The estuaries of the Amazon and Oiapoque rivers and their floras

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ESTUARY OF THE AMAZON

Introduction

The Amazon region is an enormous area of about 6 million sq. km., of which more than half (3.5 million sq. km.) is situated in Brazil. It is almost completely covered by a tall, equatorial, virgin forest.

Its area corresponds almost exactly to that of the basin of the Amazon, but in order to embrace areas with the same flora it is necessary to include the basins of some smaller rivers that drain directly into the Atlantic, such as those in Maranhão to the east of the mouth of the Amazon, and those in Amapá and the Guianas to the north. To these must be added the headwaters of the Orinoco basin. The Amazon region then, in the south and south-east, abuts on the Central Brazilian Plateau, on the east with the area of transition along 44°W., on the west with the foothills of the Andes, and on the north with the upper Orinoco region in Venezuela and with the Atlantic. The region can be clearly seen on a map of South America by observing the limits of the basins of the included rivers.

To the south and south-east of Amazonia, on the Central Brazilian Plateau, occur *campos cerrados*, or savannahs. The streams that drain these savannahs are fringed by gallery forests. Elements of the Amazonian *várzea* forests (i.e., forests that are annually flooded) occur in these gallery forests, penetrating into the savannahs sometimes more than 500 km. This gives rise to the curious fact that, in the middle of the savannah region, native rubber trees are being tapped in the gallery forests.

Because of its geological history, water and altitude are important factors in characterizing Amazonia. According to present ideas, the Amazon region was originally a mediterranean sea between the Guiana and Central Brazilian massifs. Afterwards the rise of the Andes and other areas that occurred caused much erosion and sedimentation. Amazonia, therefore, is mostly a plain situated between 0 and 200 metres altitude. The Amazon falls only 2 cm. per km. Its current is caused by the pressure of its volume of water, being little influenced by the incline of its bed.

It is customary to divide the Amazon into three parts: the upper Amazon, the lower Amazon and the estuary.

Upper Amazon

Also known as the Solimões river in Brazil and the Marañon river in Peru, it is the part from the headwaters to the entrance of the Rio Negro. The alluvial plain of this portion in Brazil measures 15,000 sq. km. (Gourou, 1950). It is covered mainly by a tall forest much more vigorous than the gallery forests in the lower course.

The alluvial or annually flooded plains in Amazonia are called *várzeas*, They vary up to 50 km. wide, especially where the *várzeas* of more than one river coalesce. The largest trees in the *várzea* forests of the Solimões are *Olmediophaena maxima* Ducke, *Hura crepitans* L., *Ceiba pentandra* Gaertn. and several species of *Ficus*. The upper Amazon does not feel the effects of the tides; flooding is caused only by the annual rains.

Lower Amazon

This is the portion between the mouth of the Rio Negro and the mouth of the Xingu. Its *várzea* terrain measures 15,000 sq. km. (Gourou, 1950). In the lower part there is a small tidal influence but, as in the Solimões, the floodings are caused by the annual rains and last several months. The river plains contain extensive areas of annually flooded, treeless fields called *campos de várzea*, covered almost exclusively by robust grasses called generically *Canarana*. This name indicates its similarity to sugar-cane and includes *Paspalum fasciculatum* Willd., *P. repens* Berg, *Hymenachne*

amplexicaulis (Rudge) Nees, *H. donacifolia* (Raddi) Chase, *Echinochloa polystachya* (HBK.) Hitchc., *Panicum aquaticum* Poir., *P. elephantipes* Nees, *P. zizanioides* HBK., *Leersia hexandra* Sw., *Luziola spruceana* Bth., *Eriochloa punctata* (L.) Desv., and some species of wild rice, *Oryza alta* Swallen, *O. latifolia* Desv., *O. perennis* Moench. and *O. grandiglumis* (Doell) Prod. (Black, 1950).

In the middle of these grassy *campos* lakes commonly occur which vary in size with the season. During the dry period they contract, the banks becoming occupied by the *Canarana*.

The gallery forests occur principally on levees along the shore of the main river, formed by the deposition of the heavier soil particles during the flood periods. Behind them the *campos de várzea* with their lakes are always found. The levee forests are not very wide, only 200 metres on the average. Among their tallest trees are *Hura crepitans*, *Calycophyllum spruceanum* Bth., *Ceiba pentandra*., *Triplaris surinamensis* Cham, etc. An interesting fact is the absence of palms.

Economically, the *campos de várzea* are very favourable habitats for raising cattle, particularly water buffaloes. Artificial pastures on the uplands (*terra firme*) are needed for them during the months of flood. At present these do not exist in the region because of the primitive methods of the inhabitants.

In these levee gallery forests Japanese immigrants are growing jute, the fibre used for sacks.

The Amazon estuary

After giving the above as an introduction, we come to the estuary usually defined on the Amazon as the part between the mouth of the Xingu and the Atlantic (see Fig. 1). According to Gourou (1950) the area of its alluvial plain is 25,000 sq. km.

