DEPARTMENT OF COMMERCE
BUREAU OF FOREIGN AND DOMESTIC COMMERCE
JULIUS KLEIN, DIRECTOR

TRADE PROMOTION SERIES—No. 23

CRUDE RUBBER SURVEY

RUBBER PRODUCTION IN THE AMAZON VALLEY

By

WILLIAM L. SCHURZ, Commercial Attaché, and O. D. HARGIS, Special Agent, of the Department of Commerce, and C. F. MARBUT, Chief, Division of Soil Survey, and C. B. MANIFOLD, Soil Surveyor, of the Department of Agriculture

PREPARED UNDER THE DIRECTION OF
H. N. WHITFORD, CHIEF, CRUDE RUBBER SECTION, RUBBER DIVISION
AS PART OF THE SURVEY OF ESSENTIAL RAW MATERIALS
AUTHORIZED BY THE SIXTY-SEVENTH CONGRESS

PRICE, 65 CENTS
Sold by the Superintendent of Documents, Government Printing Office
Washington, D. C.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1926

CONTENTS

LETTER OF SUBMITTAL

DEPARTMENT OF COMMERCE,
BUREAU OF FOREIGN AND DOMESTIC COMMERCE,
Washington, June 26, 1925.

SIR: Rubber Production in the Amazon Valley is the fourth of a series[1] of publications made under instructions from Congress "to investigate and report on the possibilities of developing the rubber-plantation industry in the Philippine Islands and Latin America." This report discusses the present status of the wild-rubber industry in the various political units of the Amazon Valley and deals with those physical, economic, and political factors that should be considered by the prospective investor in order to judge the possibilities of establishing rubber plantations there.

The proper combination of such physical conditions as topography, soil, and climate exists in many localities and over large and contiguous areas of country. These areas are found both in regions easily accessible and in regions at present lacking adequate transportation facilities. Ocean-going vessels can ascend the Amazon above Iquitos, Peru, and the Tapajoz, Madeira, and Purus for considerable distances from their junctions with the master stream. Areas near these rivers and, in less degree, adjacent areas lying along watercourses that can be used the year round by river boats of fairly large capacity are, of course, considered best from the standpoint of transportation. While excellent natural conditions exist in other regions, the lack of adequate transportation diminishes their chances for successful rubber planting. Such regions as the Acre Territory in Brazil and neighboring areas in Bolivia are handicapped not only by their great distance from an ocean shipping point but also by the decreased navigability of their rivers during the dry season. Development in still other remote regions in eastern Peru, southeastern Colombia, and eastern Ecuador, where physical

[1] The preceding numbers of the series are Trade Information Bulletin No. 180, entitled "Marketing of Plantation Rubber," by J. J. Blandin; Trade Promotion Series No. 2, entitled "The Plantation Rubber Industry in the Middle East," by David M. Figart; and Trade Promotion Series No. 17, entitled "Possibilities for Para Rubber Production in the Philippines," by C. F. Vance, J. P. Bushnell, and A. H. Muzzall, of the Department of Commerce, and Mark Baldwin, of the Department of Agriculture. Publications dealing with the possibilities of plantation rubber production in other tropical regions will appear at a future date.

conditions are otherwise favorable, may be dependent on the opening of railway communication between these districts and the Pacific Ocean.

The territory with which the report deals approximates 2,250,000 square miles in extent, or about three-fourths the area of the United States exclusive of Alaska. The population of this region is estimated at 1,500,000, or considerably less than one inhabitant to the square mile. Under present conditions it is believed that a total of 30,000 laborers might be procurable within the Amazon Basin for rubber-plantation projects—a force sufficient to plant and care for an area of at least 150,000 acres. The most available recruiting grounds for additional labor are in the northeastern States of Brazil, such as Ceara and Maranhao. Labor is most plentiful in the State of Para, especially in those districts that border the Amazon and the lower reaches of its tributaries; it is relatively scarce in most of the State of Amazonas and in the Acre Territory and very scarce in Matto Grosso. There is little surplus labor available in Bolivia, the situation in this respect being much better in Peru.

At the time the data for this report were collected, due to the low price of wild rubber the industry in the Amazon Valley was at a low ebb. Then the usual wage of the class of labor needed in the lower Amazon was 2 to 3 milreis per day, equivalent to 25 to 35 cents at the prevailing rate of exchange. In the upper Amazon the wage schedule was somewhat higher. The price of rubber has since risen rapidly, which has stimulated production in Amazonia and probably affected both the amount of labor available and the daily wage paid.

As a rule, the laborer of the Amazon is of good physique, inured to exposure and under proper incentive capable of long-continued effort. Man for man he could possibly be classified as superior to the Indian and Javanese labor used on the rubber plantations of the Orient and at least equal in efficiency to Chinese labor.

Public land can be obtained in large tracts and at a nominal price in Para, Amazonas, Matto Grosso, and in the Amazon region of Peru and Ecuador, but little unalienated land is available in the Acre Territory or in Bolivia. At the present time high export taxes hamper the wild-rubber industry in Brazil, but the governments of the different political units have indicated their readiness to reduce the tax materially as an inducement to the establishment of rubber plantations. There is no export tax on Peruvian rubber, and the Bolivian tax is very low.

Respectfully,

JULIUS KLEIN, *Director.*

To Hon. HERBERT HOOVER,
Secretary of Commerce.

RUBBER PRODUCTION IN THE AMAZON VALLEY

INTRODUCTION

This report represents the result of an investigation made by a special field party in the Amazon Valley during the period from August 1, 1923, to May 13, 1924. Four representatives of the United States Department of Agriculture cooperated with us, whose findings will be published independently.

PLAN OF THE REPORT

The report will be divided into two parts, the first of which will serve mainly as a résumé and comparison of the data contained in the regional reports that form the second part. As a basis for the regional reports, the Amazon Basin was divided into nine sections, the same method of treatment being employed in the discussion of each.

The area covered comprehends that part of the Amazon drainage basin in which rubber is native or where natural conditions would permit of its cultivation. This embraces by far the greater part of the Amazon Valley, excluding only the higher Andean regions and certain minor sections which are unsuitable, by reason of unfertility or other causes, for the growth of Hevea.

The area extends east and west along the Equator through about 30° of longitude, or a distance of some 2,000 miles. The extreme north and south distance within the area under survey is about 21° of latitude, equivalent to over 1,400 miles, the great bulk of it lying south of the Equator and likewise of the course of the Amazon. This represents roughly the geographical limits of the native habitat of the Heveas. The total extent of this territory approximates 2,250,000 square miles, divided as follows: Brazil, 1,486,900 square miles (Amazonas 694,800, Para 424,600, Matto Grosso 308,800, Acre Territory 58,700), Bolivia 200,000, Peru 225,000, Ecuador 100,000, Colombia 150,000, and Venezuela 30,000 square miles.

Among the more important rivers of the Amazon system whose basins were investigated were the Tocantins, Xingu, Tapajoz, Madeira, Mamore, Beni, Madre de Dios, Acre, Purus, Ucayali, Huallaga, Negro, and Branco. In all, the survey covered some 37 rivers, representative of conditions in all parts of the Amazon Valley. Many penetrations inland were made for the purpose of ascertaining conditions in the interior.

ACKNOWLEDGMENT OF INDEBTEDNESS FOR ASSISTANCE

Our investigations were greatly aided by the active good will shown us by the Governments of Brazil, Bolivia, and Peru. They particularly facilitated our work by placing well-equipped steamers

at our disposal, thereby enabling us to cover a much larger territory than would otherwise have been possible. In various ways these Governments and their local representatives contributed to the greater effectiveness of our work, the Brazilian Government, for example, naming a special commission of experts to cooperate with our party.

It would be difficult to acknowledge our indebtedness to each one, whether Government official or private individual, who aided us in our labors. However, we desire to express our appreciation of the contributions to the success of our investigation which were made by a few of the outstanding public men of the three countries. Among Brazilians were Dr. Miguel Calmon, Minister of Agriculture, Industry, and Commerce; Dr. Sebastiao Sampaio, Under Secretary of Foreign Affairs; Dr. Antonino E. de Souza Castro, Governor of the State of Para; Dr. Jose da Cunha Vasconcellos, Governor of the Acre Territory; Col. Leopoldo de Mattos, Fiscal Delegate of the State of Matto Grosso at Manaos; and Dr. Barroso Rabello, Mayor of Para; among Bolivians, Dr. Rodolfo Arauz and Col. Herberto Arinez, respectively the superior civil and military authority in the Territory of Colonias; among Peruvians, Gen. Gerardo Alvarez, Prefect of the Department of Loreto, and Sr. Samuel Young, Mayor of Iquitos.

Among the many private individuals whose kindness we take pleasure in acknowledging are M. Paul LeCointe, director of the Commercial Museum of Para; Dr. Guilherme Paiva, general manager of the Amazon River Steam Navigation Co.; Alexander Macfarlane, general manager of Manaos Harbor; Sr. Oswaldo Vaca Diez, of Riberalta; Sr. Pablo Zumaeta, of Iquitos; and Capt. Goncalves, of the *Andira;* and among proprietors of rubber properties and commercial firms, Suarez and Seiler, of Bolivia; Araujo and Mattos Areosa, of Manaos; Nicolau da Costa, of Para; and Israel and Hernandez, of Iquitos, not to name many others.

