucheira*, *Hebepetalum*, *Vantanea*, *Sacoglottis* and *Humiria*, the latter being the most common) and beautiful trees of several species of the Leguminous genus *Dimorphandra* (subgenus *Pocillum*).

The soil and, in the case of large savannahs, also the climate, are certainly responsible for the presence, in many parts of the hylaea, of large open areas ("campos") (11) or small spots ("campinas") of open land, surrounded on all sides by the great virgin forest. Some authors attribute the presence of open land in the middle of virgin forest to fire; this is however not true. Natural "campos" and "campinas", often separated by hundreds of kilometers, have a flora and a fauna radically diverse from that of the neighboring forests (of either virgin or secondary growth) and with many species in common, never observed elsewhere in the same region. The true natural "campos" are grasslands inhabited by a flora foreign to the hylaea, of species widely distributed over the continent or belonging to the "cerrado" of Minas Gerais, Mato Grosso, etc. (12). "Campinas" (dimi-

(11) In all "campos" of large extension, the summer season is more defined and the drought is greater than in the neighboring forest country. This can easily be observed in the center of Marajó, on the limit between the campos of the Eastern half and the rain forests of the Western half. The same occurs, to a lesser degree perhaps, in the other campo countries of the Amazon.

(12) A. Sampaio in his "Fitogeografia do Brasil" says that the flora of the campos of the State of Pará does not belong to the hylaea flora but to the "Flora Geral" of Brazil (he might better have said: to the general flora of the (central) Brazilian "campos" and "cerrados").

native of "campos") are sometimes small "campos" of the same nature as the larger ones, but more often of a very different nature, poor in grasses and with a flora belonging to that of the hylaea and akin to that of the Amazonian catinga. Artificial "campinas", originating from fire, have the flora of the "capoeiras" (secondary woods), in some cases with a few herbs or shrubs (13) coming from natural "campos" or "campinas", but never having the arboreous species characteristic of the latter. On the contrary, some natural "campinas" are invaded, when burned, by shrubs of the nearby "capoeiras" replacing the spontaneous species destroyed by the fire.

The catinga of the Upper Rio Negro and Solimões is a special type of forest growing on a special type of soil.

Rivers and lakes of the hylaea are often accompanied by strips of lowland subjected to over-flowing during a certain period of each year. These lowlands are called "várzea", and the forest which covers them is called "mata da várzea", in contrast to the "mata da terra firme" of the uplands. In the Eastern part of the Lower Amazon, between the mouths of the Nhamundá and Xingú, large parts of the "várzea" are open grasslands: "campos da várzea". Different from the only periodically flooded "mata da várzea" is the "igapó", swamp forest where the soil never dries out completely even in summer; it occurs as well in the "várzea" as on "terra firme", here usually limited to the marshy banks of forest streams. The "várzea" forest of the "white water" rivers (rivers which carry copious sediments) is entirely different, in its floristic composition, from that of the rivers with colorless or "black" water; the former is characterized by a high percentage of trees without distinct heartwood or with softer wood than that of their congeneries growing in the "várzea" of the rivers of black water.

In the "várzea", the larger rivers are often bordered by narrow bands of higher alluvions rarely or never flooded, called "restingas" (14); the forest, here, is in several cases a "várzea" forest with some trees of the "terra firme" forest. Trees widespread and frequent in the "várzea" of "white" rivers but unknown on the ordinary "terra firme" (with poor

(13) The pretty Melastomaceous *Rhynchanthera grandiflora*, near Manaus.

(14) In Southern Brazil (Rio, Santos etc.), restingas are old maritime beaches of white sand with black humus, covered with shrubs and small trees like some "catingas" of the Rio Negro but with other species. Akin to those maritime restingas are the "taboleiros" of the Northeast Brazilian litoral (Ceará, Pernambuco etc.).

soil) appear on "terra firme" in places where the soil is fertile; such trees are, for example, the common "sumaúma" (*Ceiba pentandra*) and the "pau mulato" (*Calycophyllum Spruceanum*). The presence of "sumaúma" on "terra firme" is reputed as indicating good soil, by the agriculturists of the country.

The lowlands of the coastal belt of the hylaea and of the great Amazon estuary are flooded by the influence of the Atlantic tide. The forest of the lowest, daily flooded land, is more closely related to the igapó; the higher land, flooded only by the spring tides, resembles the "várzea" forests of the other parts of the region. The salty or brackish alluvions of the seacoast are inhabited by a more or less cosmopolitan flora which has nothing to do with the hylaea.

Most of the so called "serras" of the States of Pará and Amazonas are hills not exceeding 150 meters in altitude and clothed with the ordinary forest flora of the neighboring country. Different from these are the "serras" of the Municipalities of Almeirim and Monte Alegre, where the ranges start a short distance from the Northern shore of the Lower Amazon and extend into the unexplored interior. I visited several of these "serras" and found in most cases the upper parts covered with rather dry forests of low or medium size trees containing a relatively high percentage of apparent endemics. The highest one is the Serra de Parauaquara which, according to the geologist HARTT, is 360 meters high. Still higher mountains, in the interior of the Brazilian hylaea, apparently exist only in the upper Rio Negro basin where the Serra do Curicuriari rises above 1,000 meters in its inaccessible peaks. Botanical explorations have been made only on a lower mountain (Cabari, a little above the town of São Gabriel) and the group of rocky hills which are known collectively as the Serras do Jacami (above Santa Izabel); the forest of their slopes does not differ from that of the neighboring country, but on the open, shrub clad tops, several endemic species grow. The mountains of the Eastern part of the Northern boundary of Brazil are botanically unexplored, with the single exception of the Serra Acaraí where the flora, as indicated by some collections made by A. C. SMITH, is that of the hylaea; those of the Territory of Rio Branco (Pacaraima, Roraima, etc.), on the other hand, have a truly extra hylaeian flora.

The factor of climate is less important than that of the soil, for the subdivision of the hylaea into local floras. The temperature of the whole region is permanently high, except in the Southernmost part where

strong and relatively cold South winds may blow sometimes in June and July, without affecting the vegetation. The local subdivisions of the hylaea, however, partly depend on the quantity of the annual rainfall and of its distribution throughout the year. Most of the region has an annual rainfall of 2300 mm or more; some parts, as the Lower Amazon between Trombetas and Xingú, and certain parts of the Tapajós and Middle Xingú, have 1500 to 2000 mm. The first category includes regions with more or less abundant precipitation during the whole year (Western part of the Solimões and its tributaries, Middle and Upper Rio Negro, and a great part of the Amazon estuary (15), and others with heavy rain in "winter" but scarce in "summer" (littoral of the State of Pará (16), Eastern half of Marajó, Northern shore of the mouth of the Amazon). In this zone, and to a somewhat lesser extent along the Lower Amazon, the action of the strong and nearly continuous wind ("vento geral") of the dry season is evident in the poorer aspect of the forest. The climate of the Western section of the Lower Amazon (from the mouth of the Trombetas upwards) and the Eastern section of the Solimões (from Manaus to Tefé) is intermediate between that of the neighboring countries above cited and is characterized by more rain (2000 to 2300 mm) and less regular seasons. In most parts of the middle and upper courses of the Northern tributaries of the Amazon, the rains are more copious and more regularly distributed throughout the year (17); in the corresponding parts of the Southern tributaries, the rain is scarce from June to August. Entirely different from the climate of all other parts of the Amazon basin is that of the savannah country of the Upper Rio Branco where 6 to 8 months of the year are dry; this country has not however a true hylaeal flora.

(15) In Belem, the mean rainfall registered at the Pará Museum from 1895 to 1915 was 2520 mm; highest rainfall in March: 387 mm; lowest in November: 66 mm; four months (January to April) had above 300 mm; three months (September to November) had below 100 mm. Later, the meteorological station of Belem was transferred from the Museum (in the city) to the suburb Marco, Northeast of the city, where the rainfall is higher (2800 mm). The rainfall is still heavier in a zone more Northeast crossing the Bragança railroad where the thunderstorms of the afternoon are much more frequent than in the city of Belem; observations made in the years 1918-1938 by Dr. F. Coutinho de Oliveira and his family at Magoari near Ananindeua gave an annual average of 3211 mm; 470 for March, 135 for November; January to May with above 300 mm; there was no month with less than 100 mm.

(16) In Clevelândia (on the Oyapoc river, boundary of Brazil with French Guiana) the main rainfall from 1914 to 1938 was 3267 mm; highest, in May, 516 mm; lowest, in October, 39 mm. In Tracuateua (near Bragança, Eastern littoral of Pará), the main rainfall was 2254 mm; highest, in April, 427 mm; lowest, in October, 6 mm. (Atlas Pluviométrico do Brasil, Departamento Nacional de Produção Mineral, Rio de Janeiro, 1948).

(17) In Taracú (Rio Uapés), the main rainfall from 1914 to 1938 was 3531 mm; highest, in May, 484 mm; lowest, in October, 198 mm. It is the highest observed in Brazilian Amazonia. (Ibidem).

Flowering and fruiting vary in the different parts of the hylaea according to the distribution of the rain throughout the year. Anywhere in the forest, mature fruits are much more copious in the rainy season ("winter") than in the dry or less pluvius "summer". The flowering of the trees of the upland forests, in localities with a long and heavy rainy season, is nearly restricted to summer; it is more abundant at the beginning and the end of this season where the summer rains are scarce. In those parts of the hylaea where the two seasons of the year are not sharply defined and often irregular (as, for example, in Manaus), floriferous and fructiferous forest trees can be found every month; in normal years, however, flowers are more abundant during the two periods of transition and chiefly in the middle of summer. In the "várzea" forest and the igapó, most plants (including the epiphytes) flower at the time of the highest waters of the year; in the non-inundable "campos", many trees flower in summer but some trees and nearly all herbs and low shrubs in winter; on the sandy "campinas", most of the ligneous plants flower at the end of the rainy season and during the dry season. Differing from the greatest part of the hylaea, the Upper Rio Negro basin has two very rainy seasons and two less rainy seasons, each year; the catingas, here, flower chiefly in October, climaxing the little summer (the longer summer, there, is in February and March). In the savannah country of the Rio Branco, flowering is almost entirely limited to the wet season.