In the upper part of the Amazon, as stated, the floodings are caused by the annual rains, but as one approaches the ocean, the river bed becomes so wide that the rains lose their effect in causing the floodings. In the estuary floodings are caused by the tides. In March-April and in September the tidal floodings in the lower estuary are strongest. Thus the September flood occurs in the middle of the dry season which runs from June to December.

The enlarging of the river bed at its mouth causes a reduction in the flow velocity of the stream. This, plus the effect of the tides, causes the deposited sediments to form hundreds of islands connected by an intricate network of canals. For this reason the upper part of the estuary is called "Region of the Islands". The canals are locally called *furos*, the larger ones being called *paranás*.

The estuary is of fresh water. Near the ocean it can become slightly brackish at certain times of the year.

The highest tides are from 3 to 4 metres. In some places a phenomenon called the *pororoca* occurs; it consists of two or three consecutive waves travelling upstream, which in shallow places break and form a surf. The *pororoca* is the beginning of the tidal flooding which occurs twice daily.

The Amazon empties into the ocean by way of two rivers, one on each side of the island of Marajó. This island has an area of more than 40,000 sq. km. Almost all of the volume of water of the Amazon enters the northern branch, between Marajó and Amapá. Only a small fraction enters the southern branch; along with the water of the Tocantins, Moju, Acará and Guamá rivers, they form the so-called Pará river and the Bay of Guajará.

When the muddy water of the Amazon empties into the sea, it is pushed by an ocean current towards the coast of Amapá and the Guianas. The mud is deposited along the coast forming bars across the river mouths, obstructing navigation. For this reason also sandy beaches in the region are found only east of the mouth of the Amazon.

Vegetation of the Amazon estuary

As previously stated, the alluvial plain of the upper Amazon supports *várzea* forests. In the lower Amazon *várzea* forests are less important on the inundated terrain, the tall, grassy *campos de várzea* being much more extensive.

In the estuary these *campos de várzea* do not occur. On the older islands important vegetation types are found, rich in tree species and valuable as timber sources.

In this "Region of the Islands" the main sawmills of the State of Pará are located, and both sawn lumber and logs come from it.

Timber from the *várzea* forests and the adjacent upland forests is transported by water, the logs being made into rafts.

The *várzea* forests of the estuary contain an abundance of palms and these strongly influence the physiognomy of the vegetation. The most common species are *Euterpe oleracea* Mart. ("açaí"), *Mauritia flexuosa* L. f. ("buriri"), *Raphia taedigera* Mart. ("jupati"), *Manicaria saccifera* Gaertn. ("ubuçu"), *Iriartea exorrhiza* Mart. ("pachíuba"), *Astrocaryum murumuru* Mart. ("murumuru"), etc.

The principal vegetation types of the estuary are forests, *furos* vegetation, *campos* and mangrove swamps.

Estuary forests

Since the area of these forests is so large it is difficult to give a general description. We prefer to give data about two particular places. Breves in the south or Marajó Island, and Belém, further down river and neaf the ocean.