This list would be incomplete without mention of our high regard for the members of the Brazilian commission which accompanied us on our travels in that country and which included Dr. Hannibal Porto, Dr. Avelino Ignacio de Oliveira, Dr. J. G. Kuhlmann, Dr. Fernando Soledade, and Col. Raimundo Monteiro da Costa. We also owe much to the cooperation of the commercial associations of Manaos and Iquitos. Among Americans we are particularly indebted to George Pickerell, consul at Para, and James Roth, vice consul at Manaos, and to Dr. H. N. Whitford, chief of the Crude Rubber Survey, whose intelligent and sympathetic direction of our work from Washington greatly aided our progress.

PART I

HISTORY OF THE AMAZON RUBBER INDUSTRY

BEGINNING OF THE INDUSTRY

The rubber industry of the Amazon Valley is now nearly a century old. According to the official records of the Province of Para, Brazil, 31,365 kilos (69,147 pounds) of rubber were exported from that area in 1827. By 1853 this total had risen to 2,365,285 kilos (5,214,560 pounds) as a result of the greater demand created by the discovery of the process of vulcanization. From that year the production of the upper Amazon area is entered separately under the newly created Province of Amazonas, whose exports first exceeded those of the Province of Para in 1887. During this period new fields were opened in the basins of the Madeira, Purus, and other rivers, and the areas under exploitation in the lower Amazon country were being pushed farther up the main tributaries, such as the Tapajoz.

Meanwhile, beginnings of an industry had been made in the non-Brazilian sections of the Amazon Basin. The first recorded shipment from Peru came down the Amazon in 1853 to the total amount of 3,591 kilos (7,917 pounds), but the chief interest of the Peruvian rubber gatherers was in caucho, or the product of the Castilla, in quest for which they even penetrated far up some of the Brazilian rivers.

The first shipment of rubber from Bolivia is said to have reached Santo Antonio on the Madeira in 1865, but the Bolivian field was actively developed only from the eighties onward, when the Suarez brothers, Vaca Diez, and other pioneers began their operations in the basin of the Beni.

Venezuela first exported rubber down the Rio Negro and the Amazon in 1866, and the first lot of Colombian rubber is reported to have come out in 1869. However, the industry never reached important proportions in either of these countries, due to the remoteness of their rubber-bearing areas and the difficulty of transportation by the only outlets available.

Of the other Brazilian areas, Matto Grosso was opened late, the first recorded shipments by way of the Amazon having been made in 1900. Some rubber from the far interior of that State was also sent out over the watershed to navigation on the Paraguay at Corumba. On the acquisition of the Acre Territory from Bolivia by the treaty of Petropolis in 1903 that highly important area began to swell the total of Brazilian production. Between 1904 and 1908 exports from the Acre rose from 2,249,440 kilos to 11,270,453 kilos (from 4,959,116 pounds to 24,847,097 pounds).

By 1908 the total exportation of Amazonia had risen to 40,807 metric tons (40,164 long tons), of which Brazil produced 35,686

metric tons (35,124 long tons). The next year the rubber "boom" in the Amazon Valley was well under way and continued after the fluctuations of that year until April, 1910, when prices reached their apex. Under the stimulus of the extraordinary market conditions credits were extended throughout the different branches of the rubber business and the ground thus prepared for the disastrous crisis that was certain to follow the inflation of prices. This crisis came with the abrupt drop in prices which began in April, and resulted in the ruin of most of the houses in Manaos and Para that traded in rubber, as also of many producers who had overextended their credits in the apparent belief that the exaggerated high prices of rubber would continue indefinitely.

GOVERNMENT-AID PROJECTS

Though foreign rubber, especially from Africa, had been appearing in the market for several years, producers in the Amazon Valley

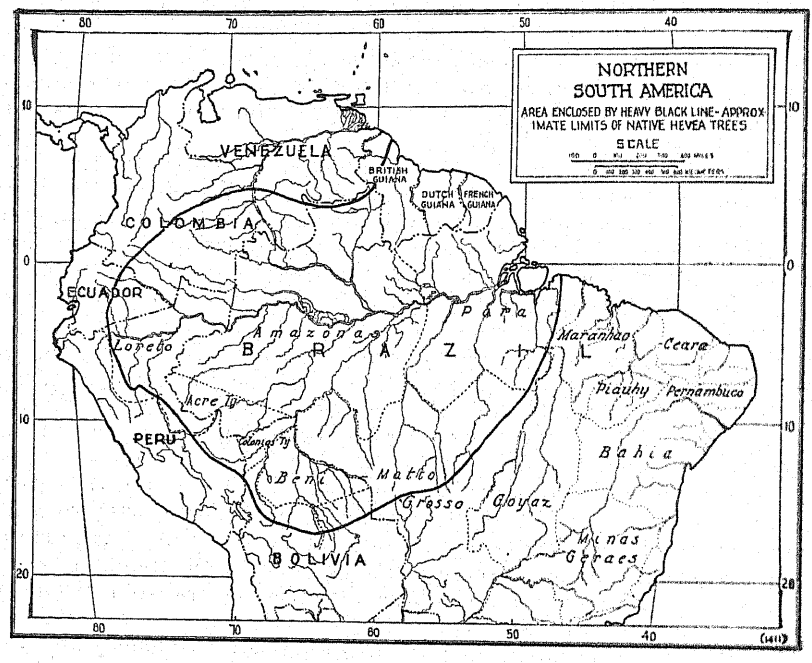


FIG. 2

had shown little concern over the future possibilities of this competition. However, the advent of rubber from the plantations of the Middle East, whose impending importance the Brazilians were disposed to minimize, was by 1910 seriously threatening the position of Amazon wild rubber. In 1913 the production of the Asiatic plantations passed the wild output of the Amazon area, and two years later had hopelessly outdistanced it.

The rubber interests of the Amazon country, disheartened by the results of the great crisis in the industry and by the rising menace

of plantation rubber, appealed for Government aid. The form which this aid first took was that known in southern Brazil (where the plan had already been tried in connection with coffee) as "valorization." However, the circumstances in the two cases were entirely different, since Amazonian rubber no longer held such a dominant place in the world market as was held by the coffee of Sao Paulo.

The Bank of Brazil was, nevertheless, intrusted in 1911 with the work of valorizing rubber, in the belief that by accumulating and withholding from the market a sufficiently large stock it could maintain the price of the product. This expedient failed to retard the decline of the industry, the Bank of Brazil losing immense sums in its effort to stem the tide of falling prices.

"DEFENSE OF RUBBER" SCHEME

The Government was meantime elaborating the vast project which was finally put into execution under the name of Defesa da Borracha (defense of rubber). This scheme was sponsored by the Minister of Agriculture, and organized under the auspices of that department of the Federal Government. The purpose of the Government was announced by a decree of January 5, 1912, and the complete regulations were issued in another decree of April 17 of the same year. The principal provisions of the preliminary decree were:

1. Exemption from import duties of tools and materials used in rubber industry.

2. Premiums for the planting of rubber trees, including not only seringueira (Hevea), but caucho (Castilla), maniçoba (Manihot), and mangabeira (Hancornia). Additional premiums for the cultivation between rows of rubber trees of food plants and plants with industrial uses.

3. Establishment of experiment stations for the study of Hevea culture in the Acre Territory and in the States of Matto Grosso, Amazonas, Para, Maranhao, Piauhy, and Bahia, and for the culture of maniçoba and mangabeira in Piauhy, Ceara, Rio Grande do Norte (or Pernambuco), Bahia, Minas Geraes, Sao Paulo, Goyaz, Parana, and Matto Grosso.

4. Premiums for the establishment of factories for refining and standardizing rubber for shipment and for the manufacture of rubber goods.

5. Erection of immigrant hotels and hospitals at several points.

6. "For the purpose of facilitating transportation and reducing its cost in the Amazon Valley," the following improvements were to be made:

(*a*) Construction of narrow-gauge railroads along the Xingu, Tapajoz, and other rivers in the States of Para, Matto Grosso, and Amazonas.

(*b*) Construction of a railroad to leave the line of the Madeira-Mamore near the mouth of the Abuna, thence across the Acre Territory to the Jurua.

(*c*) Construction of a trunk railroad from Para to connect with the system of the Central of Brazil at Pirapora in Minas Geraes, with the northeastern lines at Coroata in Maranhao, and with branches to navigable points on the Araguaya, Tocantins, Parnahyba, and Sao Francisco.

(*d*) Opening to all-year navigation for vessels of 3-foot draft of the following rivers: The Negro, between Santa Isabel and Cucuhy; the Branco, to Fort Sao Joaquim; the Purus, from Hyutanaham to Senna Madureira; and the Acre, to Riosinho das Pedras.

7. All vessels destined for river navigation within the region covered by the scheme to be exempted from customs and other duties.
8. Favors to be granted for the establishment of coal fueling stations at several points on the Amazonian rivers.

OTHER FEATURES OF THE PLAN

9. To promote the production of foodstuffs in the Amazon Valley the Government proposed the following means:

(*a*) Leasing of two of the federal reservations on the Branco River for the breeding of livestock on a large scale, the production of cereals and other food crops, and the establishment of packing houses, dairies, rice-hulling mills, and flour mills.
(*b*) Colonization of the Sao Marcos reservation of the Federal Government on the Branco River for the production of foodstuffs and the breeding of draft animals.
(*c*) Premiums and other favors to concerns which would locate in the Acre Territory and in the States of Amazonas and Para in accordance with the above-mentioned clauses.
(*d*) Exemption from import duties and other favors for the establishment of an enterprise for the salting and preserving of fish in the Amazon Valley.

10. Decision to verify the legality of land titles in the Acre Territory.
11. Proposal to hold an exposition of the rubber industry every three years in Rio de Janeiro.
12. Proposal of the Federal Government to enter into agreements with the state governments of Para, Amazonas, and Matto Grosso for the reduction of export duties on rubber, and corresponding reduction of export duties in the Acre Territory.