The rain forest of the hylaea in most of the region exhibits the classic exuberance of the equatorial forests in plenitude, but the trees fail to reach the large size of some trees of the Indies and of Tropical West Africa, and much less that of the giant *Coniferae* and *Eucalyptus* of temperate climates. The mean height of the large trees which form the canopy of the forest can be estimated in about 30 to 40 meters; in some places this is greater (for example: near Gurupá, on the Lower Trombetas and in the Acre Territory); in many others, it is smaller (e. g. extensive areas of the Rio Negro basin, most of the forests along the Lower Amazon, and the hill country North of the latter). It is difficult to estimate the height of a tree in a dense forest; we measured two, of excepcional size, which were cut down: a *Dinizia excelsa* with 55 meters of total height, and a *Cedrelinga catenaeformis* with 49 meters. The *Dinizia* was the smallest of a group of several trees of the same species, South of Gurupá; its bole, at 2,5 meters above the soil, measured 1,45 meters in diameter. Another tree of the same group had a diameter of more than 2 meters, at 3 meters above the soil,

and its total height could not be estimated at less than 60 meters. HUBER, on the Middle Purús, saw a bole of *Apuleia molaris* measuring 43 meters from the base to the first branch. From these observations, we can conclude that the highest trees in Amazonia exceed 60 meters but we do not know if some may reach 70 meters. Species of trees reaching in some cases 50 meters are: *Olmediophaena maxima* (fam. *Moraceae*); *Cedrelinga catenaeformis*, *Dinizia excelsa*, *Parkia gigantocarpa*, *Mora paraensis*, *Apuleia molaris*, *Hymenolobium complicatum*, *H. petraeum*, *H. excelsum*, *Coumarouna ferrea* (*Leguminosae*); *Swietenia macrophylla* (*Meliaceae*); *Vochysia maxima* (*Vochysiaceae*); *Ceiba pentandra*, *Huberodendron ingens*, *Aguiaria excelsa* (*Bombacaceae*); *Terminalia amazonia* (*Combretaceae*); *Cariniana rubra*, *C. micrantha* (*Lecythidaceae*); *Tabebuia ipe* (*Bignoniaceae*). *Bertholletia excelsa*, the famed Brazil nut tree, may only exceptionally reach 50 meters, but its unbranched trunk (if in virgin forest) up to the small crown, may measure 3 meters in diameter, being exceeded only by some *Ceiba pentandra* and by the bole of some very old *Caryocar villosum* (which is never so high). There can be no doubt that the greatest mean height among the Amazon trees is that of *Dinizia*; in the Western half of the region where it is lacking, *Swietenia* or *Cedrelinga* may occupy the first place. Among the 30 to 40 meters high trees which form the canopy of the hylaea, *Leguminosae* are the best represented family, in number of species and of individuals. *Moraceae*, *Lecythidaceae* and *Sapotaceae* occupy the following places as to the number of the individuals of those trees, the *Moraceae* and *Sapotaceae* also in number of species; *Rosaceae* (chiefly *Parinarium*, seldom *Licania*), *Linaceae* (several *Sacoglottis* and *Vantanea*), *Meliaceae* (*Cedrela*), *Elaeocarpaceae* (various *Sloanea*), *Combretaceae* (various *Buchenavia*), *Apocynaceae* (some *Aspidosperma* and *Parahancornia*) and, in certain parts of the region, also the *Vochysiaceae*, are well represented. Among the lianas or bushropes, the largest we have ever seen was a *Bauhinia Siqueiraei* growing near Belém; the nearly cylindrical base of its stem had a diameter of 60 cm. Giant climbers are frequent in certain *Abuta*, *Dolioscarpus*, *Maripa*, *Moutabea* (one specimen, observed near Manaus, had a diameter of 34 cm) and *Salacia*, *Strychnos Erichsonii* (maximum diameter registered by KRUKOFF: 12 inches), *S. Peckii*, *S. glabra*, and *S. Froesii* (26 cm). The vines of certain *Bignoniaceae* may also reach considerable proportions.

The so called "scarcity of flowers" of the tropical rain forest is universally alleged but by no means always true, at least for the hylaea. Whoever travels in October from Santa Isabel up the Rio Negro will have a

different impression. Certainly, many trees of the interior of the virgin forest do not flower yearly but only at intervals of several or many years, and most species have inconspicuous, small, green or whitish flowers, but even so there can be no doubt that the percentage of large forest trees with showy flowers is larger in the hylaea than in extra-Amazonian Brazil (18). Most of these trees are *Leguminosae*, *Vochysiaceae* or *Bignoniaceae* with purple, pink or yellow blossoming crowns often appearing above the general canopy of the forest like giant bouquets (most noteworthy: several species of *Hymenobium*, *Coumarouna* and *Vochysia*, *Schizolobium amazonicum*, and *Tabebuia ipe*). Other Amazonian trees with beautiful flowers are: *Eperua purpurea* (19), *bijuga* and *campestris*, the magnificent, orchid-flowered *Heterostemon mimosoides* and *ellipticus*, *Elizabetha macrostachya*, *Brownea grandiceps* and *Etaballia guianensis* (*Leguminosae*); *Vantanea guianensis* (*Linaceae*); *Vochysia eximia*, *Qualea suprema*, *cyanea*, *ingens*, *pulcherrima*, *decorticans* and *Dinizii* (*Vochysiaceae*); *Cespedezia spatulata* (*Ochnaceae*); *Platonia insignis* (*Guttiferae*); *Couratari tenuicarpa* and other species, *Couroupita guianensis* and *Asteranthus brasiliensis* (*Lecythidaceae*) (20); *Couma macrocarpa* and *guianensis* (*Apocynaceae*); *Tabebuia serratifolia* and *Jacaranda copaia* (*Bignoniaceae*); *Capirona decorticans* (*Rubiaceae*). The Leguminous *Parkia pendula*, *Macrolobium acaciaefolium* and *Elizabetha princeps* and the Anacardiaceous *Anacardium Spruceanum* are remarkably ornamental through the assemblage of various characters.

It is not possible to establish phytogeographic subregions in the hylaea, because we still ignore almost completely the flora of the uplands between the navigable rivers. And even in the easily accessible parts of the country, large extensions remain quite unexplored. Furthermore, in such an immense flora, no botanist can pay equal attention to all families of plants, the more important ones generally being preferred. It is a strange fact that within the hylaea the longitude plays a far more important role than the latitude, in the composition of the flora. The difference in the floras of Belém and Santarém is much more striking than that of

(18) The subtropical mountain forests of Rio de Janeiro, São Paulo and Minas Gerais, poor in large trees in such conditions, are on the contrary very rich in small trees of beautiful blossoming species of *Melastomaceae*.

(19) The remarkable beauty of this tree, common in the upland forests and high *atingas* of the Upper Rio Negro, has already been noted by Spruce. The blossoming crowns are of such an intense purple that Indians, as related by some travelers, used to say that it is not good for the eyes to behold them!

(20) Knuth, in "Pflanzenreich", puts this plant in a new family: *Asteranthaceae*. By all characters (including fruits and wood) excepting those of the flowers, it is however a true *Lecythidaceae*.

Belém and Cayenne, though the distance of the latter is greater. The collections show a greater number of species for the Middle and Northwestern Amazonia than for the Eastern and Western part of the region; SPRUCE attributes the greatest richness of species to the country between the headwaters of the Caquetá and Guaviare. Amazonia is one of the two centers of the dispersion of the palms of the world but their distribution in this region is not uniform; the greatest number of species grows in the Western part, but in individuals the Amazon estuary is the richest. The least number of species as well as of individuals occurs in the relatively dry country of the Eastern part of the Lower Amazon. Beside the palms, the most important element of the physiognomy of the hylaeen plants are the *Leguminosae*, the largest and best studied family (846 species are now registered for the Brazilian Amazonia alone, with exclusion of the Upper Rio Branco); their greatest richness seems to correspond to the geographic area of the genus *Elizabetha* which crosses obliquely the Center of the region, from the Caquetá, the Upper Rio Negro and the mountaneous South of British Guiana and Southwest Dutch Guiana to the Middle Tapajós and Lower Madeira (with unknown Southern limits). Two hundred and six species of *Leguminosae* are registered for the neighborhood of Belém, 275 for Manaus. Other numbers, for the species belonging to well studied families or genera and registered for Belém and Manaus are: *Myristicaceae*: 6 and 25; *Vochysiaceae*: 10 and 12; *Bombacaceae*: 8 and 14; *Buchenavia*: 2 and 10; *Strychnos*: 6 and 13; *Aspidosperma*: 2 and 6. Of *Myristicaceae* and *Strychnos*, a still larger number of species however grows in the Western part of the Amazon, relatively well explored in the country of the boundaries of Brazil, Perú and Colombia. The Western hylaea is the American center of distribution of *Musaceae* and *Zingiberaceae* and the world center of that of *Marantaceae*; the contrary occurs in the distribution of *Gramineae* (except *Bambuseae*) which abound in species and individuals chiefly in the Eastern part of the hylaea. The small number of species of *Polypodiaceae* and *Cyatheaceae* is contrasting with the richness of these families in the subtropical Andes and the table mountains of Guiana. For the *Orchidaceae* no species lists are available but their frequency is higher for the Middle Amazonia and at a minimum for the Eastern part; only the species of commercial value are however sufficiently studied. *Rosaceae* *Chrysobalanoideae* have their world center in the hylaea; they are everywhere frequent, abounding in the Middle and Eastern sectors more than in the Western. *Solanaceae*, *Rubiaceae* and *Compositae* increase in number of species from

East to West; the latter are poor in species everywhere in the region but chiefly in the Eastern part.

The alluvions of the seacoast are for the greatest part mangrove, often being followed on the landward side by salty marshes ("apicuns" in Eastern Pará and Maranhão) with herbaceous vegetation (chiefly "paraturi": *Spartina brasiliensis*) and low "campos"; their flora, as well as that of the sandy beaches, is extra-hylaeal, being related to that of the Atlantic coast of all Tropical America. A brief but very good description of the maritime alluvions of the coast of the State of Pará was given by HUBER in "Mattas e Madeiras Amazonicas".

Only beyond these formations does the Atlantic sector of the hylaeal forest begin, accompanying the lower basins of the coastal rivers and covering the great Amazon estuary (21) (which reaches westwards to the lowest part of the Jari and Xingu) as well as the lower Tocantins including the rio Pará and the lower courses of its tributaries. In this sector of the hylaea, the rivers are subjected to the influence of the Atlantic tides, with mangrove formations in their lowest courses where at least in the summer months the water becomes brackish (isolated trees of *Avicennia* and *Rhizophora* are found along the Breves channels, westwards up to the Tajapurú). The upland forest of this zone, frequently of great exuberance, is remarkably homogeneous, containing a large number of species described by AUBLET from French Guiana and recently registered for the flora of Belém and even more eastward along the Bragança road or to Maranhão. The presence of many trees growing in or around the great estuary but not yet observed in the relatively well explored Guianas nor in Eastern Pará ought to be attributed to the immigration by water way, of species proceeding from the Upper or Middle Amazon. *Hevea brasiliensis* is the most notable of these species. The Brazil nut tree (*Bertholletia excelsa*) is nearly missing in this zone, except for some rare individuals growing in upland forest near Belém and along the Bragança railroad; its Eastern limit is Northwestern Maranhão, the basin of Rio Gurupi (R. L. FROES).