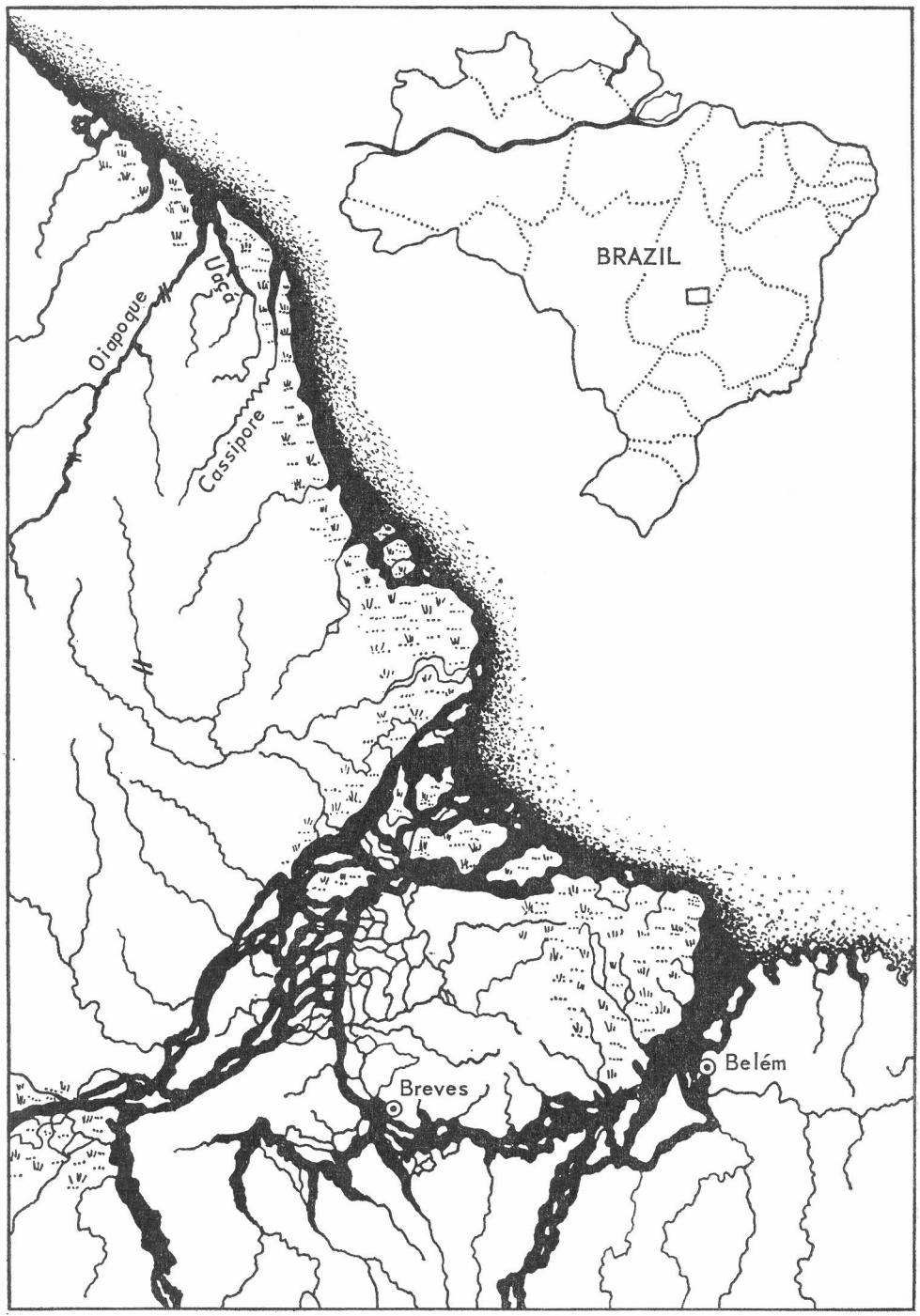

FIG. 1. Map showing the estuaries of the Amazon and Oiapoque.

Estuary forest in Breves. In 1956 we spent a month in this locality, obtaining data as yet unpublished. These will be partly presented here to give an idea of the forest. We were accompanied by two soil specialists who published independently their soil data (Vieira and Santos, 1962).

The vegetation we studied was partly in a terrain whose soil becomes periodically somewhat soaked, and partly in upland *terra firme* whose water table comes almost to the surface in the rainy season.

Data for 1 hectare of a transect. All plants with trunks 10 cm. in diameter or more were counted; 516 individuals in 157 species in 36 families were encountered. The most common species were: *Iryanthera paraensis* Huber (5.62 per cent of the total), *Protium* sp. (5.23 per cent), *Eschweilera corrugata* (Poit.) Miers (4.84 per cent), *Protium spruceanum* Engl. (3.88 per cent), *Licania* sp. (2.52 per cent), *Chrysophyllum prieuri* A. DC. (2.33 per cent), *Tovonita* sp. (1.94 per cent); *Aspidosperma album* (Vahl) Ducke (1.74 per cent), *Aniba burchelli* Kosterman (1.74 per cent); *Gilibertia* sp. (1.74 per cent). These 10 most common species make up only 31.6 per cent of the total number of individuals, showing how rich in species this vegetation is, with a consequent small number of individuals per species.

The frequency in trunk diameter classes was: 10-20 cm.; 308 individuals; 20-40 cm., 110 individuals; above 40 cm., 98 individuals.

Data for 10 hectares of a transect. The transect here was 10 by 10,000 metres; individuals were counted only when they had a trunk diameter of 25 cm. or more at 1.5 metres from the ground, and the volume of wood in the trunk from ground level to the lowest bough was also calculated: 1,271 individuals were counted, in 235 species, in 40 families.

The 10 most common species were: *Eschweilera corrugata* (6.22 per cent), *Taralea oppositifolia* Aubl. (5.90 per cent), *Vouacapoua americana* Aubl. (3.54 per cent), *Eschweilera odora* (Poepp) Miers (3.46 per cent), *Pentaclethra macroloba* (Willd.) Kuntz (2.60 per cent), *Macrolobium brevense* Ducke (2.60 per cent), *Licania macrophylla* Bth. (2.12 per cent), *Licania* sp. (1.57 per cent), another *Licania* sp. (1.57 per cent), *Vochysia inundata* (1.57 per cent). Only 31.15 per cent of the individuals were included in these 10 species.

The 235 species yielded 2,131.30 cu. metres of wood, or 212.13 cu. metres per hectare, or 0.65 cu. metre per species, on the average.