CROP DIVERSIFICATION AFTER RUBBER CRISIS

The purpose of the rubber defense act was excellent, and most of the provisions of the law well calculated to aid in the revival of the Amazon rubber industry. However, several circumstances made its failure inevitable. In the first place, the program was too vast for execution. Even the large credits voted to put the decree into effect were entirely inadequate for the purpose, and there was lacking moreover, the experienced administrative personnel that was needed for its execution. Under these circumstances little that was permanent could be accomplished, and the following year most of the enterprises which had been initiated ceased operations. Thenceforth except for sporadic State laws for the encouragement and protection of the native rubber business, the industry was abandoned to the working of natural laws. This meant the rapid decline of the position of Amazonian wild rubber in the world market as larger areas of plantations in the East came to maturity.

The crisis had brought financial ruin to many of those engaged in the production and sale of rubber and led to the abandonment of considerable areas of rubber country. Some salutary results came of all this, among them the diversion of interest to other industries such as castanha (Brazil nuts) and, in Peru, cotton. It also led to

the wider cultivation of foodstuffs for local consumption, in contrast to the old system of buying nearly all food from Manaos or Para, much of which was of foreign origin.

INVESTMENT OF FOREIGN CAPITAL

An interesting phase of the history of the rubber industry in the Amazon Valley was the investment of foreign capital in several enterprises, either for the working of wild rubber or the planting of Hevea. Of these companies, listed below, many have disappeared from the field, in some cases having transferred their holdings to local interests, although a few have continued to work their properties.

Name of company	Nationality	Location		Remarks
		Country	River	
Braillard & Co. (Seiler & Co.)	Swiss	Bolivia	Madre de Dios	Operating.
Soc. Picollet	French	do	Abuna	Do.
Alfredo Barber & Co	German	do	Orton	Do.
Vezie et Cie	French	do	Madidi	Liquidated.
Zeller, Villinger & Co	German	do	Mamore	Operating.
Bolivian Rubber Enterprise (Ltd.)	British	do	Mapiri	Do.
Anglo-Bolivian Rubber Estates (Ltd.).	do	do	Blanco	Do.
Inambari Rubber Estates (Ltd.)	do	do	Inambari	Liquidated.
Tumbopata Rubber Estates (Ltd.)	do	do	Tambopata	Do.
Orton & Bolivian Rubber Co	do	do	Orton	Do.
Bolivian Rubber Syndicate	American	do	Acre	Do.
Comptoir Colonial Francais	French	Brazil	Javary	Do.
Moju Rubber Estates	American	do	Moju	Operating.
Cie. de Caoutchouc de Canutama	French	do	Purus	Liquidated.
Anajas Rubber Estates	British	do	Anajas (Marajo I.)	Do.
Diamantina Rubber Estates	do	do	Tapajoz	Do.
General Rubber Co	American	do	Juruena	Not operating.
Guapore Rubber Co	British	do	Guapore	Operating.
Julio Muller Rubber Estates	do	do	do	Do.
De Mello Rubber Co	do	do	Acre	Liquidated.
Pacaya Rubber Estates	do	Peru	Pacaya	Do.
Peruvian Amazon Co. (Ltd.)	do	do	Putumayo	Operating.

PRESENT STATE OF NATIVE (WILD) RUBBER INDUSTRY

The wild-rubber industry in the Amazon Valley has in the past few years fallen from the standing of a highly profitable business to that of a precarious and demoralized undertaking. This has been brought about by the increasing production of the plantations of the Middle East and the consequent overwhelming competition. The Eastern plantations have furnished a cleaner and more uniform product to the manufacturers at a price below which wild rubber can not be produced profitably except in certain favorable localities. Added to this came the business depression of 1920 and 1921 and the continued low price of crude rubber. The result in the Amazon Valley has been a general curtailment of output, with acute losses for proprietors of rubber-producing lands and hardships for the gatherers.

At the present time the industry is in a very uncertain and depressed condition. On some rivers in Brazil—for example, the lower

Purus—the rubber area has been abandoned and the population has moved to other sections. In Peru gathering has practically ceased. Rubber is still being produced in eastern Bolivia, but this is mainly due to the fact that a few individuals control immense acreages and even here the production has been curtailed. In many of the areas of the valley which formerly depended entirely on rubber the inhabitants are turning to the exploitation of other products, either agricultural or forest. In certain localities where large amounts of caucho (*Castilla ulei*) still remain there is a tendency toward increased production of this rubber, since it does not require so much

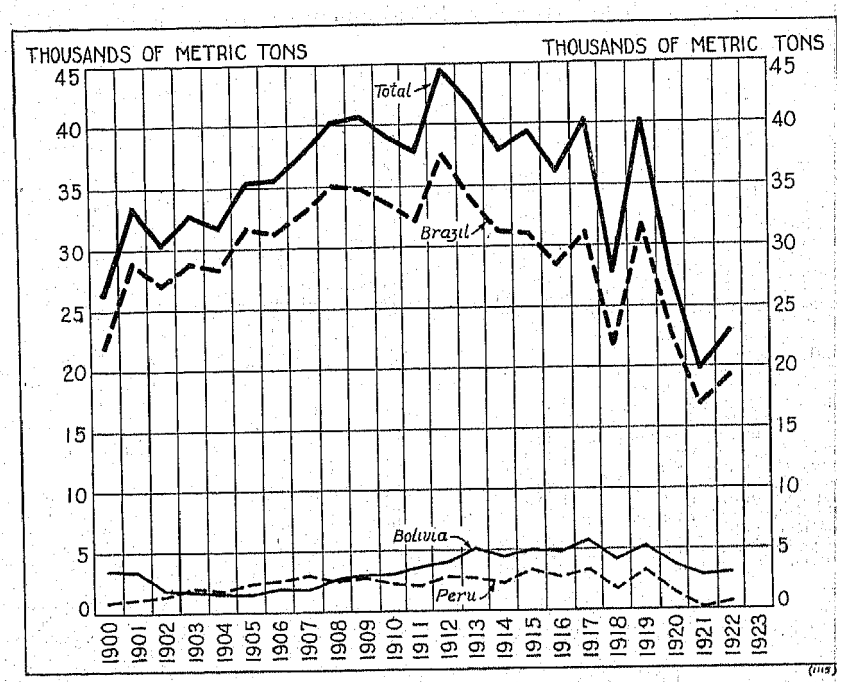


FIG. 3.—Production (exports) of crude rubber, Amazonia

overhead expense as Hevea, and the gatherer can produce a much larger quantity in a season, thereby greatly reducing the initial cost.

The decline in Brazil, Bolivia, and Peru, from the year of highest production (1912) through 1923 is made evident by the following table. The statistics, which are from official sources, represent exports; but in the lack of production records of any kind and in the absence of domestic consumption the figures can be regarded as equivalent to output and are so employed in this review. The quantities are given in metric tons of 2,204.6 pounds—the "ton" used throughout this report. Some discrepancy exists between the totals given here and those appearing in the regional reports of Part II, the latter having been locally compiled from various sources.

TABLE 1.—PRODUCTION (EXPORTS) OF CRUDE RUBBER, AMAZONIA, 1912–1923

Years	Amazon region [1]				Brazil outside Amazon region [2]
	Brazil	Peru	Bolivia	Total	
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
1912	38,173	2,814	4,080	45,067	4,114
1913	34,450	2,780	5,143	42,373	1,781
1914	31,714	2,272	4,485	38,471	1,817
1915	31,555	3,401	5,055	40,011	3,611
1916	28,868	2,812	4,917	36,597	2,627
1917	31,595	3,295	5,842	40,732	2,403
1918	22,215	1,737	4,288	28,240	446
1919	32,251	3,232	5,347	40,830	1,001
1920	22,927	1,478	3,759	28,164	661
1921	17,182	133	2,844	20,159	257
1922	19,483	607	3,079	23,169	373
1923	[3] 17,991	567	2,979	21,537	(4)

[1] The small quantity of rubber coming out of Colombia, Venezuela, Ecuador, and the disputed territory, down the Amazon River system probably loses its identity and is included in the exports from Peru and Brazil.
[2] Mangabeira and maniçoba rubber; chiefly the latter.
[3] Official figure for all Brazil; practically all from Amazon Valley.
[4] Figures not yet available; see note 3, just preceding.

HEVEA

Of the more than 20 classified species of Hevea only two, *Hevea brasiliensis* and *Hevea benthamiana*, produce a commercial, high-grade rubber, and of these the former is by far the most widely distributed. It is this tree which is ordinarily understood when the term "Para" or "fine" rubber is used.

Both *Hevea brasiliensis* and *Hevea benthamiana* produce fina or "fine" rubber, though some authorities claim that the benthamiana rubber is slightly inferior to the brasiliensis. Some of the other species—for example, the *Hevea guyanensis*, which yields a smaller quantity of latex—produce a weaker rubber known on the local markets as fina fraca ("weak fine") in Brazil and jebe debil in Peru. Other species, such as the collina, the pauciflora, or a mixture of several, produce a weak rubber known locally as fraca, torrada, etc.

In general, the different species are localized as to their natural habitat. This is especially true of the two most important, *Hevea brasiliensis* being found almost wholly on the south side of the Amazon River (the only areas so far known on the north side being around the town of Codajaz west of Manaos and in the Macapa zone near the mouth of the river) and *Hevea benthamiana* being confined practically to the northern tributaries of the Amazon. Some of the other species, particularly guyanensis and spruceana, are distributed over the whole valley.