Among the large number of trees peculiar to this zone of the hylaea, only a few of the most representative, observed in the State of Pará, can here be cited: the monotypic genera *Euxylophora* ("pau amarelo" of Pará), *Coleostachys* and *Meliandra*; *Virola Melinonii* and *crebrinervia*, and *Iryan-*

(21) Viz: Huber, Materiais para a flora amazonica V, Bol. Mus. Goeldi III: 400 (1902), and Contribuição á geographia physica dos furos de Breves, Bol. Mus. Goeldi III: 447 (1902).

thera Sagotiana (Myristicaceae); *Parinarium Rodolphi* (22) (Rosaceae); *Parkia paraensis* and *reticulata*, *Dimorphandra glabrifolia*, *Hymenaea palustris*, *Jacqueshuberia quinquangulata*, *Ormosia Coutinhoi*, and *Vatairea paraensis* (Leguminosae); *Hortia excelsa* (Rutaceae); *Erisma juscum* and *Vochysia guianensis* (Vochysiaceae); *Sacoglottis amazonica* and *excelsa* (Linaceae); *Tapura singularis* (Dichapetalaceae); *Poraqueiba guianensis* (Icacinaceae); *Lacunaria crenata* (Quinaceae); *Loreya arborescens* (Melastomataceae); *Manilkara paraensis* and *Siqueiraei*, *Pradosia praealta*, *pedicellata* and *Huberi* (Sapotaceae); *Ladenbergia paraensis* (Rubiaceae). Noteworthy are also the big climbers *Strychnos Blackii* (of the daily overflowed swamp forest of the estuary), *Landolphia paraensis* (Apocynaceae), *Elaeophora abutifolia* (Euphorbiaceae) and *Guatteria scandens* (Anonaceae), and the pretty epiphytic shrub *Schlegelia paraensis* (Bignoniaceae). Epiphytes, in this zone, are numerous, but scarce here are the beautiful orchids so abundant in the Center and West of Amazonia (this has also been observed in Dutch Guiana). In the swamp forests of the estuary, the landscape is dominated by the various aspects of the palms along the channels, chiefly "miriti" or "buriti" (*Mauritia flexuosa*) in large stands of individuals of all ages, and, alternately, much "assai" (*Euterpe oleracea*), "jupati" (23) (*Raphia taedigera*) and "ubussu" (*Manicaria saccifera*); big leafed *Monocotyledoneae* of other families abound here. The shores are often accompanied by thickets of "aturia" (*Machaerium lunatum*) and "veronica" (*Dalbergia monetaria*) alternating with extensive formations of the tall Araceous *Montrichardia arborescens* ("aninga"); large formations of the common "ueuuba" (*Viola surinamensis*) are seen in many places. The largest trees, here, are the common "sumaúma" (*Ceiba pentandra*), the "cedrorana" (*Cedrelinga catenaeformis*) and the "pracuuba" (24) (*Mora paraensis*); the latter occurs also in the State of Amazonas but only rarely. Some widespread Dicotyledoneous plants proper to deeply flooded river banks are, in the hylaea, limited strictly to the coastal belt; for example: *Inga Bourgoni*, *Pithecolobium Huberi*, *Derris latifolia*, *Derris moniliformis*, and *Hippocratea (Hylenaea) comosa* (the "fava de arara" — not to be confused with the "castanha de arara" which is the Euphorbiaceous tree *Joannesia*

(22) Several authors prefer the name *P. montanum* Aubl. which however is a "mixtum compositum" of leaves from *P. Rodolphi* Huber and an endocarp from *P. pajura* R. Ben. (= *P. montanum* Huber).

(23) In the State of Amazonas where *Raphia* does not grow, "jupati" is the small forest palm *Iriartella setigera*.

(24) Not to be confused with other trees of identical common name growing in other parts of Amazonia.

heveoides); the abundant and characteristic "aturia" (*Machaerium lunatum*) of the first line of the vegetation along the banks accompanies the Atlantic tides up the Amazon to Monte Alegre. All these species grow in fresh and slightly brackish water.

Open savannahs ("campos" in Brazil) are numerous in the Atlantic zone, many of them between the hylaea forest and the sea coast. The most extended ones lie in the Eastern half of the island of Marajó and in the Territory of Amapá. As above stated, these savannahs have an extra-hylaeal flora, well studied in Brazil (Marajó) by HUBER, and in Dutch Guiana by PULLE and his eminent pupils. Characteristic for many of these savannahs is the widespread "mangabeira" (*Hancornia speciosa*), well known for its savoury fruits. This tree is frequent in the unflooded "campos" of Marajó, Macapá and Maracanã, reaching westward up the Amazon to Arraiolos (West of the Lower Jari), and along the Lower Tocantins. It reappears in the Southern part of the Amazon country, in the small "campos" near the rapids of Mangabal of the Middle Tapajós and in the "campos" of Humaitá on the Rio Madeira (25). It is distributed throughout two areas where it grows exclusively in summerdry forests of low trees or savannahs with scattered small trees ("agreste", "cerrado", "tabuleiros", "restingas", "chapadas", "campos"), never occurring in rain forests. The larger area is found in the middle of the continent, extending South-North, from the subtropics of Southern Brazil, Paraguay, Northern Argentina and perhaps Southeastern Bolivia through Mato Grosso and Goiás to the South of the States of Amazonas and Pará (cf. supra); the Eastern limit of this area is in the Center or West of the States of Paraná, São Paulo, Minas Gerais, Bahia and Pernambuco, the South of Ceará and Piauí, and the Center, South and Southwest of Maranhão. The second area, forming a narrow and often widely interrupted zone, accompanies the sea coast from Bahia to Dutch Guiana (viz: PULLE, Flora of Suriname) entering quite far into Pará along both sides of the mouth of the Amazon and Tocantins. The "campinas" of white sand with black humus which are found in widely separated spots through this zone, have a distinct but irrefutably hylaeal flora; a special chapter will later be devoted to this subject.

It has already been said that the great estuary of the Amazon and Tocantins does not interrupt the relative homogeneity of the hylaeal

(25) Many people believe the "mangabeira" has been brought by the ancient Indians from Mato Grosso where in the "cerrado" it is common. But equally isolated in these campos and never observed in the surrounding rain forest, rattlesnakes occur which surely have not been introduced deliberately.

flora from Maranhão to the Guianas. The valley of the Lower Amazon however divides the Northeast and the Southeast of the hylaea in two rather distinct floras. The Northeast is the hill country of the middle and upper courses of the coastal rivers of the Atlantic drainage between the Amazon and Essequibo, as well as of the basin of the latter (with exclusion of the high Southwest) and of the tributaries of the Lower Amazon, westward to the Eastern side of the wide basin of the Trombetas. It is the most heterogeneous part of all the hylaea, the high rain forests here being to a great extent substituted by summer — dry forests of lower trees, shrubland or more or less open “campos” resembling the “cerrado” of Central Brazil. The best explored part is in British Guiana; in Brazil, larger botanical collections have been made in some parts of the Trombetas basin, in the country Northeast of Obidos, and on the low “serras” North of the Amazon river from Monte Alegre to Almeirim. In this sector the Brazil nut (*Bertholletia excelsa*) reaches its Northeastern limit. Of the numerous plants which seem to be peculiar to this part of the hylaea, only a few collected in Brazil may be cited here: *Zamia Lecointei* (Cycadaceae), *Cynometra longifolia*, *Tachigalia grandiflora*, *Swartzia Duckei* and *Ormosia cuneata* (Leguminosae), *Cusparia trombetensis* (Rutaceae), *Vochysia mapuerae* (Vochysiaceae), *Bonnetia Dinizii* (Theaceae), *Lacunaria Sampaioi* (Quiinaceae), *Lophostoma Dinizii* (Thymelaeaceae), *Ctenardisia speciosa* (Myrsinaceae), *Mostuea brasiliensis* (Loganiaceae), *Ferdinandusa scandens* (Rubiaceae), all hitherto collected only in the Trombetas basin; *Caesalpinia paraensis* (Leguminosae) and *Ferdinandusa nitida* in Monte Alegre; *Macaírea viscosa* (Melastomataceae), *Buchenavia corrugata* (Combretaceae) and *Ferdinandusa cordata* on the hills West of Almeirim. A very characteristic tree of dry hills from Monte Alegre to the interior of Macapá is *Peltogyne paradoxa*. *Passiflora longiracemosa*, *Pouteria speciosa* and *Lepidocordia punctata* (monotypic genus of Borraginaceae) were observed in Southern British Guiana and also North of Obidos or on the Trombetas. In the Northwest, this flora does not reach the upper Rio Branco as the senior author formerly thought.

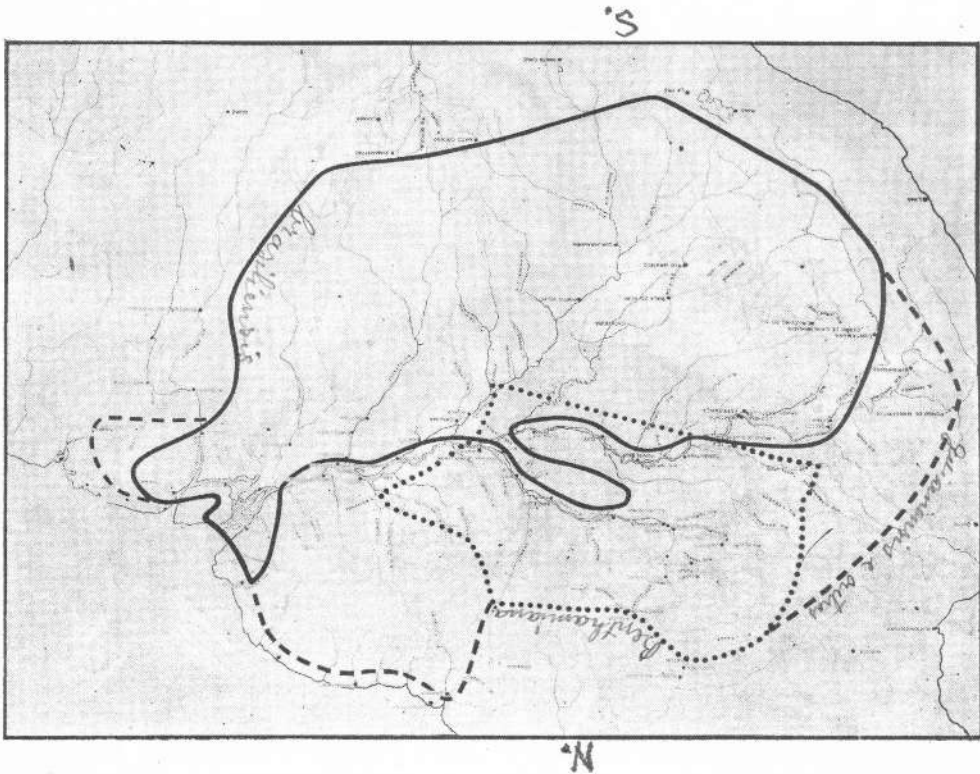
The Northeastern hylaea presents large extensions of “campos”, with grasses and other herbs and dispersed trees or sometimes rather densely covered with shrubs (“campos cobertos”); a transition between the latter and the true forest is often called “campina-rana”. In the hill “campos” of Monte Alegre, strips or spots (“ilhas”) of forest often deciduous in the dry season, contain many species possibly endemic or at least not

yet observed in other localities; like the true "campos", these forests are also foreign to the hylaea flora.

The Southeastern hylaea included the basin of the Tocantins from the uplands along the Southern half of the lower course up to Marabá or perhaps to the confluence of the Araguaia; more observations are needed to decide this point, chiefly as to the question of the Southern limit of the area of *Hevea guianensis*. Nothing is known of the flora from the upper courses of the smaller tributaries of the Pará estuary both sides of the lower Tocantins and of that of the headwaters of the Gurupi; the presence of *Bertholletia* in the upper basin of the latter has been duly verified, and of mahogany (*Swietenia macrophylla*) in the upper Capim and Guamá (R. L. FROES). Nothing is known of possible affinities of the flora of the Tocantins with that of the Xingu nor of the flora of the plateaux of low altitude, covered with exuberant rain forests. Due to the greater uniformity of the country, the flora, here, may not be so rich in species as the flora of the Northeastern hylaea; it may be richer in botanical "novelties" because has been less explored.

The forest of the uplands accompanying the middle Tocantins abounds in *Bertholletia*, and FROES discovered *Swietenia* in many places here. Characteristic trees are *Cenostigma tocaninum*, *Bombax tocaninum* and *Bauhinia bombaciflora* whose flowers are the largest of this genus. *Discolobium tocaninum* grows in the water between the rapids. A relative poverty of species is evident on the banks of the Middle Tocantins, when compared with the rich flora of the banks of the Middle Tapajós or Rio Negro; besides the smaller number of ligneous species, there is also a remarkable lack of epiphytes, orchids for example. Very curious is the presence, on the uplands of the Middle Tocantins, of *Strychnos Melinoniana*, known only from the distant Northeastern hylaea, and of *S. solimoesana* of the Solimões (both collected by R. L. FROES). Elements of Central Brazilian origin such as *Martiusia parvifolia*, frequent around Marabá (R. L. FROES), and *Parkia platycephala* ("campina" of Breu Branco near the lower rapids of the river) are noteworthy. *Calliandra tocanina*, *Calliandra falcifera* and the pretty Melastomaceous *Microlicia paraensis* of the sandy "campina" of Arumateua (near the lowest rapids), not yet observed elsewhere, may all be of similar origin.