The 10 species with the greatest wood volume were: *Taralea oppositifolia* (6.3 per cent of the total), *Vouacapoua americana* (4.9 per cent), *Eschweilera corrugata* (3.7 per cent), *E. odora* (3.4 per cent), *Vochysia inundata* (3 per cent), *Goupia glabra* Aubl. (3 per cent); *Cedrelinga catenaeformis* Ducke (2.6 per cent), *Osteophloeum platyspermum* Warb (2.4 per cent), *Caryocar microcarpum* (2.4 per cent), *Saccoglottis cuspidata* Bth. (2 per cent). These 10 species gave 33 per cent of the total wood volume.

Thus, timber production also involves many species, without predominance of any one or few. This is a problem in exploitation, particularly as regards standardization.

The tallest tree encountered was an individual of *Dinizia excelsa* of 41 metres. Eleven species had individuals over 30 metres tall (two of these emergents are *Cedrelinga catenaeformis* and *Dinizia excelsa*), 176 species had individuals between 20 and 30 metres tall, and 48 species had individuals between 8 and 20 metres tall.

The basal area of the trunks of the counted species was 20.18 cu. metres per hectare. The 10 species with the largest basal area were: *Taralea oppositifolia* (8.12 per cent of the total basal area), *Voucapoua americana* (4.62 per cent), *Eschweilera corrugata* (3.88 per cent), *E. odora* (2.39 per cent), *Goupia glabra* (2.83 per cent), *Vochysia inundata* (2.42 per cent), *Osteophloeum platyspermum* (2.42 per cent), *Caryocar microcarpum* (2.25 per cent), *Pentaclethra macroloba* (2.17 per cent), *Licania macrophylla* (2.03 per cent).

Data for 1 hectare of cut trees. On 1 hectare all trees with trunks over 10 cm. in diameter were cut at about ground level. The hectare was made up of four plots of 1/4 hectare each, distributed along a line 5 km. long. The thick trunks (25 cm. and over) were measured with tape directly to calculate their volume. Thin trunks and cut boughs to about 5 cm. diameter were piled up and the volume of the pile measured, applying a correction factor previously worked out to obtain the volume of pure wood.

A total of 402 individuals were counted in 155 species in 35 families. The total volume of trunks alone, 25 cm. and over in diameter, was 331 cu. metres; that of these trunks plus boughs and thin trunks was 455 cu. metres.

The 10 species giving the greatest amount of wood were as follows (in each case with the volume of cubic metres of thick trunks followed by the volume of trunks plus boughs): *Chrysophyllum oppositum* Ducke (24.03, 34.30), *Dinizia excelsa* Ducke (23.88, 28.79), *Tachigalea myrmecophila* Ducke (9.03, 9.05), *Vouacapoua americana* (13.30, 17.33), *Pouteria engleri* (14.04, 17.27), *Osteophloeum platyspermum* (13.23, 14.74), *Macrolobium brevense* (8.91, 12.86), *M. campestre* (7.77, 12.28), *Pithecelobium pedicellare* (6.07, 9.43), *Taralea oppostitifolia* (6.48, 9.18).

Várzea forest in Belém (Plates V and VI). The following information is extracted from a previous paper (Pires and Koury, 1959).

Data for 1 hectare of cut trees. The hectare was made up of four plots of $^1/_4$ hectare each, distributed at random within a small area. All woody plants with trunks of 5 cm. and over were cut at about ground level and the volume of wood measured as described above.

Total volume of thick trunks was 236.26 cu. metres, total volume of wood 433.80 cu. metres; 539 individuals in 53 species in 21 families were counted.

Species with the greatest number of individuals were: *Astrocaryum murumuru*, 152; *Euterpe oleracea*, 113 (counting each clump of several stems as one individual); *Carapa guianensis*, 19; *Bactris* sp., 17; *Quararibea guianensis*, 15; *Hevea brasiliensis*, 13; *Inga cinnamomea* Bth., 13; *Hura crepitans*, 12; *Guazuma ulmifolia* Lam., 12.

Data from 3.8 hectares. In the same area a plot was laid out 100 metres wide, running perpendicular from the edge of the Rio Guamá 380 metres to *terra firme*. Of woody plants with trunks 10 cm. in diameter and more, there were 1,837 individuals in 107 species in 33 families. There were 1,133 individuals with trunks from 10 to 20 cm. in diameter, 375 with trunks 20 to 40 cm. in diameter, and 329 with trunks more than 40 cm. in diameter.

The 10 most common species were *Euterpe oleracea*, *Astrocaryum murumuru*, *Pithecelobium latifolium* (L.) Bth., *Carapa guianensis*, *Quararibea guianensis*, *Hura crepitans*, *Pentaclethra macroloba*, *Hevea brasiliensis*, *Inga nobilis* Willd. and *Protium heptaphyllum* March. For further details consult Pires and Koury (1959), Cain *et al.* (1956) and Black *et al.* (1950).

Vegetation of furos, *river banks and recently formed islands.* The forests of Breves described above occupy the higher *várzeas* and also some areas of terrain not flooded but whose water table comes almost to the surface during the rainy season. The terrain to be discussed now, also at Breves, is always very muddy and clayey. It has a uniform flora that is not very rich in species and which is the same in the whole estuary region. It occurs along brook and river banks and mouths of tributaries.