DISTRIBUTION OF HEVEA BRASILIENSIS

Hevea brasiliensis is found principally in a belt of varying width which begins east of the Moju River in the State of Para and swings around in a semicircle until it reaches the foothills of the Andes in

Bolivia and Peru. Its northern edge can be roughly taken as the first line of cachoeiras, or rapids, in ascending all the rivers flowing north into the Amazon. In the State of Para this limit is rather close to the Amazon River, approximately 100 miles. It gets farther away from the Amazon until near its center on the Madeira and Mamore Rivers it is approximately 800 miles. Then, as it swings around through western Brazil and eastern Bolivia and Peru it again reaches approximately the same distance from the Amazon as in Para.

The belt is irregular in width, being narrowest at its eastern and western limits and widest in the middle, stretching back into the highlands of the State of Matto Grosso to 15° south latitude. The tree is not distributed uniformly in this belt but is found in irregular areas—in the valleys and along the banks of all the rivers, and on the hills and rough lands, where it attains its best development.

In the area between the northern limit of this belt and the Amazon *Hevea brasiliensis* is found only on the banks of rivers and the flood lands of the river valleys. These trees evidently have sprung from seeds washed down originally from the uplands above, as doubtless also did the Heveas on the islands of the delta.

DISTRIBUTION OF BENTHAMIANA AND OTHER SPECIES

Hevea benthamiana is found on all the main rivers in Brazil (and their tributaries) which flow southward into the Amazon, particularly above their cachoeiras, or rapids. This is true also of the tributaries of the Amazon which have their source in or flow through Ecuador, Peru, and Colombia. Benthamiana is also found, in Brazil at least, in the forests of the uplands. Since a large part of the area above the cachoeiras in Brazil consists of campos, or open grasslands, with the forest growth confined to clumps and along the margins of the rivers, the known rubber-bearing area is very much less than on the south side. (There are large sections of this region still unexplored.) *Hevea benthamiana* is also found in isolated spots on the south side of the Amazon, particularly on the lower Jurua River.

The most important of the other species of Hevea are the guyanensis, collina, pauciflora, and spruceana. As a general rule they are localized in their distribution separate from the brasiliensis, though occasionally some of them, particularly the guyanensis, are found intermingled therewith. What factors cause this differentiation are not yet clear. All of these species are widely distributed over the whole Amazon Valley. The *Hevea spruceana*, known locally as the barriguda (bellied) on account of its shape, is found on the low swampy lands of the rivers. It has no commercial importance beyond the use of its wood for the manufacture of the boxes for shipping rubber. The guyanensis is found in the area between Guiana and the Amazon, in the western end of the basin in Ecuador and Peru, and, on the south side, on the uplands of the southern affluents of the Amazon. So far as known none of these last-named varieties are present in the highlands of Matto Grosso, the Acre, and eastern Bolivia.

CHARACTERISTICS OF HEVEA BRASILIENSIS

In its natural state the Hevea is an ordinary forest tree in appearance. It has a straight, cylindrical stem without branches until near the top. Its crown of leaves is small. Under conditions which allow a greater freedom of development these characteristics are much modified; the tree is lower, with its branches beginning near the ground, and it develops a large crown of leaves.

In those areas where *Hevea brasiliensis* is found in relatively large numbers, and where it has its best natural development—as, for example, in the Acre Territory of Brazil—the soil is uniform and of a texture easily penetrated by roots. The taproot gradually tapers from the base to the end, going down 10 to 15 feet and in some cases possibly deeper. The lateral roots radiate in all directions a short distance underground; where the taproot is obstructed in its downward growth by encountering a hard surface or a permanent water level it splits up into many branches which then extend laterally.

Hevea brasiliensis sometimes attains large size but rarely equals in this regard such trees as the Brazil nut (*Bertholletia excelsa*) or the sumauma (*Ceiba pentandra*). Hevea trees were encountered which measured as much as 16 feet in girth at 3 feet from the ground and were approximately 150 feet in height. An authentic case of a tree measuring 28 feet in girth was heard of. It is rare, however, to find trees measuring as much as 14 feet in girth; the average girth of the tapped tree in the Amazon Valley is around 7 feet (corresponding to a diameter of 2.2 feet), with an average height of 80 to 100 feet. The wood is soft and easily broken.

BARK STRUCTURE

It is the nature of its bark which has caused the Hevea to become the premier rubber-producing tree of the world. This is made up of a thin corky exterior, brown or gray in color, below which are two layers of cells and tissue, then the thin, soft cambium (or cell-forming) layer adjacent to the wood. These four layers constitute what is commonly understood as the bark. On old trees the bark may be as much as an inch thick, but ordinarily it is around three-eighths to one-half inch on mature trees.

A network of special cells extending around the tree, arranged more or less in a longitudinal direction, in the bark between the cambium and the outer corky layers, contains the latex.

The bark has an admirable consistency for the passage of sharp tapping implements, combined with a remarkable faculty for recovering from the effects of wounds and the quick renewal of excised bark.

YIELD PER SEASON

Little accurate work has been done or records published on individual tree yields in the Amazon country. It is not possible, therefore, to give average yield per acre or for trees of a certain age, as can be done on the Eastern plantations.

Yields are estimated by estradas, or groups of wild trees, these varying in number from 120 to 200, with an average of 150 trees.

FIG. 4.—A forest *Hevea brasiliensis* at Tres Casas on the lower Madeira

It has in the past been the general rule for the seringueiro to tap two estradas, tapping each on alternate days. The tapping season is from four to six months in the dry period, though for various reasons the tappers do not work more than 100 to 150 days in this time.

The production per man per season varies widely, depending on such factors as age of trees, local climate, length of time the trees have been tapped, and the skill and industry of the individual tapper. In the lower Amazon Basin and the lower courses of the

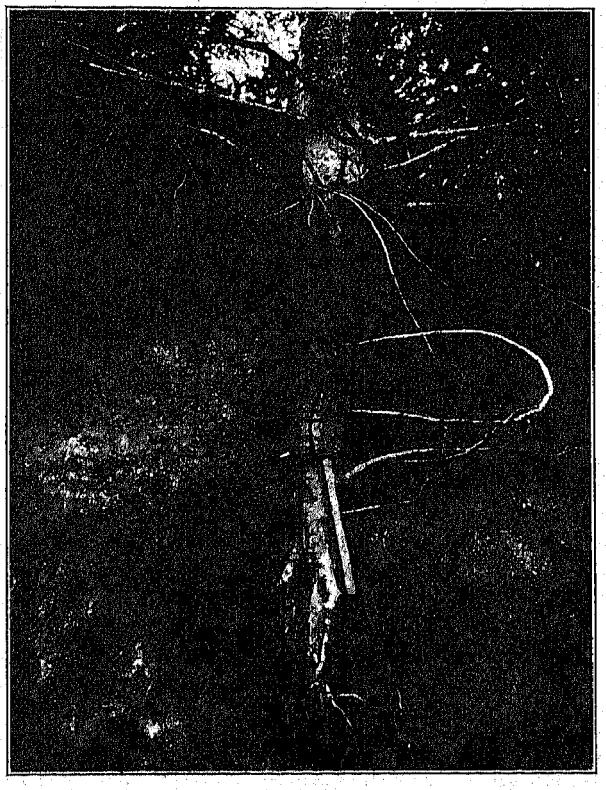


FIG. 5.—*Hevea brasiliensis*, showing tap root. Abuna River, Acre Territory

rivers where rubber has been produced for many years, such as the Madeira, Purus, Jurua, and Javary, the production per man per season is very small, being around 450 pounds. On the upper rivers and in the regions where the trees have not been tapped for so long or where virgin trees are available the average is much higher, ranging from 800 to 2,200 pounds or more.

YIELD PER TREE

The French botanist, O. Labroy,[1] after an extended investigation on the Tapajoz and Xingu Rivers states that for the regions examined "the production of an average tree per tapping was estimated to be 22 grams [0.776 ounce] of 'fine' rubber. For 140 days

[1] Labroy, O., A Borracha no Brazil, p. 32.

of the tapping season there would be obtained 22 grams×140=3.08 kilos [6.79 pounds] per tree, or approximately 400 kilos [say, 880 pounds] of dry rubber per estrada. To this must be added approximately 100 kilos of scrap." An addition of 25 per cent for the scrap would, therefore, make the average yield per tree per tapping 27½ grams [0.97 ounce].

After a tree has been tapped for several years in succession the yield diminishes and the tree is said to be cançado, or tired. It is the custom to allow such trees periods of recuperation[2] ranging from 8 to 12 years, after which they are tapped again.

Many trees die from the effects of drastic tapping (which causes wounds through which wood-boring insects enter), but where care is taken in tapping and periods of rest are allowed the productive life of the tree is very long. Trees along the lower rivers, many of which were planted 40 and 50 years ago, are still producing. One lot below the town of Maues planted in 1859 was healthy and vigorous in appearance; though not tapped regularly at present, the trees are still productive.

It is our opinion that under an equality of circumstances, such as ages and conditions of cultivation and methods of tapping, the individual tree yield would be greater in the Amazon Valley than is the present average yield on the Eastern plantations.

QUALITY OF PRODUCT

In its broadest classification the rubber produced in the Amazon Valley is divided into three categories—"fine" (fina), "weak fine" (fina fraca), and "weak" (fraca). Except in the case of "fine" there is great confusion as to the source, from a botanical standpoint, of the different classes. Little scientific work has been done in South America in this connection for several years, and authorities differ greatly among themselves in the botanical classification of the Heveas with respect to commercial production. This apparently has been due to production being confined to "fine" only, the price received for the inferior kinds not being sufficiently remunerative.