The flora of the middle and upper Xingu basins is practically unknown. The upland country between Vitoria and Altamira where the senior author made two very rapid botanical trips, is covered with great



DISTRIBUTION OF THE GENUS HEVEA

- Bounding area of *Hevea brasiliensis*
- Bounding area of *Hevea Benthamiana*
- - - - Bounding area of the genus *Hevea* composed of species other than *Hevea brasiliensis* and *H. Benthamiana*

rain forests; *Pithecolobium macrocalyx*, *Bombax macrocalyx* and *Matisia bicolor* were collected there and possibly endemic. From Providência on the Xingu came the samples of *Strychnos xinguensis* of the Pará Museum. Most of the forest trees observed in the above mentioned country belong to species also growing near Belém and on the Tocantins, fewer belong to species lacking there but growing on the Tapajós.

The Northeastern and Southeastern hylaea contains the Western limits of many species common throughout the Atlantic zone. *Vouacapoua americana*, the famed "acapu" of Pará, reaches westwards to the Eastern

half of the Trombetas basin (Rio Acapu) and to the small Curuá river West of the Xingu; *Tabebuia ipe*, the "pau d'arco roxo", to the Middle Xingu and to the small Rio Branco Northeast of Obidos. This town is 9 kilometers East of the mouth of the Trombetas has a flora, which, though for the greater part consists of elements common throughout the Eastern Amazonia, also has various species of the Rio Negro flora.

The Northern hylaea comprises the great basin of the Rio Negro except the Upper Rio Branco, the basin of the Upper Orinoco (including the region of the "raudaes"), the basin of the Lower and Middle Japurá or Caquetá (at least the Eastern part), and the Western part of the wide Trombetas basin. The flora of Southwestern British Guiana is related to it. Large extensions of the Northern part of the country lie out of the limits of Brazil. Botanical material has been brought together by several collectors among whom most notable was SPRUCE whose work in the upper Rio Negro and Upper Orinoco has not yet been equaled.

In this country, the hylaea flora reaches the climax in number of genera, species and endemisms. The trees, here, are generally not so large, the leaves are smaller and darker, the flowers more frequently showy than in the other parts of the hylaea. These characteristics are most accentuated along the rapids of certain tributaries of the Upper Rio Negro, as for example, the Uaupés and the Curicuriari (26). The most dominant families among the woody plants are the *Leguminosae*, followed by the *Rosaceae*, *Chrysobalanaceae*, *Vochysiaceae*, *Sapotaceae*, *Euphorbiaceae*, *Guttiferae* and *Linaceae*. The *Leguminosae Caesalpinioideae* have here one of their two centers of distribution in the world (the other being the equatorial West Africa); most outstanding are the numerous endemic species of the beautiful genera *Dimorphandra*, *Peltogyne*, *Eperua*, *Heterostemon* and *Elizabetha*; the genera *Dicorynia* and *Aldina* represented by very numerous individuals; the genera *Macrolobium* and *Swartzia* having here their principal centers, with many endemic species. Noteworthy also are *Jacqueshuberia purpurea* and *Vouacapoua pallidior* representing two small characteristically hylaeal genera. Of the other *Leguminosae*, the best represented are the *Sophoreae* with many genera having here their principal center and with numerous endemic species; most noteworthy are the two species of *Monopteryx* (both known as "uacu")

(26) Viz: Ducke, Flora do Curicuriari, An. 1.^a Reun. Sulamer. Bot. 3: 389 (1938).

and the monotypic genera *Panurea* and *Petaladenium*. Of the very large number of noteworthy plants of other families only a few, growing within the limits of Brazil, may be cited here. *Gnetaceae*: *Gnetum paniculatum*, frequent on the flooded banks of Rio Negro (and Essequibo). *Rapateaceae*: one of the two centers lies in the catingas of the upper Rio Negro basin, with several endemisms (the other, which is by far the greatest, is on the arenitic plateaux and table mountains beyond the Northern limit of the hylaea). *Palmae*: "piassaba" (*Leopoldinia piassaba*), "jará assu" (*Leopoldinia maior*), "caraná assu" (*Mauritia carana*) and "caraná" (*Mauritiella aculeata*). *Orchidaceae*: a greater number of species with ornamental flowers than in any other part of the hylaea; most remarkable: *Cattleya eldorado*, common in the Lower Rio Negro, chiefly in "campinas". *Proteaceae*: better represented here than in any other part of the hylaea. *Oleaceae*: *Chaunochiton loranthoides*, with flowers resembling the Loranthaceous genus *Psittacanthus*. *Myristicaceae*: the Rio Negro basin together with the Solimões are the principal center of dispersion of this family in the Americas. *Rosaceae*: a large number of *Licania*, many *Couepia* and *Hirtella*, and several *Parinarium*, on sandy beaches often with numerous individuals. *Linaceae*: more abundant than in any other part of the hylaea in species and individuals, in all kinds of forest, with many endemics. *Rutaceae*: several endemics with the most remarkable *Nycticalanthus speciosus*. *Malpighiaceae*: more arboreous species exist here than in the other parts of the hylaea. *Vochysiaceae*: this beautiful family, well represented in species and individuals throughout the hylaea except the "várzea" of the Lower Amazon, has its most important center in the Western part of the upper Rio Negro basin where SPRUCE collected numerous species on the Uaupés, and the senior author twenty-one on the Curicuriari (a small river South of the latter). *Trigoniaceae*: *Euphronia licaniodes*, one of the rare trees of this family. *Euphorbiaceae*: several genera and many species apparently endemic, most remarkable being *Hevea microphylla* (27) and *Hevea rigidifolia*. *Cyrillaceae*: the monotypic *Cyrillopsis paraensis* from Rio Negro, Nhamundá and Trombetas; *Cyrilla racemiflora* having its Southern limit on the Curicuriari, the only place South of the equator where this specie of Northern origin was found (28). *Anacardiaceae*:

(27) Synonym: *H. minor* Hubei, not Hemsley.

(28) The Northern limit is in Virginia.

Anacardium parvifolium and *A. negrense*, both endemic in the Rio Negro basin and noteworthy for important characters. *Tiliaceae*: various *Mollia* and the pretty *Lueheopsis althaeiflora*. *Elaeocarpaceae*: the Rio Negro is the greatest center for *Sloanea*, here represented in all types of forest by numerous species of all sizes from treelets to large trees and including many undescribed species. *Bombacaceae*: very well represented by trees of all size and in all forest types. Most remarkable is the "duraque", *Aguiaria* (29) *excelsa*, the highest tree of the forest along the rapids of the upper Rio Negro, with fruits adapted for dissemination by wind and water. *Ochnaceae*: the pretty genera *Blastemanthus* and others, and numerous *Ouratea*. *Guttiferae*: abundant in apparently endemic species; most noteworthy is the monotypic *Lorostemon*, collected near Manaus and in British Guiana. *Lecythidaceae*: perhaps less important here than in the other parts of the hylaea. Remarkable is the famed and beautiful *Asteranthus brasiliensis* of swamp forests from Santa Isabel upwards, first collected by ALEXANDRE RODRIGUES FERREIRA in the 18th century, then by SPRUCE in the middle of the 19th century, and recently by FROES and DUCKE. *Combretaceae*: numerous *Buchenavia* having here their chief center, and the genus *Ramatuella*, limited to the Upper Rio Negro. *Melastomataceae*: better represented in the upper Rio Negro basin than in any other part of the hylaea. *Ericaceae* (including the *Vacciniaceae*, not so easily acceptable as a separate family, for a field botanist!): *Psammisia leucostoma* is frequent in the catingas of the Upper Rio Negro; *Leucothoe Duckei*, observed only on the sandy "campinas" on the Eastern side of Lago de Faro (the wide mouth of the Rio Nhamundá) where the widespread *Gaylussacia amazonica* also grows (it also occurs on "campinas" in the Middle Trombetas and Middle Tapajós). *Sapotaceae*: though a very important element of the whole hylaeal flora, it seems that the part of the region discussed here is still richer than the others; most noteworthy are various species of *Pradosia* and the "ucuqui" (*Pouteria ucuqui*), one of the largest trees of the upper Rio Negro which is also present on certain places of the Upper Solimões and which has fruits appreciated by the indians. *Loganiaceae*: numerous *Strychnos*, most of them also occurring in the chief center (Upper Solimões and tributaries) but with four species collected only in the proximity of Manaus

(29) In honor of the late Comandante Braz Dias de Aguiar, head of the Brazilian Boundary Commission.

(*macrophylla*, *Krukoffiana*, *Froesii* and *pachycarpa*). *Verbenaceae*: *Vitex spongiocarpa* and *V. calothyrsa*, both remarkable for their fruits with spongi-ous mesocarp, adapted to dispersion by water. *Rubiaceae*: more numerous than in the Eastern hylaea, but less than in the Western. Noteworthy are: the genus *Henriquezia*, beautiful trees highly characteristic of the landscape when in bloom, frequent on the whole Rio Negro; two of the three species of the interesting genus *Gleasonia* (whose third grows only on Mount Duida, Venezuela); the monotypic *Dendrosipanea*; most *Retiniphyllum*. *Compositae*: relatively poor in genera and species, as in the whole hylaea; most noteworthy is the beautiful crimson flowered *Stiffia uniflora*, observed in only one plant near Santa Izabel, Rio Negro. Family uncertain: the monotypic *Peridiscus lucidus* of the Rio Negro.

The great variety of the flora of the Rio Negro and the neighboring rivers is probably related to the variability of the ecological conditions, greater here than in any other part of the hylaea. Here one encounters the highest mountains, such as the Serra Curicuriari which rises above 1.000 meters, but the flora of these mountains still remains unexplored. On their base as well as on the slopes of the low "Serras do Jacami" above Santa Izabel, the forest abounds in trees of the ornamental *Elizabetha princeps*. The rocky tops of these and other low "serras" are covered with a shrubby vegetation containing many *Clusia*, *Bromeliaceae*, orchids (*Sobralia liliastrum* in abundance, *Epistephium Duckei* frequent on humus, and many epiphytic species including the beautiful and rare *Catasetum pileatum*) and a few apparently endemic dicotyledoneous plants.

The flora of the middle course of the Caquetá (Japurá in Brazil) (30) where MARTIUS gathered the most important of his Amazonian collections, is related to that of the upper Rio Negro basin, though containing many species of its own. Most interesting here is the Cerro de la Pedrera ("Cupati", in Martius' time), a lonely hill of about 360 meters rising from the lowest rapid of the river. It was first explored by MARTIUS, and later visited by others (including DUCKE in 1912). Its slopes are covered with trees like those of similar places in the Rio Negro country; the rocky and sandy summit has a catinga-like vegetation with many apparent endemics, among

(30) In Martius' time, the provisory limit between the possessions of Spain and Portugal was the fall of Araraquara.

the most notable being *Zamia cupatiensis*, *Cephalocarpus dracaenula* and *Oenocarpus circumtextus*. In the forest along the rocky banks of the rapids there grow two handsome *Leguminosae*: *Elizabetha Duckei* from whose crimson colored vegetative buds an intensely sweet liquid drops down, and the pretty *Brownea longipedicellata*, both never observed elsewhere. The country between the middle Caquetá and the upper Uaupés (in Southeastern Colombia) has recently been visited by R. E. SCHULTES and several Colombian botanists, but only a small part of the results has till now been published.