The most common species are: *Euterpe oleracea*, *Mauritia flexuosa*, *Raphia taedigera*, *Manicaria saccifera*, *Iriartea exorrhiza*, *Astrocaryum murumuru*, *Bombax aquaticum*, *Quararibea guianensis*, *Matisia paraensis* Huber, *Crudia tomentosa* (Aubl.) Macbr., *Macrolobium acaciaefolium* Bth., *M. bifolium* (Aubl.) Pers., *Campsiandra laurifolia* Bth., *Swartzia acuminata* Willd., *Ormosia coutinhoi* Ducke, *Taralea oppositifolia*, *Dalgerbia menetaria* L. f., *Machaerium ferox* (Mart.) Ducke, *M. lunatum* (L.) Ducke, *Pterocarpus amazonicus* Huber, *Mucuna altissima* (Jacq.) DC., *Ischnosiphon aruma* (Aubl.) Kcke., *Ravenala guianensis* (Rich.) Bth., *Montrichardia arborescens* Schott, *Gnetum nodiflorum* Brong., *Cyperus giganteus* Vahl, *Hernandia guianensis* Aubl., *Licania macrophylla*, *L. heteromorpha* Bth., *Hevea brasiliensis*, *Hura crepitans*, *Buettneria divaricata* Bth., *Symphonia globulifera* L., *Cydista aequinoctialis* (L.) Miers.

In some areas of the estuary almost pure formations of *Mauritia flexuosa* known as "buritizais" were found.

Common floating plants are *Nymphaea rudgeana* Meyer, *Salvinia* sp., *Pistia stratiotes* L., *Eichornia azurea* (Sw.) Kunth, *E. crassipes* (Mart.) Solms, *Reussia rotundifolia* (L. f.) Castell.

For further details consult the detailed paper of Huber (1943).

Estuary campos

The island of Marajó, with an area of more than 40,000 sq. km., has its south-south-west half covered with forest while the rest is natural open fields (*campos*). Other smaller nearby islands in the mouth of the Amazon (Caviana and Mexiana, have *campos* vegetation. The *campos* of Marajó are quite different from the *campos de várzea* cited for the lower Amazon region. The terrain is drier and the grasses not so robust. The grasses rarely exceed half a metre in height, the most important species being of the genera *Panicum*, *Paspalum*, *Axonopus*, *Andropogon*, *Aristida*, *Leptocoryphium*, *Trachypogon*, etc. On *terra firme* (not flooded) typical species of the *campos cerrados* (savannahs) of Central Brazil appear, such as *Tabebuia caraiba*, *Curatella americana*, *Hancornia speciosa*, *Salvertia convallariaeodora* St. Hil., etc. A common species is a native cashew, *Anacardium microcarpum* Ducke.

According to Gourou (1950) and others, not all the terrain of the islands of Marajó, Caviana and Mexiana are of fluvial origin; part is older soils belonging to the *Barreiras* series. Therefore, the *campos* of Marajó are similar to analogous formations on the Pará and Maranhão coasts, such as the *campos* of Bragança and of Perizes.

In the north of Marajó there occur many lakes, ponds and marshes, Lago Arari being the largest. Here grows a rich aquatic flora of attached and floating plants, including *Pontederiaceae*, *Nymphaeaceae*, *Azola*, *Salvinia*, *Utricularia*, *Pistia*, etc. In this region, depressions with water are called *mondongos* while the higher places that do not become flooded are known as *tesos*.

In some areas in the estuary region, such as in the Baía de Guajará, depressions of irregular form occur, a few hectares in area, distributed along the shore of the bay. These are filled with marshes bathed twice a day by the tides. Here grow an abundance of sedges, including cutting species of *Scleria*, some legumes, *Marantaceae*, *Typha*, etc. These depressions are called *pirizais*, while similar depressions in the Oiapoque estuary are called *cariazais*.

The *campos* of the Amazon estuary are very important economically because they constitute the principal cattle-raising region of Amazonia. Owing to the proximity of Belém, the cattle-raisers have a higher cultural level; included among them are many doctors, lawyers and other professionals living in the city. They are interested in breeding and selection and hold annual cattle fairs.

Mangrove swamps

This is not a typical vegetation type for Amazonia. Its species are well known in other regions: *Rhizophora*

mangle L. ("mangue", "mangue verdadeiro"), *Avicennia nitida* Jacq. ("ciriuba"), *Laguncularia racemosa* Gaertn, and *Conocarpus erectus*. Subsidiary species are *Pterocarpus draco*, *Hibiscus tiliaceus* St. Hil., *Anona palustris* L., and *Pithecelobium cochleatum* Mart. In areas of sticky clay (*tijuco*) *Spartina brasiliensis* Raddi ("paratura") occurs with its sharp-pointed leaves that can puncture men's feet.

Rhisophora grows quite far up the estuary, into fresh water, growing all around the island of Marajó. According to Huber, there are two varieties, the typical and the *racemosa*. *Avicennia* penetrates even further up river.