BOTANICAL CLASSIFICATION

The most common classification of the Heveas is the following, which is substantially that of the late Dr. Jacques Huber,[3] former director of the Museu Goeldi, Para:

"Fine"—Brasiliensis and benthamiana.

"Weak fine"—Guyanensis, or a mixture of this, brasiliensis, or benthamiana.

"Weak"—Collina, negra, cuneata (or peruviana Lechl.), lutea, and paludosa.

Other Heveas which are poor latex yielders and produce a weak and sticky rubber are spruceana, discolor, and similis.

At the present time the "weak" varieties have little commercial importance. These trees, however, form an immense reserve of wild

[2] A modification of this system of allowing definite periods of rest may have in the future some influence in Eastern plantation practice in prolonging the productive life of the trees.

[3] Proceedings of the International Rubber Congress, London, 1911, p. 80.

rubber which may or may not have a commercial importance in the future.

The difference between "fine" and "weak" rubber is pronounced. The "weak" lacks the tensile strength, elasticity, and nerve of the "fine." "Fine" rubber is hard, and the balls will hold their shape for years, while the "weak," being softer, will soon flatten out.

MARKET GRADES

Rubber from the *Hevea brasiliensis* (or *Hevea benthamiana*) is divided into three grades by the purchasers—fine (fina), medium (entrefina), and coarse (sernamby virgin and sernamby rama).

Fine.—By this term is understood the mass, or balls, produced by coagulation with smoke, as described on page 22. It is the highest grade of rubber and is the equivalent of the term "hard fine Para."

Medium.—This is the product produced when the latex coagulates in a clotty condition or when the smoking is incompletely done. It is taken in thin strips from the layers when the balls are cut open for inspection and classification.

Coarse.—The term "sernamby virgin" is used to designate rubber produced from naturally coagulated latex. It often forms in the container, before coagulation of the whole is completed, thus corresponding to "lump" in plantation processes. It is used to form the core in making the pellas or balls. The same term is used to designate the masses sometimes found on virgin or tapped trees resulting from a copious exudation of latex caused by wounds or disease.

Sernamby rama is the ordinary coarse or scrap. It is the residue from the cups, the containers, and the drippings which have coagulated naturally. It is the cheapest grade produced, being badly oxidized from the action of the sun, and contains much dirt and foreign matter.

PRICE IN RELATION TO SOURCE

The relative proportions of the three classes produced are fine 61 per cent, medium 11 per cent, coarse 28 per cent.

The buyers in Manaos and Para, in fixing the prices to be offered, make a distinction as to the source of the rubber, it being considered that the product from certain localities is superior to that from others. The different classes are shown in the following outline:

Fine:
- Sertão (interior)—
  - First quality.—Federal and upriver (Acre, Bolivian, and Peruvian).
  - Second quality.—Upper Madeira, Purus, Jurua, Matto Grosso.
  - Third quality.—Lower Jurua.
- Islands.
- Upper Xingu.
- Upper Tapajoz.
- Caviana Island.

Coarse:
- Sertão (interior and upriver).
- Islands.
- Cameta.

WILD AND PLANTATION HEVEA COMPARED

Until the advent of plantation rubber, fine hard Para was the best rubber commercially procurable, the most widely used, and the standard of comparison by which other rubbers (including plantations later) were judged. Until quite recently fine hard Para has exhibited more uniformity in respect of rate of cure than plantation rubber, this possibly being due to the more advanced age of the trees or to the fact that the mass is built up by working on a number of days.[4]

South Americans generally believe that the Amazonian product is superior to Eastern plantation rubber, pointing to the fact that for many years it commanded a premium over the latter. However, with the recent advances made in plantation processes of preparation there seems to be no reason to consider the Amazon latex inherently better or the system of coagulation productive of a superior rubber.

Whitby[5] states that the method of preparation followed in making fine hard Para appears to have no advantages from the point of view of the quality of the rubber produced, as judged by vulcanization tests, over the methods used on plantations.

CAUCHO

The first rubber produced on a commercial scale in South America was derived from one of the species of Castilla. Production began in Peru on a small scale in 1882 and gradually increased, not only in Peru but in the adjoining countries. The Peruvian gatherers, known as caucheros, have always been the pioneers in the exploitation of this product in the Amazon Valley, and their activities carried them over all the rubber-bearing section of South America as far north as Central America. The area in which this tree is found covers a wide range, it growing wild from Mexico southward to the interior of Matto Grosso in Brazil.

In South America the rubber derived from this tree is always called caucho. Its scientific name is *Castilla ulei*, and it appears to be the only species of the Castillas in the Amazon Valley. In its vegetative character it differs little from the species of this genus found in Mexico and Central America. It is a large tree; many equal in size the largest Heveas.

DISTRIBUTION OF CASTILLA

In the Amazon Valley the Castilla occurs in a wild state from the Andes Mountains to the Tocantins River. It is found on the highlands between all the southern affluents of the Amazon, roughly beginning at 100 miles' distance from this river. In some of these regions, particularly in the Brazilian States of Para and Matto Grosso, where transportation is difficult and exploration has been held back by the presence of hostile Indians, large reserves of caucho

[4] Department of Agriculture, Federated Malay States, Bulletin No. 27, 1918, p. 364.
[5] Whitby, G. Stafford, Plantation Rubber and the Testing of Rubber, p. 201. Longmans, Green & Co., London, 1920.

are known to exist. Caucho is also found in some localities on the north side of the Amazon, particularly on the Rio Negro and on the Trombetas. Little that is definite is known of the area west of the Rio Negro and north of the Solimoes (Amazon), since much of it has not been thoroughly explored for its rubber possibilities.

Peru and Bolivia were originally rich in caucho, but due to the system of collection the most available trees have been destroyed, and while a considerable amount of caucho still exists it is to be found only in distant places difficult of access.

YIELD PER SEASON AND PER TREE

In the best localities a mature tree will produce 25 kilos (55 pounds) of dry rubber, with the average around 20 kilos (44 pounds). The cauchero, in a season of six months, usually collects about 1,500 kilos (3,300 pounds). In some places on the upper Mamore River he can collect from 3 to 4 tons (3,000 to 4,000 kilos) in a season.

In Brazil at the present time there is a slight trend toward an increased production of caucho in proportion to that of Hevea. For the four-year period 1906–1909 Hevea formed 81.75 per cent and caucho 18.25 per cent of the rubber shipped from Manaos. In 1910–1913 the respective shares were 82.25 and 17.75 per cent; in 1914–1917, 81.75 and 18.25 per cent; in 1918–1921, 80.50 and 19.50 per cent.

MARKET GRADES

Caucho comes under the general classification of "fine" and on the Para and Manaos markets is subdivided into the two general classifications, sernamby de caucho (caucho ball) and caucho prancha (slab).

In this case the nomenclature is confusing, since the sernamby (literally, scrap) is the higher grade. The sernamby de caucho is that which has coagulated naturally in the incisions on the trees and has been pulled out in strips or ribbons, which are rolled or tied in balls or blocks. The caucho prancha, or slab, is that which runs into a hole in the ground or a receptacle and coagulates naturally or with the aid of soap or vines. It is dirty, has a fetid odor, and is of poor appearance. This may also be pressed into blocks, then cut into strips and wound together.

Caucho easily becomes "tacky" when exposed to the sun, and should be kept under cover.

COLLECTION AND PREPARATION OF HEVEA

The methods used in collecting and preparing Hevea are practically uniform over the whole Amazon region. These methods have been in use since the beginning of the industry, but recently there has been, on the part of many proprietors, a gradual recognition of the destructive effect of former methods of tapping and a tendency to change to a less drastic system. The new system, as discussed below, promises to save many trees and to increase the yield of individual ones.

UNIT OF TAPPING

The unit of working is the estrada (literally, a road or path). A collection of estradas having a central headquarters is known in Brazil as a seringal and in Bolivia and Peru as a gomal. The store or warehouse (barracão in Brazil) is usually situated on the bank of a river for convenience of transportation, but it may be situated inland, in which case mules are used to carry supplies in and the rubber out to the river. The estrada is an irregular path leading from tree to tree and in the form of a loop, thus coming back to the starting point. Side paths, known as mangas, lead off from the main trail to adjacent trees.

The number of trees in an estrada varies with the density of the Heveas in the forest. It is rare that Heveas are encountered in clumps of three or four. Some may stand close together, fifty or a hundred feet apart, and the next tree may be a hundred yards away. In the early days of the industry, when the trees were fresh, the average number of trees per estrada was 120 to 150. At the present time the average is nearer 180 to 200. In some localities, however, as on the Ouro Preto River, in the Madeira area, where trees are found relatively close together, some estradas have as many as 240 to 380 trees. In the high and hilly land of the upper rivers estradas have from 100 to 200 trees, with an average of about 120.

The average estrada is 5 to 6 miles long, requiring about two hours' walk to cover it without tapping. The former general rule was for one seringueiro to tap two estradas, tapping each in turn every other day; but in many regions at present one tapper has three estradas, tapping each in turn the fourth day.

TAPPING AND COLLECTION METHODS

Tapping is started in the morning as early as the light will permit. The tapping instrument is a small hatchet (machadinho) with a handle about 2½ feet long. The heads are supposed to be of soft iron with a cutting edge 1¼ to 1½ inches wide, but many tappers use steel machadinhos with a cutting edge of 3½ inches.