Highly remarkable for the flora of the Rio Negro basin are the extensive formations known as "catínga", a popular name which is principally used for the deciduous forests of the dry Northeast of Brazil, not existing however the slightest affinity between the two formations (31). The most characteristic Amazonian "catínga" is that of the Middle and Upper Rio Negro basin, most extensive in the Western part of the latter which includes the rivers Curicuriari, Uaupés and Issana; away from the Rio Negro, the only place in the hylaea where a similar formation has been observed is São Paulo de Olivença on the Solimões river. The Amazonian "catínga" grows on upland soil of silica with black and very acid humus, in regions with heavy rain throughout the whole year; in certain places it is composed of low trees and shrubs with tall trees scattered here and there; in others it is formed by shrubs and very low trees of nearly uniform height. Nearly all woody plants, here, have persistent foliage and many have showy flowers. Many "catíngas", at least the more shrubby ones, in certain seasons have a poor appearance, but, when abundantly flowering (on the Rio Negro, usually in October), that of a beautiful park. The variety of species in these "catíngas" exceeds that of any other formation in any part of the hylaea. Among the large number of species apparently limited to the true "catíngas" of the upper Rio Negro basin, some of the most noteworthy, observed within Brazilian territory, may here be cited: *Rapateaceae*: of several genera and species and with abundance of individuals, chiefly on marshy ground. *Myristicaceae*: *Virola parvifolia* and *Compsonaura debilis*. *Leguminosae*: *Pithecolobium leucophyllum*, many *Macrolobium*, *Dicymbopsis Froesii*, *Eperua leucantha*, *Pellogyne catíngae*, *Tachigalia rigida*, *Aldina dis-*

(31) In fact, the main region of catíngas, situated along the Uaupés, has the heaviest known rainfall for the whole Amazon.

color, *Monopteryx angustifolia*, *Panurea longifolia*, *Hymenolobium nitidum*. *Linaceae*: *Sacoglottis heterocarpa*. *Vochysiaceae*: *Vochysia cattingae*. *Euphorbiaceae*: *Hevea rigidifolia*. *Icacinaceae*: *Pleurisanthes simpliciflora*. *Bombacaceae*: *Scleronema Spruceanum*. *Caryocaraceae*: *Anthodiscus obovatus*. *Quinaceae*: *Froesia tricarpa*. *Melastomataceae*: *Loricalepis Duckei*. *Apocynaceae*: *Couma cattingae* and *Neocouma ternstroemiacea*. *Rubiaceae*: *Platycarpum negrense*, *Calycophyllum obovatum*, *Gleasonia uaupensis*, various *Retiniphyllum* and *Pagamea*. A large number of other plants grows on river banks bordered by "cattinga", the most remarkable being the *Vochysiaceae* here represented by numerous species of *Vochysia*, *Qualea* and *Erisma*, nearly all with showy and some with magnificent flowers. The numerous arboreal *Linaceae* and the arboreal Trigoniceous *Euphronia licanioides* are also of special interest.

Certain species proper to the "cattinga" occur in the Rio Negro as well as in the Solimões (near S. Paulo de Olivença); for example *Iryanthera obovata*, *Hevea pauciflora* var. *coriacea*, *Lissocarpa Benthami* and *Ladenbergia amazonensis*. On the other hand, a larger number of vicariant species have been encountered in the two "cattinga" regions. Almost all larger trees of the "cattinga" also grow in virgin rain forests of the vicinity.

The Amazonian "cattinga" has no close affinity with any other type of forest, and much less with the open grass and shrub clad "campos". The only formation having any relationship with it is that of the "campinas" with sandy soil and black humus, scattered here and there throughout rain forests and "cattingas". Many shrubs and low trees of the "cattinga" also grow on the periphery of such "campinas", chiefly those of the Lower Rio Negro; there is however a striking difference, evidenced by the scarcity of *Rosaceae* and of epiphytic orchids in the "cattinga", contrasting with the frequency of the former and the extreme abundance of the latter on the "campinas" (if not burned!). *Strychnos* seems to be absent from both "cattinga" and "campinas". Certain "restingas" of the sea coast of Rio de Janeiro and Santos (not to be confused with the "restingas" of the Amazonian "várzea") have a superficial resemblance to the Amazonian "cattinga", but nearly all the species are different. An excellent detailed description of the "cattingas" of the Upper Rio Negro was given by SPRUCE in his "Notes of a botanist on the Amazon and Andes".

The Southern hylaea includes the whole basin of the Tapajós and that of the Madeira with the exception of the extreme South of the latter and the Andine Southwest. The basins of the Purus (at least up to the mouth

of the Acre) and the small Southern tributaries of the Solimões up to the Rio Tefé might be better attributed to this part of the hylaea rather than to the Western part; their flora however is very insufficiently known. Most typical for this part of the hylaea is, according to our present knowledge, the flora of the Tapajós and of the Eastern tributaries of the Madeira. The "várzeas" of the Lower and Middle Purus have a flora related to that of the "várzea" of the Amazon river, but *Salix* is lacking here.

The Southern hylaea seems to approach the Northern hylaea in richness of species and beauty of flowers. Here, larger collections were made by KRUKOFF near Três Casas and on the Rio Livramento in the lower Madeira basin; by DUCKE around Borba and Maués and chiefly on the Middle Tapajós, as well as on the uplands South of Parintins and Juruti Velho; by BLACK and others in the Ford estates of Boa Vista and Belterra on the Lower Tapajós. On the banks of the latter, the flora resembles that of the corresponding part of the Rio Negro and Nhamundá but is very inferior in number of species; among the many low trees with small dark leaves, we note the absence of the numerous *Vochysiaceae*, *Ochnaceae* and *Guttiferae* with flowers which embellish the banks of the Lower Rio Negro. On the Middle Tapajós, chiefly near the rapids, the flora is much richer. Of the many plants apparently endemic in the Middle South of the hylaea, only a few of the most noteworthy may here be cited: the handsome palm *Euterpe longispathacea* of the hills of the Middle Tapajós; the only Magnoliaceous of the hylaea, *Talauma amazonica*, discovered in a swamp forest near the Middle Tapajós; the *Leguminosae*: *Eperua oleifera*, *E. campestris*, *Palovea brasiliensis*, *Elizabetha paraensis*, *E. bicolor*, *E. durissima* and *Coumarouna speciosa*; the beautiful Malpighiaceae tree *Lophanthera lactescens* of the Middle Tapajós; the largest Polygalaceous of the world, *Polygala scleroxylon*, a tree with very hard and heavy wood, of the Lower Madeira; the *Vochysiaceae*: *Qualea homosepala* and *Vochysia assua*, both of the high upland Southeast of Parintins; the dwarf "seringueira" *Hevea camporum* of the hill "campos" of the Upper Marmelos; the "castanha de arara" *Joannesia heveoides* from Tapajós, Parintins, etc.; the monotypic Celastraceous *Goniodiscus elaeospermus*, from Maués; the enormous *Huberodendron ingens* (fam. *Bombacaceae*), from the high upland Southeast of Parintins; the Quiinaceous *Lacunaria grandiflora*, from the Middle Tapajós and Madeira; the large Sapotaceous *Manilkara excelsa* of the rapids of the Tapajós; *Duckeodendron cestroides*, akin to the *Solanaceae* but a large forest tree with hard wood, spread from the Middle Tapajós

to the Lower Madeira; the monotypic *Rubiaceae* trees *Parachimarrhis breviloba* (from Tapajós) and *Dialypetalanthus fuscescens*, the only genus in this family having dialypetalous flowers (from Tapajós and Madeira); *Polygonanthus amazonicus*, from Maués, still dubious as to its affinities. A monotypic Olacaceous *Curupira tejeensis* was recently discovered by the junior author near Tefé on the supposed boundary between the Middle and the Western part of the Amazon.

The two following trees may be registered as very characteristic elements of the landscape in most parts of the Southern hylaea, though somewhat passing its limits (in the sense of the present study). The first one, *Physocalymma scaberrimum*, is a Lythraceous tree with showy purple flowers, common from the Tapajós through the Madeira and Purus basins to Coari on the Southern shore of the Lower Solimões; crossing the mouth of the Rio Negro, it reappears in certain places near Manaus. *Martiusia elata*, a large Leguminous tree with golden flowers and large deep red pods, is frequent in many places along the rivers Tapajós, Madeira and Purus; in the basin of the latter it reaches the Territory of Acre.

Zollernia paraensis (the "pau santo" of Pará), *Theobroma grandiflorum* ("cupuassú") and *Cordia Goeldiana* ("freijó" of Pará), all three well known in Eastern Pará and Northwestern Maranhão, reach the Tapajós but are lacking North of the Amazon River. Other species, widely distributed over the West of the hylaea, reach their Eastern limit on the Middle Tapajós: for example, *Theobroma microcarpum* and the beautiful swamp palm *Iriassæa ventricosa* ("pachiuba barriguda").

A large number of plants are common to the floras of the Northern and Southern hylaea; they are found at a distance of several to many kilometers North and South of the great river but never grow in the "várzea" of that river nor on the narrow upland zones accompanying its shores. Best known are the linalol yielding "pau rosa" (*Aniba Duckei*) and the medicinal "puchuri" (*Licaria puchury maior*). Other interesting species occurring North and South of the Middle Amazon (32) are: the "ubussu" palm classified in two species or varieties of *Manicaria*, from Trombetas, Rio Negro and Japurá in its Northern area, and from Maués and the Lower Purus in its Southern area; the curious and rare Olacaceous *Brachynema ramiflorum* (hill country of Middle Tapajós and Trombetas); the

(32) Western part of the Lower Amazon and Eastern part of the Upper Amazon (Solimões), in the sense of the commonly accepted division of the Amazon plain in only two parts (not acceptable for botanical studies!).

Anonaceous *Duguetia* (*Geanthemum*) *flagellaris* flowering from subterraneous branches, of Trombetas and Rio Negro in the North and Juruti Velho in the South; the Leguminosae *Recordoxylon amazonicum* (one of the largest trees of the Middle Rio Negro and Middle Madeira) and *Uleanthus erythrinoides*, the latter with flowers whose petals are rose or blue from the beginning, observed along rapids of the Middle Tapajós and Rio Marmelos on the South and the Rio Urubu on the North; the palm-like Rutaceous *Sohnreyia excelsa* with a height of 20 meters, which dies after fructifying only once, spreading over the uplands from Manaus to the Lower Trombetas, and, South of the Amazon, from Juruti Velho and Maués to Northern Mato Grosso and the Guaporé Territory; the ichthyotoxic Ochnaceous *Wallacea insignis* (basins of Rio Negro and Urubu, and of Tapajós and Madeira, along rapids); *Strophocactus Wittii*, a cactus climbing like *Vanilla* on boles of trees or humid rocks (basin of the Rio Negro and Middle Purus); the large Rhizophoraceous *Sterigmapetalum obovatum* (Manaus, Madeira and Tapajós); the Apocynaceous *Couma utilis* ("sorva pequena"), with edible fruits, widely spread over both sides of the Middle Amazon. Of special interest is the presence, in swamp forest bordering the shrub clad Campo Grande near Borba (Lower Madeira), of the Rubiaceous *Platycarpum orenocense*, a tree formerly observed only on the savannahs of Maypures near the cataracts of the Orinoco.