In very sandy soils and on dunes, *Chrysobalanus icaco* ("agiru") is common.

ESTUARY OF THE OIAPOQUE

Introduction

The Oiapoque acts as the frontier between Brazil and French Guiana (included here are also a few shorter rivers that empty directly into the Atlantic). The Oiapoque estuary is only about 100 km. long. On the Guiana side, uplands approach the river, while on the Brazilian side, near the mouth the alluvial plains become quite wide, the *várzeas* of the Oiapoque, Uaçá, Caripi, Urucauá and Cassiporé rivers uniting. This forms a large area of recent sediments, the material coming from the Amazon and being pushed northwards by an ocean current, as previously explained. At its mouth, where the Oiapoque unites with the Uaçá, the exit is very wide and shallow, and to enter or leave by boat it is necessary to pay much attention to the tides. At low tide wide muddy areas become visible, not only along the banks but in the middle of the mouth also.

The *pororoca* originates in this wide part of the mouth and ascends the Uaça up to the place called Encruso at the mouth of the Caripi. In this whole stretch the water is extremely muddy, and cannot be used for drinking even by the Indians, who are not very demanding.

The Oiapoque estuary, properly speaking, does not exceed 100 km., terminating at the Cachoeira Grande Roche, which is as far as the tidal influence reaches. Upstream from here the bed of the river is pure granite, and the appearance of the river changes considerably with the time of year; in the dry season there is only a comparative trickle through its rocky bed.

The Cachoeira Grande Roche is the point of a radical change in the Rio Oiapoque. The tides terminate there, the landscape changes, and the marginal vegetation and even the fauna change. Many fish species, such as *arraia* and *tucunaré* are not found above this point; from here upstream occur fish species proper to rapids, that feed chiefly on the carpet of *Podostemonaceae* growing on the granite rocks. Even in the estuary, at low tide, some granite blocks may be seen.

The uplands beyond the alluvial plain of the river have a rolling topography. According to Lima *et al.* (1960), the soils in general are reddish-yellow latosoils of the common type in Amazonia, with lateritic concretions (*piçarra*) common in the hills.

The flood-plain vegetation of the Oiapoque region can be divided into *várzea* forest of the Oiapoque proper, *várzea* forest of the lower Uaçá and *campos* of the upper Uaçá.

River Oiapoque

At the mouth there are extensive mangrove swamps, principally of *Rhizophora mangle*, with a few formations of *Avicennia nitida*. From the mouth to Cachoeira Grande Roche the alluvial plain is quite narrow. The chief plants represented, besides mangrove, are a few palms (*Euterpe oleracea* and *Mauritia flexuosa*), dense riverside formations of *Montrichardia arborescens*, *Virola surinamensis*, *Pithecelobium corymbosum*, *P. huberi* and *Pentaclethra macroloba*.

Eperua rubiginosa and *E. falcata* are both common on the riverbank (the former being more frequent), from the mouth to the mouth of the Ingarari, disappearing upstream. Their wood is much used for fences, floors, firewood, construction of docks, etc. Both species are called "apá". Because of their frequency, their long pendulous inflorescences and beautiful violet-rose flowers, these species characterize the riverside landscape.

Bombax aquaticum is a very common species; above Cachoeira Grande Roche it starts to diminish, gradually yielding its place to *B. munguba* and disappearing completely in the middle Oiapoque.

Also common are *Sloanea grandiflora*, *Alchornia* sp., *Quararibea guianensis*, *Combretum cacoucia*, *Tabernaemontana* sp., *Cydista aequinoctialis*, *Callychlamys latifolia*, *Adenocalymma bilabiatum*, etc., and many lianas, especially *Bignoniaceae*.

Lower Uaçá

The lower course of this river has *várzea* forests that are wider than those in the Oiapoque, and which contain a few additional species, but the total number of species is not large. Above the mouth of the Caripi (up to which the *pororoca* reaches) the *várzea* forests start to diminish gradually in height, width and density. Certain species, such as *Triplaris* sp., *Cordia* sp., *Mauritia flexuosa*, *Euterpe oleracea*, *Guadua latifolia* (right at the river bank), *Pentaclethra macroloba*, *Virola surinamensis* and *Carapa guianensis*, which were rarer downstream now become dominant.

Further upriver the forest becomes even more diminished and the grassy *campos de várzea* can be seen behind them. In the forest the leguminous tree, *Macrolobium acaciaefolium*, becomes dominant. It presents a peculiar appearance with its trunk and boughs com-

PLATE V.
Várzea forest in Belém, where flooding is caused by the tides.

PLATE VI.
Várzea forest in Belém, at the Instituto Agronômico do Norte, showing a drainage canal and some clearings. The vegetation near the river (the Guamá) is primary forest.