Incisions are made in the bark with a quick upward swing, making a cut with the lowest part to the left and the highest toward the right. If a small machadinho is used, the bark soon heals over and no great damage is done, but with the large machadinho quite often chunks of bark fly out, thus giving borers a chance to enter, or else producing large burrs or knots. The cuts are made in parallel lines, and the number per tree at each tapping depends on the size of the tree; small trees may have two cuts and larger ones up to 10 or more. The distance between cuts is about 2 inches vertically. Trees are tapped up to 10 or 12 feet above the ground, and for this height a light ladder is carried or else a platform is built around the tree. After each incision a small notch is made, into which a tin cup with a capacity of about half a pint is fitted to receive the latex flowing from the cut.

The above operation will require 2½ or 3 hours per estrada. The seringueiro (tapper) will then begin his round again, emptying each cup into a receptacle shaped like a milk can, holding about 2 gallons

FIG. 6.—Wild *Hevea brasiliensis*, Acre Territory, illustrating trunk deformity caused by machadinho system of tapping

or else into a caucho-coated bag of his own making. The cups are telescoped together and left on a stick until his next round.

In the Tapajoz area the method of collection is slightly different from that just described. The actual tapping is practically the same, but instead of collecting the latex in individual tin cups a channel is made around the tree with a vine, the space between the vine and the tree being closed with rubber or clay. The latex runs down the tree and is conducted into a single receptacle. This method is extremely wasteful; probably not over 75 per cent of the latex is actually col-

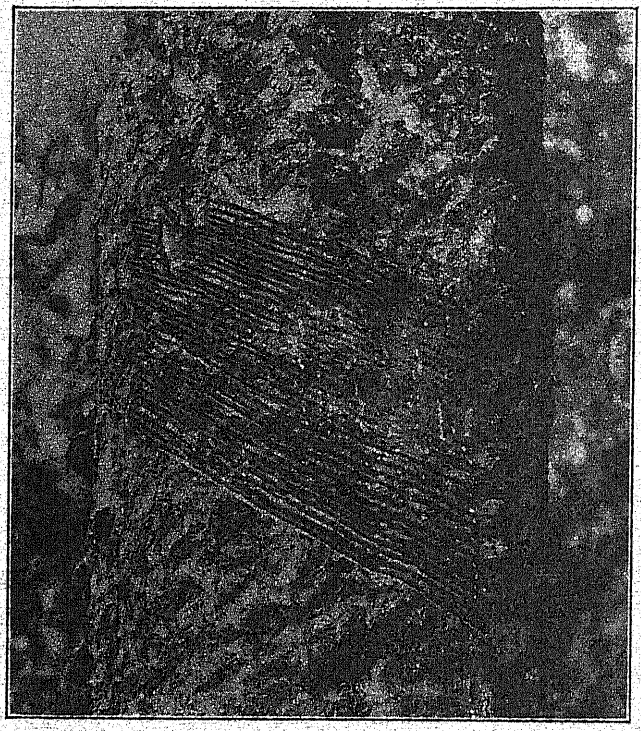


FIG. 7.—Improved method of tapping old trees by use of Amazon knife. The bark renews much more evenly and smoothly than when tapped with the machadinho

lected. On the lower Tocantins mollusk shells are used to catch the latex, which coagulates naturally in the shells and produces what is known as Cameta scrap.

NEW SYSTEM OF TAPPING

It was our observation that the machadinho as used by the present generation of seringueiros is destructive to the trees. Many of the more foresighted and progressive proprietors have realized this, and some have abandoned its use completely.

The practice that came under our observation which seems to offer the best results on trees that have already been badly scarred is that carried out at the Seringal Porvir, on the Acre River, between

Xapury and Cobija. Here the instrument used is a modified form of the Jebong knife known as the Amazonia mesquita. The cutting part is much smaller, being 3 to 5 millimeters (millimeter=0.03937 inch) wide. The width of the metal forming the knife is about 22 millimeters. Besides the paring part of the knife, it has a sharp steel prong, designed to make a perpendicular stab or incision into the channel at regular intervals and cut the latex tubes.

At Porvir this latter process is not used—only the knife proper. The practice as seen is essentially as follows: The exterior or rough bark of the tree is scraped off, and shallow cuts are made on a fourth of the circumference, on opposite sides of the tree, at the same tapping. The cuts are the width of the cutting edge, approximately 5 millimeters, and 5 millimeters apart, thus leaving a ridge of uncut bark between (see fig. 7, p. 20). If the tree is a large one a wider interval, say 10 millimeters, is probably better, as with this width more latex is secured. The coagulated rubber is allowed to remain in the channel until the wound is healed, when it is pulled out and becomes sernamby, or scrap.

The bark renews very rapidly, and if that allowed to remain is scraped off a few months later a smooth surface is the result; and this repeated over a period of a few years should leave a good even thickness of smooth bark, which could be "shaved" or tapped by the excision method of the Orient, if desired. The length and number of cuts can be modified at will to give any period of time for bark renewal desired.

ACTUAL RESULTS OBTAINED

On an old estrada near the headquarters on the Seringal Porvir, badly mutilated and abandoned because not furnishing enough latex to work, the knives were started as an experiment. With the machadinho the estrada gave 4 liters of latex, or 2 kilos (4.4 pounds) of rubber, per tapping. With the knife it is said now to give 14 liters, or 7 kilos (15.4 pounds), of rubber.

On the better estradas with the machadinho from 14 to 16 liters of latex were obtained, equal to 7 to 8 kilos (15.4 to 17.6 pounds) per tapping. With the knife they claim to get 20 to 24 liters, equivalent to 10 to 12 kilos (22 to 26.5 pounds) of rubber—an increase of 250 per cent on the old poor estradas and 40 to 50 per cent on the better interior estradas. Furthermore, the number of trees per seringueiro has been decreased; with the machadinho the estradas consisted of 200 trees, and with the knife they average from 140 to 160 trees. This is substantially in accord with reports obtained on the Suarez establishment Porvenir in the Tahuamanu zone (Bolivia), where the system is being introduced.

The knife for tapping has also begun to supplant the machadinho in the Codajaz district, on the Solimoes, and on the Jurua and Javary, with, so it is affirmed, increasing production per man.

OBJECTION TO USE OF KNIFE

On the part of many there is objection to the use of knives of any kind for extracting the latex, the claim being made that it causes the tree to become diseased or else kills it outright. This arises

from the fact that some years ago, during the period of high prices, investigators sent to the Amazon from the Middle East tried to introduce the Eastern system of tapping on the native forest trees. At that time the Eastern plantation trees were badly overtapped—some almost to their branches. The result in the Amazon Valley was that the tapping surface of the trees immediately became diseased from a form of canker, and many died.

It is not generally realized in the Amazon that the drastic tapping methods of the Eastern plantations of 1907–1914 went out of vogue long ago, and it would appear that these objections are founded on a wrong conception of current practice. With our present knowledge it is not surprising that the forest trees experienced so heavy a mortality when subjected to such drastic treatment.

The objection that the excision method of tapping causes the tapping surface to become diseased may have resulted from the location of the trees so tapped on low, damp ground with a complete absence of sunlight. It would appear that if an area around each Hevea in the forest were cleared, thus allowing sunlight to enter, this trouble would be greatly diminished.

In a few cases observed by the field party, where experiments were being carried out with knives, the mistake was being made (except at Porvir) of tapping through the cambium layer to the wood. This, of course, would do more damage to the tree than the machadinho.

PREPARATION OF THE RUBBER

After the latex from an estrada is collected it is brought into the seringueiro's smoking hut (fumadór), where it is placed in a tin receptacle resembling a wash basin and of sufficient size to contain all the latex that might be collected in one day. A fire is started in a furnace, over which is placed an open galvanized-iron cone to concentrate the heat and smoke. When the fire is burning well a mass of palm nuts is introduced, preferably the urucuri (*Attalea speciosa*). If these are not at hand, others are used, such as the inaja or babassu or even certain woods, as the balsamo, abiurana, pao mulatto, and others. Soon a clear, white, dense smoke, rich in pyroligneous acid and creosotic vapors, is issuing from the funnel. The ball, or pella is started with some sernamby or coagulated rubber of good quality passed around a smooth pole 5 or 6 feet in length supported on horizontal bars above the furnace, thus leaving the operator free to rol it about over the aperture from which the smoke issues. He places the pole over the iron vessel and pours latex over the small ball, then revolves it in the smoke stream. In a few seconds the latex is coagulated, and the process is repeated until all that day's latex is treated. This is continued day by day until a ball is made which when dry will weigh 30 to 60 kilos or any other weight desired. In this way each day's production is coagulated so that when the ball is cut open the rubber appears in concentric layers, the thickness of each layer corresponding to one day's coagulation.

This process is modified in various ways. In the Madeira region much rubber is produced in balls the size of a man's head, or smaller, known as "Madeira fine." Each ball represents a day's work. Another form, which also represents a day's work and weighs 4 to 8 pounds, is called "Madeira knapsacks"; these are made on

flat, square paddle instead of a round pole, the end of the bolacha, or biscuit, being slit to withdraw the paddle. The balls are left out in the sun to dry and no especial care is taken of them.

Rubber from the Putumayo River in Peru comes on the market as "Putumayo block." This is a "weak fine" rubber produced by the Indians, which is allowed to coagulate naturally. Together with the sernamby (scrap) it is washed in hot water and worked to remove bark, dirt, and impurities. It is then pressed into blocks and shipped in this form.