Several species widely distributed over the Eastern hylaea reach their Western limits in the Middle of the region. The common "assai" of Pará, *Euterpe oleracea*, in spontaneous growth, only reaches Obidos on the Northern side, but on the Southern side it attains the hinterland of Parintins. The giant Leguminous *Dinizia excelsa* and the biggest of all species of "massaranduba", *Manilkara Huberi*, reach the Rio Negro and the Madeira; another giant Leguminous, *Hymenolobium excelsum*, the Nhamundá and Parintins. A great number of species coming from Western Amazonia seem to reach their Eastern limit here, because a larger number of the species growing in the vicinity of Manaus has been observed near Iquitos, than that of Belém. Several species have been observed in the Middle or Western parts of the hylaea and also in the Amazon estuary, but not yet in the intermediate country: *Macrolobium brevense* and *Matisia paraensis*, at the mouth of the Javari and in the Pará estuary; *Macrolobium Huberianum* and *Sclerolobium Goeldianum*, on the Trombetas and Rio Negro, respectively, and both together on the Rio Capim (near Belém). *Poupartia amazonica*, an Anacardiaceous tree collected at a few localities in the Guaporé Territory

and East of the Lower Trombetas, is frequent on several places of the mouths of the Amazon.

The Northern half of the Amazonian flora, excepting the coastal belt with its great estuary, is separated from the Southern half by a wide band of lowland ("várzea") periodically flooded by the Amazon river and having its own flora. The Eastern part of that zone (from the mouth of the Rio Negro to that of the Xingu where the estuary of the great river begins) is generally designated by the name "baixo Amazonas" (Lower Amazon); the Western part belongs to the Lower Solimões (Upper Amazon). The Eastern half of the Baixo Amazonas is in the State of Pará and is characterized by the presence of large tracts of "campos da várzea", grasslands covered by the yearly "enchente" (overflowing of the river); here, the rainfall is less than in any other part of the hylaea and the summer is much drier, with strong daily East winds. An accentuated reduction in the number of the species as well as in the size of the trees and lianas is here observed in all kinds of forest, and readily attributable to the factors of the climate mentioned above; due to the same factors, a similar reduction is also observed in many places of the first layer of the upland forest which accompanies the margin of the great river. In the upper part of the Lower Amazon (belonging to the State of Amazonas), as well as on the Solimões, no natural "campos" exist; the summer drought is often interrupted by thunderstorms and the wind is not so strong. Here, the aspect of the vegetation is more vigorous.

The "várzea" forest, in the entire Amazon valley, is not so rich in species of trees as is the forest of the "terra firme". On the Upper Amazon it is richer than on the Lower Amazon, but a very great percentage of species is common to the whole "várzea" from the State of Pará to Eastern Peru. In all the "várzea" forests, the largest tree is the common "sumaúma" (*Ceiba pentandra*); *Olmediophaena maxima*, the "muiratinga" (or "capinuri", on the Upper Solimões) often equals the sumaúma in height. Trees of large size and very common at least in the Eastern and middle parts of this "várzea" are "munguba" (*Bombax munguba*), "tacacazeiro" (*Sterculia elata*), "pau mulato" (*Calycophyllum Spruceanum*), "castanha de macaco" (*Couroupita subsessilis*), "paricá grande" (*Pithecolobium niopoides*) and several species of *Ficus*; somewhat smaller, "piranheira" (*Piranhea trifoliata*), "taperebá" (*Spondias mombin*), "pracuuba" (*Lecointea amazonica*), "macacaúba" (*Platymiscium Ulei*), "ucuuba branca" (*Virola surinamensis*), "andiroba" (*Carapa guianensis*), "parapará" (*Cordia tetrandra*) and "mu-

tamba" (*Guazuma ulmifolia*); the very common "tachizeiro" (*Triplaris surinamensis*) and "marimari grande" (*Cassia grandis*) call the attention to the traveler when covered with flowers at the beginning of the dry season. The low river banks are often occupied by *Cecropia* ("imbaúba") of several species, sometimes in nearly pure stands; here is often common the widespread *Muntingia calabura*. The only species of *Hevea* growing in the "várzea" between the Rio Negro and Xingu is the "seringueira barriguda", *Hevea Spruceana*, common chiefly on swampy and deeply inundable shores or mouths of lakes; it accompanies the Amazon from the confluence of the Içá down to the Rio Maracá in the Amapá Territory. *Bombax* (*Pachira Spruceanum*) is noteworthy for its flowers which seem to be the largest observed on Amazon trees; this tree, often confused with *B. (P.) insignis*, is also widely spread in the Rio Negro basin. In thickets on very low places of the "várzea" forest of the Solimões and Madeira grows *Crescentia amazonica*, closely related to the common, cultivated *C. cujete* and perhaps its native form. On sandy beaches of the Amazon river (not of other rivers!), *Salix Humboldtiana* var. *Martiana* appears in groups or rows and is recognizable at a large distance by its light green foliage, a shade not seen here on other trees. The *Vochysiaceae* seem to be absent in the "várzea" forest of the Lower Amazon, a fact which is curious because this family is well represented in the "várzea" of the Upper Amazon and of all tributaries of the great river, as well as on the uplands accompanying it. The flora of these narrow upland zones is not very different from that of the interior North or South, but is decidedly poorer in species and always of lower growth and with more numerous deciduous trees. This may possibly be related with the drought and the strong wind of the summer (33).

Most conditions of the "várzea" of the Amazon are repeated approximately in the tributaries with "white" (muddy) water, the most important being the Madeira. There is, however, one striking exception: the absence of the willow *Salix Humboldtiana* var. *Martiana*, here replaced by the Euphorbiaceous *Alchornea castaneifolia* and the small *Compositae* tree *Tessaria integrifolia*, all three having the same common name "oeirana";

(33) Summer rains, in all of the Lower Amazon known, are more frequent in the interior of the country, even at short distances from the Great River, than in its immediate vicinity. For example: Monte Alegre and Colonia Itauajuri; Santarém and Piquiatuba; Óbidos and the extinct Colonia Curuçambá; Parintins and the uplands South of the Paran do Ramos. This appears most striking in Óbidos where rain is rare in October and November, while it is rather frequent about six kilometers North of the town and very frequent at a distance of some 30 kilometers. The same is observed at Manaus, where, at least in the dry months July to September, the rain is much more frequent and more copious a few kilometers North of the city (Flores, for example) than in the city.

the latter is limited to the Western and Southwestern hylaea (including the Madeira) and the subandine belt. The same species of *Cecropia* which abound on the low, deeply inundable banks of the Amazon river, accompany these tributaries; chiefly on the Madeira and on the Purus they form extensive nearly pure stands. In the "várzea" forest of the upper part of the Lower Madeira and Purus species of Western origin appear, as *Manilkara inundata* and others.

The West of the hylaea is an immense plain occupying both sides of the Upper Amazon (called Solimões in Brazil, Marañon in Peru above the mouth of the Huallaga); it reaches from the Pongo de Manseriche at least down to Tefé and the Japurá (approximately) and includes the basins of the tributaries below their rapids as well as the lower and middle courses of the tributaries which have no rapids (Juruá, Jutaf and other less important ones). Because of insufficient knowledge, the Eastern limit of this flora is still uncertain; we know only that the flora of both sides of the Lower Solimões is more akin to that of the Middle than that of the Upper Amazon. Unlike the middle and the Eastern parts of the great river, the Upper Amazon river (from Tefé upwards) shows no positive evidence of splitting the flora in two halves, a Northern and a Southern one; more collections are however needed to confirm this, the only part of the country which has been fairly well explored being that part from Iquitos down to S. Paulo de Olivença (34).

As already mentioned, a very important percentage of species is common to the whole "várzea" of the Amazon river, from the State of Pará to Eastern Peru. The further West one goes, the richer the "várzea" becomes in species, having here many species elsewhere growing only on the uplands. Most interesting here is the distribution of *Hevea brasiliensis*, not yet observed in the "várzea" of the Lower Amazon in a spontaneous state, but frequent on both shores of the Solimões and Peruvian Amazon up to Iquitos (and perhaps further); South of this river, its area reaches the Southern limit of the hylaea, while on the Northern side it is restricted to a narrow zone flooded yearly by the same river. A characteristic tree of the flooded shores of the Upper Amazon is *Piptadenia pteroclada*, common from Tefé upwards. In the high "várzea" forest above S. Paulo de Olivença

(34) *Monopteryx uacu* and *Manilkara surinamensis* have only been observed here on the Northern side, of the Solimões, *Phytalephas microcarpa* only on the Southern side, but much more observations are needed to prove that this river is the Southern or Northern limit respectively of the areas of these widely distributed species.

Parkia inundabilis grows, and, below Tabatinga, *Septotheca Tessmannii*, both large trees of characteristic feature, the latter known formerly only from the Ucayali (Peru). In the "várzea" near Tabatinga and around Iquitos *Iryanthera Tessmannii* is abundant; it is a Myristicaceous of unusually small size. *Coumarouna micrantha*, *Ceiba Burchellii* (35), *Ochroma lagopus*, *Manilkara inundata* are large trees growing in "várzea" forest not only on the main river but also on some of the larger tributaries down to Purus and Madeira. In many "várzeas" the monotypic Euphorbiaceous *Didymocistus chrysadenius* and various representants of the huge-leafed Rubiaceous genus *Pentagonia* occur.

As mentioned above, "terra firme" and "várzea" in Western Amazonia are not so easily separated as in the further East. This "várzea" includes many islands of higher, rarely flooded "restingas" where the typical "várzea" forest is mixed with from many to few species usually growing on "terra firme". On the other hand, the "terra firme" of Western Amazonia is not a continuous upland interrupted only by the igapó of some streams as usual in the more Eastern part of the hylaea, but it is more often an undulating terrain where strips of upland alternate with depressions which are often marshy and flooded by rain water.

The most striking feature of the whole Western hylaea (including the subandine belt) is probably the abundance of *Musaceae*, *Zingiberaceae* and most of all *Marantaceae*, in species (often of rare beauty) as well as of individuals. Their principal "habitat" is in moist places in virgin forest of "terra firme" and the "restingas" in "várzea". Here, the number of the palms is very large, exceeded only in individuals in the swamp forests of the Pará estuary. As to orchids, this flora may be second only to that of the Rio Negro and the subandine limits of the region. Dicotyledoneous epiphytes are much more frequent in the Western hylaea than in the Eastern. The *Moraceae* here have a great many species, as well as individuals in the case of *Ficus* and *Cecropia*, and are well represented in species of *Brosimum* and of the tribe *Olmedieae*. The *Myristicaceae* have their chief center of distribution here which extends to the Rio Negro; they constitute here, in the upland forest, one of the best represented families of arboreous plants. The *Meliaceae* are more abundant here than in the central and Eastern parts of the region, being equaled or even exceeded in the Southwest (Acre Territory). The *Vochysiaceae* are frequent chiefly on the higher

(35) Formerly cited incorrectly as *C. samsum* by both Huber and Ducke.