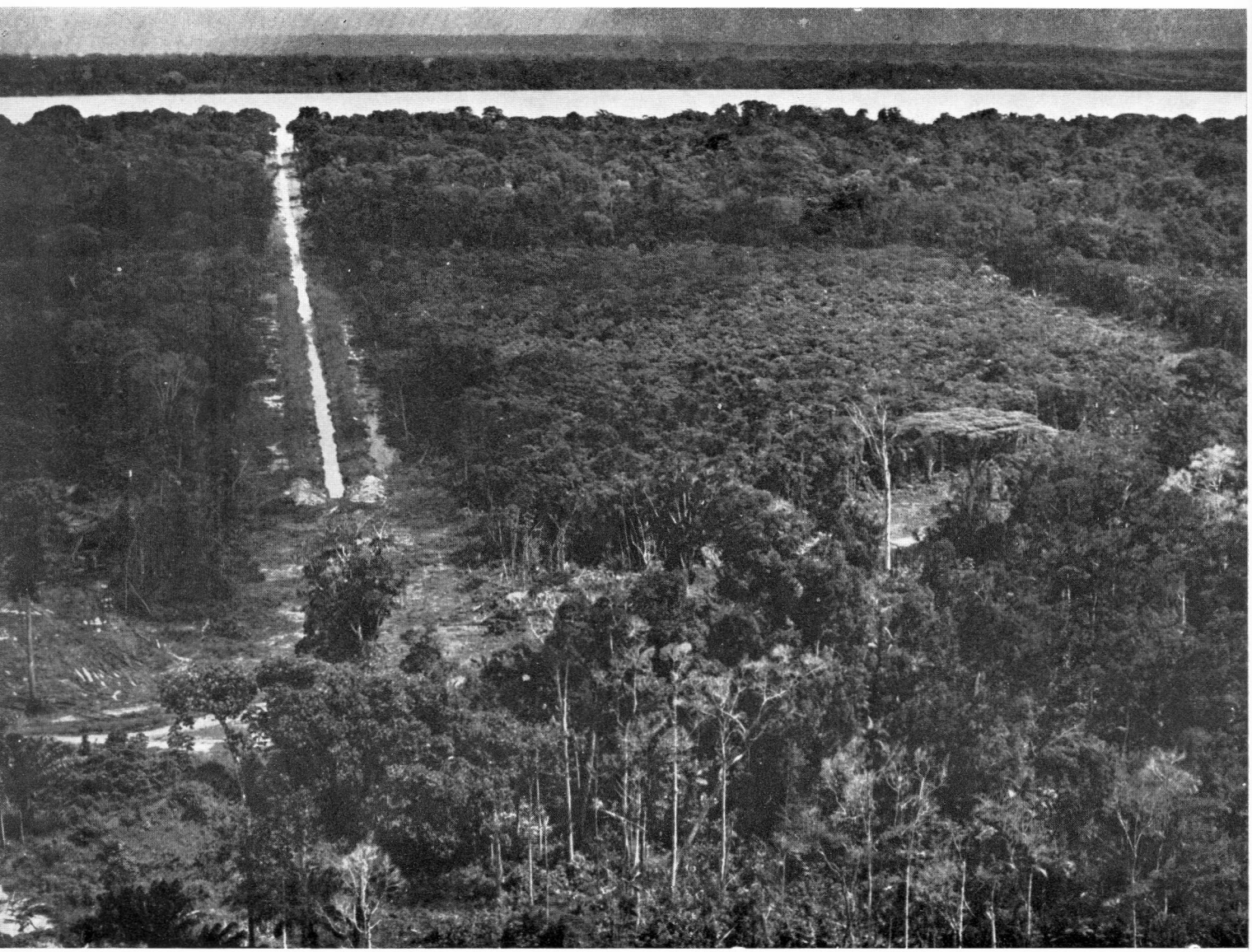

PLATE VII.
Campos de várzea in the Uaça river region.

pletely covered with the bromeliad, *Tillandsia bulbosa*, along with certain other epiphytic *Araceae* and orchids with inconspicuous flowers. Here, behind the *Macrobium*, can be seen hummocks of *Mauritia flexuosa* scattered over the *campo de várzea*. Further upstream, the *várzea* forest and the hummocks of *Mauritia* practically disappear, giving way to the pure *canarana* of the *campos de várzea*.

In the whole stretch of the river where gallery *várzea* forest occurs, of whatever composition, the forest can be interrupted by areas of marsh that, physiognomically, suggest the idea of a transition to the *campos de várzea*, but they are of a completely different species composition from the latter. These patches of marsh contain robust sedges such as *Cyperius giganteus*, *Eleocharis* sp., etc., along with *Thalia geniculata*, *Montrichardia arborescens*, *Eichornia azurea*, *E. pauciflora*, *E. crassipes*, etc. A marsh of this type is called a *cariazal*, and is similar to the above-described *pirizal* marshes of the Baía de Guajará.