COLLECTION AND PREPARATION OF CAUCHO

The method of collecting and preparing caucho differs entirely from that of Hevea in that the tree is cut down and thus destroyed in the process. Two channels are first cut in the form of a V near the base and the latex allowed to drain into a receptacle or simply onto the ground. Then the tree is felled, and rings or grooves are cut 5 or 6 feet apart the whole length of the trunk. The latex runs into receptacles or into holes in the ground and generally is allowed to coagulate naturally. Sometimes a mixture of ordinary soap, water, and certain plants (creepers) are used for artificial coagulation. The coagulum is washed in water to remove part of the impurities and then packed into bundles weighing 50 or 60 kilos, firmly held together by strips of caucho.

Peruvian caucho is usually in the form of round balls varying in size upward from that of a man's head. Another form is slabs, called "Peruvian slab," and, locally, caucho muerto (dead caucho).

COST OF PRODUCTION

Strictly speaking, there is no way of arriving at a cost of production for wild rubber by computations analogous to those used for plantation rubber. In the case of wild rubber no wages are paid; there are no fixed overhead charges, such as the recruiting and care of labor, insurance, medical service, and staff salaries; capital expenditure, on which interest might be reckoned, is usually small, though certain proprietors have considerable investments in homes, warehouses, roads or trails, steamers, launches, and animals. The seringueiro builds his own habitation, usually a flimsy palm-thatched hut, and consequently there are no charges for depreciation or upkeep on laborers' quarters.

About all that can be determined is an approximate figure for different localities, and a general figure above which production tends to increase and below which production tends to remain stationary or to decline. P. B. de Britto Pereira, in an excellent treatise on the rubber industry published in the Diario Official of the State of Amazonas for September 7, 1922, says: "The question of the cost of production of rubber in the Amazon has occupied the attention of many minds, but no one up to the present has been able to determine for certain how much it costs to produce a pound of rubber."

PRODUCTION COSTS ON SUPPLIES BASIS

Probably the nearest approach to an approximate cost of production for wild rubber would be the average expenditure of a serin-

gueiro for supplies for himself and family, such as foodstuffs, clothing, tapping utensils, rifle and cartridges, and a few cheap articles of luxury, divided by the average number of pounds produced in the season. But here again it is impossible to secure uniform or average figures, since these factors depend upon the size of his family, the energy he puts into his work, days of sickness, and time spent in hunting and in working crops other than rubber. Some approximate costs per pound for different localities, converted to United States currency at the average rate of exchange for 1923, are given below:

	Cost per pound
Acre Territory:	
Upper Jurua	$0.1404
Acre River	.1030
Upper Madeira	.0700
Upper Tapajoz	.1030
Upper Xingu (caucho)	.0463
Lower Javary	.1030
Bolivia:	
Riberalta	.0850
Lower Abuna	.0821
Cobija	.0978

Practically no "fine" rubber is being produced in Peru. The lowest price at which it would be produced was said to be around 0.61 sol, or approximately $0.27, per pound, f. o. b. Iquitos.

In the latter part of 1923 and the early part of 1924, when the price for "fine" was around 4$000 to 4$500 per kilo ($0.187 to $0.21 U. S. per pound at exchange of $0.103) the seringueiros on the upper rivers of Brazil were receiving 2$000 per kilo ($0.0934 U. S. per pound) in merchandise.

The base price in Brazil is around 4$000 per kilo f. o. b. Manaos or Para. When the price drops below this many seringaes can not work at a profit and there is a tendency to curtail production. The seringueiros find it more profitable to engage in other work such as preparing dried fish or gathering Brazil nuts. When the price goes above 4$000 per kilo more people start collecting rubber and production increases.

TRANSPORT COSTS AND EXPENSES

The local basic steamer freight rates on rubber from shipping points to Para are (large shippers secure reductions from these published rates): To Para from—

	Rate per 10 kilos
Porto Velho	1$000
Manaos	0$530
Teffe	0$840
Benjamin Constant (Remate de Males)	1$050
Cruzeiro do Sul	1$560
Rio Branco	2$200
Cobija	3$750
Labrea	1$200
Santarem	0$330
Itaituba	0$600
Cameta	0$300
Upper Xingu River	0$772

The freight rate for that part shipped over the Madeira-Mamore Railway varies with the official pauta, or quotation, in Manaos. The following figures, per kilo, are for September, 1923; at the time the exchange rate was 35 boliviano cents to the milreis: To Manaos—from Manoa (lower Abuna River), 0$700; from Riberalta, 1$178; from upper Madeira and Mamore Rivers, 0$670. To Para—from Bolivia, via Acre River at Xapury, 0$558; from upper Xingu River, 0$772.

Expenses of rubber from the Amazon exported to New York (including inspection in Manaos, packing, and cases), are, per kilo: From seringal (say, on Rio Marmellos) to Manaos, 0$670; from Manaos

to New York, including New York charges, 1$300; total, from seringal to New York, 1$970.

Actual expenses incurred in shipping 95,854 pounds of "Putumayo block" rubber from Iquitos, Peru, to New York in January, 1923, exclusive of receiving and packing charges and cost of shipping cases, but including freights, duties, insurance, and selling charges, were: Expenses in Iquitos, $549.96 U. S.; expenses to New York, $2,986.30; total, $3,536.26, equivalent to $0.0369 a pound.

Detailed items making up the above costs are shown in the regional reports.

INFLUENCE OF EXCHANGE ON PRODUCTION

In the years of highest output the milreis-dollar exchange rate was fairly constant around par and therefore had no influence on production. In the past few years the exchange rate has fluctuated greatly, showing an almost continual downward trend, and at the present time this has a vital bearing on the amount of wild rubber that will be collected in Brazil. The cost of food supplies procured or grown locally is only slightly affected, but the cost of all manufactured articles, and especially imported supplies, varies with the exchange rate. The price of rubber, being regulated by supply and demand, is dependent on the market price in the United States and Europe.

There is always a price in milreis at which producers can work at a profit, this price naturally varying with different localities and conditions. When the rate of exchange fluctuates so as to bring the price in milreis below this figure it means a loss and tends to check production. A low rate of exchange is favorable to the rubber industry. This means that for a certain price in New York more milreis (that is, more of the currency the seringueiro uses) can be paid for a kilo of rubber in Para or Manaos. On the other hand as exchange rises lower prices in milreis must be paid.

The rubber exports from the Amazon region of Brazil, the low and high prices paid in Para, and the average exchange rate for the year for the period 1912–1922 are given in the following table. The prices are for fine hard Para.

TABLE 2.—EXPORTS OF CRUDE RUBBER FROM BRAZILIAN AMAZONIA, WITH PRICE RANGE, 1912–1922

Years	Exports, in metric tons	Price range		Milreis value in U. S. currency [1]
		Low	High	
1912	38,173	4$220	5$280	$0.324
1913	34,450	2$690	4$690	.324
1914	31,714	2$350	3$390	.324
1915	31,555	2$490	4$750	.250
1916	28,808	4$506	6$650	.230
1917	31,595	3$670	5$590	.250
1918	22,215	2$130	2$710	.250
1919	32,251	2$390	3$000	.260
1920	22,927	1$800	3$000	.225
1921	17,182	1$150	3$000	.131
1922	10,483	2$125	3$350	.129

[1] Average exchange rate for the year.

Preliminary statistics for 1923 gave exports of 17,991 metric tons; the average exchange rate of the milreis for the year was $0.103.

THE MARKETING OF RUBBER

The two principal export markets of the Amazon Valley are Para and Manaos. Iquitos in Peru is the shipping point for rubber from that country. However, although billed direct to foreign port of destination, rubber from Iquitos is reshipped at Manaos or Para since the suspension of the direct steamship service between Iquitos and foreign countries. Rubber produced in Bolivia is exported via either Manaos or Para, though very small quantities from the valleys northwest of La Paz are sent out across the Andes and shipped as "Mollendo" rubber.

The comparative importance of these different export centers is shown by the following figures (quantities in metric tons of 2,204.6 pounds):

TABLE 3.—EXPORTS OF CRUDE RUBBER, 1910, 1920, 1922

Exported from—	1910	1920	1922
	Tons	*Tons*	*Tons*
Para, Brazil	16,687	10,931	8,903
Manaos, Brazil	10,680	11,678	10,124
Iquitos, Peru	2,260	1,094	609
Mollendo, Peru	306	62	2

Though simplified by the decline of the old aviador system, the rubber trade in the Amazon Valley is still unduly complicated. Ready capital is restricted to a few hands, and an elaborate credit system has been built up for financing the marketing of rubber. An outstanding feature of the whole process is the importance played by the exchange of merchandise for rubber, the profits made on merchandise being at present much larger than whatever gain results from the eventual sale of the rubber in a foreign market. In fact, the rubber industry over vast areas is sustained only by this source of profit, since under present methods of operation and in view of the prices ruling during the past few years the income from the sale of the rubber alone would afford too narrow a margin to justify production and might actually result in a loss to the producer.

ORGANIZATION AND ADMINISTRATION OF SERINGAES

The rubber-producing areas are administered by the owners or by lessees or renters who pay either a percentage of the product (or of its net proceeds when sold) or a specified weight of rubber for each estrada. Most of the owners are merchants and depend for their profits more on the sale of merchandise to the seringueiros than on the rubber itself.

The labor organization and system of administration are therefore simple. The owner or his agent has his headquarters at a central place (barracão), usually at or near the shipping point. At convenient places are located other barracões at which are stationed majordomos or superintendents. These barracões serve as stores for

supplying necessities to the seringueiros and as warehouses for the rubber when received.

For each 20 to 30 seringueiros there is an overseer who teaches the men their duties, sees that the trees are not willfully damaged or overtapped, and keeps the men at work. In Brazil this overseer, who is usually an old and experienced seringueiro, is known as a fiscal.