uplands and are represented by several species of *Vochysia*, *Qualea* and *Erismia*, often in numerous individuals. *Bombacaceae* are numerous except the genus *Bombax* represented here by only a few species; most important are the *Matisiæ*. The genus *Strychnos* of the *Loganiaceae* has in this sector its chief center of dispersion for the Americas (on Igarapé Belém, near the Western boundary of Brazil, KRUKOFF collected 18 species, and FROES 17 on the Middle Juruá). *Solanaceae*, *Rubiaceae* and *Compositae* are here better represented than elsewhere in Amazonia; most of them are herbs or shrubs, but the *Rubiaceae* include a larger number of arboreal *Cinchonoideae* and the *Compositae* present the only genuine tree of this family existing in Amazonia, *Oliganthes discolor*. *Leguminosae* and *Lecythidaceae*, in spite of their abundance, are not so rich in species as in the Middle and the Eastern parts of the hylaea and some of their most important genera are lacking (*Dinizia excelsa*, the highest tree of the hylaea, does not grow West of the basins of Rio Negro and Madeira; *Bertholletia excelsa* does not occur in spontaneous growth West of the mouth of the Rio Jutaf). The ligneous *Dicotyledoneae* seem to be richer here in species than in the Atlantic zone or in the high interior of the Eastern hylaea, but less rich than in the middle sectors of the region; among these, the following may be cited as noteworthy or possible endemic: *Myristicaceae*: various *Virola*, *Compsonera* and *Iryanthera*. *Lauraceae*: *Anaueria brasiliensis* (monotypic). *Leguminosae*: *Dimorphandra gigantea*, *Dicymbe heteroxylon* (a giant tree with anomalous wood, known only from S. Paulo de Olivença), *Recordoxylon stenopetalum*, *Hymenaea adenotricha*, *Vataireopsis Iglesiasii*, *Hymenolobium velutinum*, *Coumarouna charapilla*. *Vochysiaceae*: *Qualea cyanea*, of the Lower Içá basin, a large tree of great beauty, with deep blue flowers. *Euphorbiaceae*: *Caryodendron amazonicum* with edible seeds ("castanha de porco"). *Icacinaceae*: *Dendrobangia multinervia*. *Bombacaceae*: *Matisia cordata*, the "sapote" of Peru, frequent in the forest at the mouth of the Javari and one of the commonest fruit trees cultivated in suburban Iquitos. *Ochnaceae*: *Krukoviella scandens* (perhaps the only climber in this family) and the common beautiful *Cespedezia spatulata* which reaches East to the Middle Japurá. *Flacourtiaceae*: *Tetrathylacium macrophyllum*, and various *Mayna* (including *Carpotroche*). *Sapotaceae*: *Pradosia atrovioleacea* (with flowers of a deep violet unusual for this family) and *Calocarpum odoratum*. *Loganiaceae*: *Strychnos Barnhartiana*, *javariensis*, *Smithiana*, *Duckei* and *Castelnaeana*, never observed elsewhere. *Acanthaceae*: *Men-*

doncia gigas, a woody liana of a large size which is not usual in this family. *Rubiaceae*: the monotypic *Botryarhena* and *Striolaria*.

Many genera and species which have their geographical center in the Western hylaea extend to the Middle or Eastern Amazon. In the first place let us cite *Theobroma*, with eight species in Brazilian Amazonia, all but one (*grandiflorum*) represented in the Solimões country. Of these species, *Th. cacao* reaches East to the small Rio Branco Northeast of Obidos and to the Middle Tapajós; *Th. microcarpum*, to the Middle Tapajós; *Th. obovatum*, to the Jaú, a small Western tributary of the Lower Rio Negro; *Th. Spruceanaum*, to Obidos and Santarém; the rest of the species are distributed over the entire region. The Cycadaceous *Zamia Ulei*, frequent in the Western hylaea, reaches Manaus and Maués; the balata yielding *Ecclinusa balata* ("ucuquirana"), the giant Lecythidaceous *Cariniana micrantha* and the Apocynaceous *Couma utilis* ("sorva pequena") and *Couma macrocarpa* ("sorva grande") reach the Trombetas and Tapajós.

The *Hevea*-like *Cunuria Spruceana* and the beautiful Leguminous *Heterostemon mimosoides* and *H. ellipticus* with orchid like flowers go from the Rio Negro basin (where they are common) up the Solimões to the limits of Peru and Colombia; *H. mimosoides* also reaches Northeastwards across the Upper Trombetas to Southern Dutch Guiana, and Southeast to Maués. On the Southern side of the Upper Solimões, from the Javari down to the Camatiá (a little above S. Paulo de Olivença), the "jarina" palm *Phytelephas microcarpa* appears, of subandine origin and common in the Acre Territory. The enormous Bombacaceous *Cavanillesia hylogeiton* may be of similar origin; it is frequent on the Upper Solimões at the mouth of the Javari, as well as in the Acre Territory and in the neighboring parts of Peru.

The Western hylaea shares the highly specialized Amazonian "catinga" with the Upper Rio Negro. True "catinga" of both types (with uniformly low trees, or with scattered tall trees) has been observed in that country only near S. Paulo de Olivença (36), a town on the Southern bank of the Upper Solimões; here, a sandy plateau rises about 90 meters above the river, extending to the unexplored Southwest between the rivers Jan-diatuba and Camatiá. The soil, here, is like that of the catinga of the Rio Negro, and several plants are common to both, for example *Hevea pauciflora* var. *coriacea*, the widespread *H. viridis*, *Pagamea macrophylla*, and *Lissocarpa*

(36) Krukoff's very important collection labeled "Municipality S. Paulo de Olivença" is not from that town but from Igarapé Belém, much further West and on the opposite (Northern) side of the Solimões river where no catinga exists.

Benthami, the latter of which can be considered one of the most characteristic catinga-trees of the Rio Negro. Species discovered in the catinga of S. Paulo de Olivença and not yet observed in other catingas are: *Aptandropsis amphoricarpa* and *A. discophora* (*Olacaceae*); *Dicymbopsis amazonica*, an abundant and highly characteristic species with orchid like flowers, *Sclerolobium leiocalyx* and *Aldina occidentalis* (*Leguminosae*); *Sacoglottis reticulata* (*Linaceae Humirioideae*); *Dodecastigma amazonicum* (*Euphorbiaceae*); *Dendrobangia tenuis* (*Icacinaceae*); *Ouratea pulchrifolia* (*Ochnaceae*); *Tovomitidium clusiiflorum* (*Guttiferae*); *Froesia crassiflora* (*Quinaceae*). Noteworthy is here the lack of the numerous *Rapateaceae* of the Rio Negro catinga.

Less genuine catinga-like formations are observed in other parts of the Western Amazonia but have not been sufficiently explored botanically; one of them, near Tonantins, has frequent trees of the Rubiaceae *Ladenbergia amazonensis* which is also present in the catingas of the Rio Negro and S. Paulo de Olivença. Near Iquitos (S. Juan Viejo), the senior author visited an elevated spot with soil of white sand and black humus shaded by rather tall trees (with predominant *Taralea oppositifolia*, a species elsewhere growing only in igapó or on river banks); the undergrowth is made up of shrubs and treelets among which may be cited *Leptothyrsa Sprucei*, an unbranched Rutaceous formerly known only from the catingas of the Rio Negro basin. In swamps near the city of Iquitos a *Hevea* is found which the senior author first thought was a good species describing it under the name *H. humilior*; it is however only slightly different from the common *H. pauciflora* var. *coriacea* and is better considered a mere form of this (37).

The Northwestern hylaea comprises the upper courses of the Caquetá, Uaupés, Issana, Guainia, Guaviare and Vichada, except the Andine headwaters of some ones. This part of the hylaea as well as the partly mountainous zone of transition to the flora of the Middle Orinoco basin belongs entirely to Colombia and may perhaps be the least studied but also the most interesting part of the whole region. Colombian botanists are beginning to make research in this privileged country.

The Southwestern hylaea is, in Brazil, represented by the Acre Territory whose flora is, as already mentioned, essentially hylaeen but

(37) Seibert, in "Study of *Hevea* in the Republic of Peru", considers this plant as a hybrid between *H. pauciflora* var. *coriacea* and *H. guianensis* but gives no reasons.

with a certain number of Southern (extra-Amazonian) elements. In spite of large collections made by ULE and chiefly by KRUKOFF, many more botanists would have to work here before we could form a concept on the composition of this rich and exuberant flora. Some of the best known plants yield products of commercial value, such as *Hevea brasiliensis*, *Swietenia macrophylla*, *Myroxylon balsamum*, *Torresea acreana* and *Phytelephas microcarpa* (the jarina palm). They are present in the Eastern half of the Territory (Upper Purus and Rio Acre) as well as in the Western half (Juruá), while the Brazil nut *Bertholletia excelsa*, abundant in the Purus basin, according to all observers is lacking in the Juruá. *Strychnos asperula* is apparently characteristic for this part of the hylaea; it has been observed in the upper Purus basin and also on the Juruá. The pretty *Guazuma rosea* (38) of subandine origin is frequent in flooded forest along the Upper Purus. The highly characteristic *Euphorbia capansa* of the Rio Acre is an unbranched, palmlike treelet about three to four meters high, having a robust woody stem crowned by large leaves and an ample terminal inflorescence; its only relative seems to be *Eu. Tessmannii* of the Rio Ucayali. In the upland forest near Boca do Acre *Guadua superba* grows; it is the tallest bamboo of America; some have been seen on the Lower Javari but it is uncertain if they are native. The Meliaceous genera *Trichilia* and *Guarea* are particularly abundant here.

The subandine belt of the hylaea belongs to Bolivia, Peru, Ecuador and Colombia, excepted the unexplored Serra de Contamana (800 meters) which forms the boundary between Brazil and Peru; botanical work has chiefly been done in Peru where the Huallaga valley is best explored. Near Yurimaguas on its lower course, the flora is not essentially different from that of the environs of Iquitos. Above the rapids, large collections made chiefly around Tarapoto show a very different flora, composed of Andine, Southern extra-Amazonian and Amazonian elements; in no case can that flora be attributed to the hylaea. Further North, an important collection was made by TESSMANN near Pongo de Manseriche; this collection is remarkably rich in large forest trees, several of them never found elsewhere. In subandine Eastern Colombia, Villavieencio, on the headwaters of the

(38) Freytag, in his monograph of *Guazuma*, considers *G. rosea* as synonym of *G. crinita*. *G. rosea* is however a várzea-tree with pink flowers, of Southwestern Amazonia, whereas *G. crinita* is a forest tree with yellowish green flowers, growing on the hills of Rio de Janeiro.

Meta, is the only locality where larger collections are available; this place lies outside of the hylaea, but many Amazonian elements have been found here.