Upper Uaçá

In this region occur the vast expanses of *campos de várzea*, which begin with the disappearance of the *várzea* forests as related above (Plate VII). These *campos* occupy the larger part of the flood-plain vegetation of the Uaçá region in general, reaching east to the banks of the Cassiporé. The vegetation is almost purely one of robust grasses, and is very similar in appearance and structure to the *campos de várzea* of the lower Amazon treated above. This affinity of two Amazonian vegetations in regions so distant from each other was not previously known in the literature and was discovered by myself and personnel of the New York Botanical Garden in a joint expedition to the Oiapoque region in 1960.

The most common species in the Uaçá *campos* are *Oryza perennis*, *O. latifolia*, *O. grandiglumis*, *Echinochloa polystachya*, *Luziola spruceana*, *Panicum elephantipes*, *Hymenachne amplexicaulis*, *H. donacifolia*, *Leersia hexandra*, etc., thus the same as those in the ower Amazon. In the lower places non-grasses, such as *Montrichardia arborescens*, *Thalia geniculata* and *Polygonum acuminatum*, can be found.

This whole *campos de várzea* region is extremely rich in fish, *tracajás* (small turtles) and aquatic birds. On the other hand, the same conditions are also optimum for mosquitoes, whose bites are not only troublesome but also carry malaria.

Our observations refer especially to the Rio Urucauá, one of the tributaries of the Uaçá. Here the *campos de várzea* have a width of 500-1,000 metres on either side of the river, or are so extensive in places that one cannot see where they end, particularly eastward.

The river water of the lower Uaça is, as stated, extremely muddy and more or less brackish at certain times of the year. Because of the *pororocas* the quantity of sediment largely exceeds what may be expected. Above the point reached by the *pororocas*, the water becomes gradually clearer until transparent, although still a bit dark. In certain places, we observed green water undoubtedly caused by algae. The biological condition of these waters should be a very interesting subject because of the tremendous proliferation of fish and turtles and the consequent abundance of aquatic birds such as cranes, ducks, *mergulhões*, *guarás*, etc.

The *campos de várzea* end at a sudden rise in the land where the *terra firme* begins. In the background one can see elevations that exceed 300 metres, such as the mountains of Carupina (330 metres), Tipoca and Cajari. In these higher elevations gold occurs in the soil; it is extracted by extremely primitive methods, such as those used on Tipoca.

When the Instituto Agronômico do Norte heard about the *campos de várzea* of the Oiapoque region, it began a study on the possibility of their being used to raise water buffaloes, and is collaborating with the Army in its plan of development of the frontiers (Lima *et al.*, 1960; Lima and Santos, 1961). A pilot ranch has been set up to raise buffaloes.

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Résumé

Les estuaires de l'Amazone et de l'Oiapoque et leurs flores (João Murça Pires)

Cet article traite de la région de l'Amazone en général et plus particulièrement des estuaires de l'Amazone et de l'Oiapoque, ainsi que de leurs flores.

Le cours supérieur de l'Amazone est constitué par la partie du fleuve allant de sa source jusqu'au confluent du Rio Negro. Sa plaine d'inondation (*várzea*), qui s'étend sur 15 000 km², est couverte de futaies inondées tous les ans par la crue du fleuve provoquée par les pluies.

Le cours inférieur de l'Amazone va du confluent du Rio Negro jusqu'au confluent du Xingu. Sa plaine

d'inondation, qui couvre 15 000 km², est couverte de forêts dans sa partie supérieure. Sur la moitié inférieure, une forêt clairsemée borde le fleuve avec, derrière, les *campos de várzea*, plaines d'inondation larges de plusieurs kilomètres et couvertes de hautes herbes. L'inondation est provoquée par les pluies annuelles.

L'estuaire de l'Amazone comprend à peu près 25 000 km² de plaines d'inondation. Dans cet estuaire, les inondations sont provoquées par les marées et non par les précipitations annuelles. La plaine basse est donc inondée deux fois par jour pendant presque toute l'année, tandis que la plaine haute n'est inondée deux fois par jour que pendant les marées de vives eaux.

L'article contient des renseignements sur l'importance numérique des peuplements, les essences et le volume du bois sur pied dans les plaines inondées des régions de Breves et de Belém. On y trouve également des données sur la forêt basse qui s'étend sur des terres nouvellement formées, ainsi que sur les herbages de Marajo et d'autres îles voisines.

Des renseignements détaillés sont donnés sur la végétation des plaines d'inondation de l'Oiapoque et de l'Uaça, aux confins de la Guyane française. L'Oiapoque et le cours inférieur de l'Uaça sont bordés de forêts. Le rideau forestier qui borde l'Uaça s'amincit progressivement au fur et à mesure que l'on remonte le fleuve. Derrière ce rideau s'étend jusqu'aux terres hautes une plaine d'inondation couverte de hautes herbes. Finalement, le rideau forestier qui borde le fleuve disparaît et il ne reste plus que la plaine herbeuse. La région est extrêmement riche en poissons et en oiseaux aquatiques et convient particulièrement bien pour l'élevage du buffle d'eau.

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