We have already observed that the immense forest of the hylaea is, in many places, interrupted by open areas known as savannahs in the Guianas, as campos or campinas in Brazil. The name campo is preferably given to grass lands of relatively large extension; that of campina, to smaller surfaces poor in grasses. The campos are of two categories: "campos da várzea", periodically flooded by rivers or lakes, and "campos firmes", never flooded. "Campos da várzea" are encountered along the Atlantic littoral and accompanying the Lower Amazon in the State of Pará; they have a predominantly herbaceous flora where *Gramineae* are most important, with scattered trees or performing groups ("ilhas de mata"). All woody plants, here, belong to species of the neighboring várzea forests, and the várzea campos must therefore be attributed to the hylaea. "Campos firmes" more frequently have a soil of yellowish sand but some have clay or stony soil. Their herbaceous flora is composed of many species of *Gramineae* but always with rather numerous plants of other families (chiefly *Leguminosae* *Hedysaraceae* and *Phaseoleae*); terrestrial orchids are frequently (chiefly species of *Habenaria*); epiphytic orchids are rare. Among the the herbs, low trees and shrubs may be abundant ("campo coberto") or rare ("campo lavrado"). The flora of these campos is closely akin to that of the campos and cerrados of Central Brazil, but less rich in species; this flora is alien to the hylaea. A chain of campos accompanies the Atlantic coast (those of Marajó, studied by HUBER, being the most important); another follows the course of the Lower Amazon in the State of Pará; a third lies between the upper courses of Jari and Trombetas in Northern Pará; and a fourth, in Southern Pará and Amazonas, on the Middle Tapajós and between Purus and Madeira. The campos of the first and fourth chains are remarkable for the presence of the "mangabeira" (*Hancornia speciosa*). The campos of the third chain have, according to A. SAMPAIO (the only botanist who saw them!), a flora similar to the flora of the Central Brazilian "campos" and "cerrados" ("Flora Geral" of Brazil, of A. SAMPAIO), and probably like that of the second chain. Isolated campos of small extension are scattered through the North of Pará; only those of the Arimamba are explored. These campos occupy a plateau about 250 meters

high, on the Eastern margin of the basin of the Middle Trombetas, with a flora not essentially different from that of the others but with some endemism (as for example *Bonnetia Dinizii*). Woody plants most characteristic for nearly all true Amazonian campos are the trees *Salvertia*, *Curatella*, *Bowdichia virgilioides*, *Roupala montana*, *Qualea grandiflora*, *Vitex flavens*, the showy treelet *Palicourea rigida*, the shrub *Byrsonima crassifolia* and the dwarfed *Byrsonima verbascifolia*. Others, such as *Plathymenia*, *Vatairea macrocarpa*, *Luehea paniculata*, *Anacardium microcarpum*, *Cochlospermum insigne*, *Lafoensia densiflora*, *Jacaranda brasiliana* and *Hancornia* are limited to certain campos. *Tabebuia caraiba* is characteristic for the lowest campos, chiefly occurring in the transition to the várzea campos. The campos or savannahs of Rio Branco and Rupununi have another, much richer flora showing a mixture of elements of the above cited campos, with several apparently endemic species and many related to the flora of the very insufficiently known Lower Orinoco. *Salvertia convallariodora*, very characteristic of the Brazilian campos and here perhaps the most beautiful tree of all, is lacking in the campos of Rio Branco but present on the nearby campos of the Upper Trombetas and the savannahs of Southern Dutch Guiana.

"Campina", diminutive of "campo", is the Brazilian name of small open areas; it can refer to a small campo which may be of the above described campos or may owe its origin to the destruction of the forest by fire. More often the name is given to open spots in the virgin forest, with soil of white sand with black humus, never accessible to the flood of the rivers or lakes but frequently with marshy spots covered with stagnant water which remains after heavy rains. The most numerous and typical campinas are situated between the lower courses of Rio Negro and Trombetas where they reach their best development East of the Lake of Faro (dilated mouth of the Nhamundá); others exist in the Pará estuary at Vigia, Colares, etc. and up to Gurupá and Pôrto-de-Mós (on the mouth of the Xingu); some are scattered in the basins of Tapajós and Madeira. The same kind of campinas and the campos described above sometimes occur in the same neighborhood but each has its own soil and flora; for example, at Cupijó (near Cametá), in the region of Mariapixi (West of the mouth of the Trombetas), and also on the Ariramba. In this case, the name "campo" is applied to both formations. "Campinas" of large dimensions are often called

"campos" (for example those East of Faro: Campos do Tigre, Campos de Maracanã etc.); otherwise campinas of smaller area, isolated in the middle of forest country, are sometimes called "campos": "Campo Grande" of Borba (Lower Madeira), "Campo Grande" of Pôrto-de-Mós (mouth of the Xingu), and probably others.

Like "campos", the "campinas" are primary formations probably older than the rain forest of the hylaea; this is indicated by the presence of many plants and animals of the same species, on many campos or campinas often separated by hundreds of kilometers of rain forest where those species do not occur. The flora of clearings sometimes called campinas, originating from the burning of the forest, is entirely different; it is composed of the same species as the common secondary growth ("capoeira"). This can easily be observed on the outskirts of Manaus where such clearings occur; they often have a scanty growth of capoeira elements.

Unlike the campo flora, the flora of the "campinas" is distinguished by its great variety of woody species; it has no affinities with that of the "campos" and is a genuine, although highly specialized, part of the hylaea flora, closely allied to the catinga of the Rio Negro basin. Dry, sandy, barren places, here and there with large clumps of pretty lichens (*Cladonia*), alternate with shrubs or low trees and twisting open paths. Humid sand with black humus is often covered with small *Schizaea*, *Xyridaceae*, *Eriocaulaceae* often of large size, *Burmannia*, *Cephalostemon*, various *Utricularia*, small *Gentianaceae* and herbaceous *Melastomataceae*. *Gramineae* are less numerous than *Cyperaceae* and belong to other species than those of the "campos". *Bromeliaceae* abound in epiphytic and terrestrial species; *Orchidaceae* of epiphytic as well as semi-terrestrial species (having their roots in a thin layer of humus on the surface of the soil). The shrubby vegetation, generally of 1 to 2 meters, is composed of many families; well represented on nearly all campinas are the genera *Couepia*, *Macrobium*, *Humiria*, *Protium*, *Byrsonima* (white or pink flowered species), *Ouratea*, *Ilex*, *Clusia*, *Macaírea*, *Myrcia*, *Pradosia*, *Pagamea*, *Retiniphyllum*, with species common to all campinas, and others restricted to one or a few campinas. On certain campinas, there are extensions densely and uniformly covered by shrubs of 50 to 80 centimeters, of *Gaylussacia amazonica*, often mixed with the pretty semi-scandent *Cuphea annulata*.

Most remarkable plants of the "campinas" are: *Sphagnum* sp. (campinas of Colares, Rio Pará) and on the Jaramacaru river near the campos of the Ariramba (Trombetas); *Cephalostemon gracile* (many campinas of the Eastern third of the hylaea) and *C. cyperaceoides* (campinas of Nhamundá and Trombetas); *Abolboda excelsa* (Jaramacaru); *Chaunochiton angustifolium* ("Campo Grande" of Borba); *Couepia Duckei* (campinas or "campos" of the Nhamundá); *Hirtella Ulei* (campinas of Ponta Negra and Tarumá-miri near Manaus); *Hirtella punctillata* ("Campo Grande" of Pôrto-de-Mós); *Dimorphandra vernicosa* (campinas of Ponta Negra and of the Tarumá-miri near Manaus, and along the Padauri); *Dimorphandra campinarum* (campinas East of the Nhamundá, and near Cachoeira do Taboleirinho, Rio Mapuera, Trombetas); *Macrolobium arenarium* (campinas of Tarumá-miri and Campina do Perdido near the lowest rapid of the Tapajós); *Eperua campestris* ("Campo Grande" of Borba); *Peltogyne campestris* (campinas East of the Nhamundá and near Cachoeira Porteira of the Trombetas); *Jacqueshuberia quinquangulata* (campina of Igarapé Jacopi near Gurupá); *Swartzia arenicola* (campinas of Tarumá-miri near Manaus); *Taralea cordata* ("Campina do Perdido" (Rio Tapajós), "Campo Grande" of Borba (Rio Madeira), campinas East of the Nhamundá and campinas of Tarumá-miri near Manaus); *Byrsonima coniophylla* (campinas of the Lower Trombetas and "Campina do Perdido" of the Middle Tapajós); *Chaetocarpus echinocarpa* (campina near Itaituba, Lower Tapajós); *Sauvageia Duckei* ("Campo Grande" of Borba); *Caraipea foveolata* (campinas or "campos") East of the Nhamundá, and of the Jaramacaru (Trombetas)); *Moronobea pulchra* (campinas of Ponta Negra and Tarumá-miri (Manaus); *Euceraea nitida* (campinas of the Caquetá (Colombia) and "Campina do Perdido" (Rio Tapajós) (39); *Cuphea annulata* (campinas of the Rio Caquetá and diverse campinas in Middle Amazonia); *Gaylussacia amazonica* (campinas of the Nhamundá and West of the Lower Trombetas, campinas of the Jaramacaru (Middle Trombetas), and "Campina do Perdido" (Middle Tapajós); *Leucothoe Duckei* (campinas ("campos") East of the Nhamundá); *Pagamea Duckei* (campinas of Tarumá-miri (Manaus)). The forest bordering campinas is often catinga-like and its flora includes often species not found elsewhere; for example: *Inga inflata*, *Retiniphyllum chloranthum* and

(39) Maguire cites it for Venezuela, British Guiana and Surinam (probably from savannahs).

Ret. chlorocalyx (campinas of Tarumá-miri near Manaus), and *Emmotum holosericeum* and *Platycarpum crenocense* ("Campo Grande" of Borba) (40). On some remote campinas, there is an extreme abundance of epiphytic orchids (*Cattleya eldorado* near Manaus, *Cattleya violacea* in the Trombetas basin); on the easily accessible campinas, these plants have long since disappeared, removed by merchants or destroyed by fire.

Once again we call attention to the absence of *Strychnos* from the campinas and Amazonian catingas, though this genus is well represented everywhere in the hylaeal forests and even occurs on some campos (as *Str. parvifolia*).

Certain forest trees occur in the center of some campos or campinas as shrubs; as small trees on the periphery, and as medium or large trees in the neighboring forest. These examples may be cited: *Humiria floribunda*, on several campos and campinas; *Copaijferia Martii* and *Hymenaea parvifolia*, in the campos of Monte Alegre; *Couepia racemosa*, *Macrobium bifolium*, *M. suaveolens*, *M. campestre*, *Pradosia inophylla*, *P. pedicellata*, *Manilkara amazonica* and *Couma utilis*, in diverse campinas.

Campos and campinas are often separated from the rain forest by an intermediate formation called "campina-rana" (false campina). In some parts of the region, chiefly in the hill country North of Almeirim, Prainha and Monte Alegre, this formation does not depend on the presence of such open spaces, but, often occupies large extensions, chiefly on the hill tops and slopes. Floristic elements of the upland forest appear here mixed with species of the flora of campos or campinas.

The presence of the same species of plants on several or many campos or campinas throughout the hylaea, separated by large extensions of rain forest, indicates a very remote origin of the flora of these open areas. However there are similar formations apparently of recent origin. Near Monte Alegre and Faro and in the country called Lago Grande de Vila Franca we observe a gradual succession without sharp limits, from the lakes to the yearly flooded grass campos of the várzea and from these through an intermediate zone (with *Tabebuia caraiba*) to the "campos firmes" with *Curatella*. These lower campos have much fewer species of plants than the campos of the higher land; the richest campo-flora within the hylaea we

(40) Formerly known only from savannahs near Maypures, Upper Orinoco.

have seen, was in the hill country of Monte Alegre. The apparently recent campos lack rattlesnakes, though they are present on all true upland campos within the Amazonia (41) and restricted to them.

Campos and campinas may exist side by side, transitions between both formations being observed [nothing indicates that one might have supplanted the other; their diverse nature seems established from inception. Perhaps both formations originate from ancient river — or lake-beds: in the case of the “campos”, from “white” water (with abundant sediments); or from clear or “black” water (without sediments) in the case of the campinas having soil of white sand with black humus. This is easily perceptible in the Campina do Perdido situated about 12 kilometers East of the lowest rapid of the Tapajós. This campina is a horizontal plain of a few square kilometers, reminding one of a lake bed bordered by high dunes of white sand; its rich flora which includes the Ericaceous *Gaylussacia amazonica* is undoubtedly more ancient than the surrounding forest. Narrow zones with campina-vegetation but relatively poor in species sometimes appear on the high sandy beaches of lakes which have igapó on the lower side and upland forest on the upper side.

(41) Including those of the Rio Branco.

Correção: "Phytogeographical notes on the Brazilian Amazon."

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O mapa abaixo substitui o que foi publicado na página 23 do artigo cuja referência é dada acima.

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