At the end of each month, and in some cases at the end of each fortnight, an employee is sent to the seringueiro to determine the amount of rubber he has prepared. Against this amount he can secure merchandise, usually to one-half its value. In receiving the rubber shrinkage is calculated at 10 per cent for old and 20 per cent for new.

In the Acre Territory it costs about 700$000 to bring a man from Para and prepare him for work. This is debited to his account and deducted from the net proceeds due him on his rubber.

OWNER-TAPPER PAY ARRANGEMENTS

Each proprietor works his rubber estradas according to one or more of the following plans:

1. The seringueiro taps the estradas for his own account but is obliged to sell the rubber to the proprietor at a specified price.

2. The estradas are rented to the seringueiro, who pays a certain amount of rubber per estrada per season (or infrequently in cash), plus a certain percentage (15 per cent) of the total production for expenses of transport of goods to the seringueiro's house and freight on the rubber from the estrada to the river shipping point.

3. The estradas are rented to the seringueiro, and at the end of the season the rubber is forwarded to Manaos or Para for sale. Expenses such as freight, duty, and municipal taxes are deducted, and of the net proceeds a fixed percentage (usually 25 per cent) goes to the proprietor as rent of the trees and for transportation of supplies.

Under plan 2 the usual rent is 30 kilos of dry rubber per estrada, or 90 kilos for the usual three estradas, plus 15 per cent of the total production. The rubber is sent to Manaos or Para for sale for the account of the seringueiro, and the net proceeds credited to his account. If the seringueiro prefers to liquidate the account without sending the rubber down river for sale, the owner purchases it at a price based on Manaos or Para current quotations.

THE FINANCING OF PRODUCTION

The most available rubber-bearing areas have gradually been concentrated in the hands of a few. Some of the areas thus controlled comprise vast acreages and are veritable self-sustaining feudal states. There are many small proprietors, especially in the lower Amazon and the delta region, but usually with these the collection of rubber is a secondary industry, a sort of cash-crop feature, and the production is small as compared with that of the large proprietors.

Individual owners of seringaes who do not possess sufficient capital to bring in labor or to operate their properties obtain advances in money and merchandise from large supply houses in Para, Manaos, or Iquitos.

The seringueiro, in his turn, is dependent on his patrão for necessary supplies and must make all purchases from the latter's store. The seringueiro liquidates his account, at least theoretically, by the delivery of the rubber he produces to the patrão. After deducting all charges and the rent due the patrão from the proceeds of the sale of the rubber, the balance is credited to the seringueiro's account. The latter has (except in rare instances) received no money for his product—only merchandise, and in many cases remains in debt to the patrão at the end of the season.

AVIADOR SYSTEM

The next stage in the system is the relation which exists between the patrão, or proprietor, and the trading house in Manaos or Para. Under the former practice traders known as aviadores acted as intermediaries between the rubber producers and the wholesale houses in the cities. According to this arrangement, the aviador supplied the patrão with the merchandise necessary for the year's operations and received on consignment the rubber collected on the seringal. In the event of a year of low prices and small production the patrão might not be able to liquidate his debt to the aviador at maturity, in which case it was necessary to allow further credit for another year. To the aviador the patrão was known as an aviado or as a freguez (customer). The patrão also frequently refers to his seringueiros by the same term of freguezes.

The aviador purchased his goods from the large wholesale or importing houses in Manaos or Para. This also was a credit transaction, the account being covered by promissory notes, commonly for 120 days or more. The aviador was accustomed to charge his aviado a commission of 10 per cent for merchandise furnished him, and, moreover, generally received a bonus from the wholesaler from whom he bought the goods for shipment to his aviados upriver.

Since the many failures of aviador houses that followed the great crisis in the industry, the aviador system in its original form has virtually disappeared, to be replaced by more direct relations between the proprietors of rubber properties and the trading houses in Manaos and Para. Thus, it is now the custom for the proprietor to order merchandise direct from the wholesale house to which he consigns his rubber for sale. This has served to eliminate the aviador, who acted as intermediary. The wholesale supply house now performs virtually the functions of the former aviador, and the term is still frequently applied to it. Also long credits are still the rule.

SALE TO THE EXPORTER

The final sale to the exporting firm is generally made through a broker, whose customary commission at Para is 15 reis per kilo for upriver rubber and 20 reis for island rubber. At Manaos the broker generally receives 20 reis per kilo. Before a consignment of rubber is bought the balls are cut in half in the presence of the exporter or his agent, to ascertain if the rubber has been properly cured or if it has been adulterated or mixed with foreign matter such as stones.

The only direct purchasing agency of a foreign rubber-manufacturing firm in the Amazon Valley is a subsidiary of an American

company, for whose account it purchases rubber at Para and Manaos. Other exporting houses act as buying and exporting agents for American or European firms. Frequently, the wholesale trading house exports rubber direct. A few large firms, such as that of Suarez in Bolivia and Nicolau da Costa at Para, may themselves handle every stage in the marketing of the rubber produced on their own properties, dispensing with intermediaries.

IMPROVEMENT IN ECONOMIC ASPECT

It is thus seen that the whole industry rests upon an unsatisfactory and uneconomic basis. However, it can be said that conditions in this respect appear to have greatly improved in recent years. Formerly when the price of rubber was high credits were extended lavishly. Extravagance was the rule with both the patrão and the seringueiro, and reckless and needless buying was encouraged in both. The seringueiro was kept in debt in order to hold him to his work. He was not allowed to grow his own foodstuffs but was forced to buy everything he needed for his maintenance at the store.

At the present time in most cases advances in merchandise are made only on rubber already produced and on hand. Save in a few instances, the seringueiros are encouraged, and even required, to produce their own foodstuffs.

Over most of the Amazon Valley the production of rubber has resolved itself into a sort of secondary industry. Only in the upper reaches of the southern tributaries of the Amazon (the Xingu, Tapajoz, Madeira, and Javary), the Acre Territory, and eastern Bolivia can it be considered the main industry at this time.

THE FINANCING OF EXPORTS

The exporter buys rubber in Manaos or Para at so many milreis per kilo, the seller delivering the rubber at his warehouse and the exporter paying the export duties and other charges incidental to shipment.

Export duties are paid according to the official pauta, or schedule of values, fixed weekly for the purpose. At Manaos and Para there is a pauta for State and a separate one for Federal rubber, the latter including all rubber originating in the Acre Territory. For the former class the pauta is organized by the State recebedoria, or collector of revenues, and for Acre rubber by the Federal customs authorities. The pauta is announced every Saturday for the following week, being the average of the daily prices furnished by the local commercial association for the previous week.

The rubber is sold by the exporter in the currency of the country of destination. Terms are generally f. o. b., seldom c. i. f. The exporter first reduces kilos to pounds, deducting shrinkage more or less in accordance with the following percentages (the amount of shrinkage varies with the grade of the rubber, its origin, and the season of the year): On new-crop "upriver fine," for purposes of export the probability of shrinkage is calculated at around 5 per cent. Thus, for a 100-ton contract in New York about 105 tons of rubber will actually be shipped. Except for July, August, and September shipments of fresh rubber, 4 per cent should cover the

shrinkage. In the case of "caucho ball, coarse" an allowance of about 8 per cent is made for new and 7 per cent for older lots. For "virgin coarse" the usual allowance is 7 or 6 per cent, depending on the age of the rubber. The green rubber from the islands, which is marketed soon after being prepared, carries a heavy proportion of moisture and consequently a high percentage for shrinkage is allowed, amounting to as much as 14 or 16 per cent. This is contrary to the case of Acre or Bolivian "fine," which has generally lost much of its original moisture during months of storage in the interior and the long river voyage to Para.

Exchange is calculated in accordance with the rate given by the bank discounting the draft which accompanies the shipping documents.

THE PROBLEM OF EXCHANGE

The problem of exchange in connection with the shipment of rubber is thus described by M. P. Shelley, of Para, who was attached to the American field party:

There are three classes of local merchants sending rubber to the United States:

(*a*) Branches of American firms. Each of these has a different manner of financing rubber, each its own policy. One firm sends ready cash to buy the rubber; another may send a letter of credit; still another may be occupied with banking, in collecting for American merchants, etc., and so have Brazilian currency with which to make purchases.

(*b*) Brazilian establishments dealing in rubber. They conduct their transactions by means of a sterling letter of credit.

(*c*) Local merchants. They receive rubber from the interior and send it on consignment to a New York commission house. Generally, they draw 80 per cent of the value of the rubber when shipped. The commission house sells the rubber to the best advantage and settles with the Brazilian afterwards.

In Brazil, just as in the Far East, the rubber dealer can receive his money when he is able to sell the drafts authorized by the letter of credit. The only difference here is that in order to obtain Brazilian currency he must sell the drafts to firms which buy English currency, and consequently must accept the rate of exchange offered, which is regulated by supply and demand.

A HYPOTHETICAL TRANSACTION

Let us suppose that Jones & Co., New York, are rubber importers dealing with, say, Antonio Gonzalez, of Para. A manufacturer in the United States makes inquiry of Jones & Co. as to whether they can sell him 20 tons of "up-river fine" at 75 cents a pound, to be delivered within the next three months. Jones & Co. immediately cable Antonio Gonzalez a firm offer of 70 cents a pound, f. o. b. New York, for 20 tons of rubber, to be delivered during the months of September, October, November, leaving 5 cents as a margin for extra expenses, profits, etc. Let us say the inquiry was made early in September. Mr. Gonzalez, having made his calculation as to the possibility of obtaining rubber and as to the price he may have to pay, together with the quantity available at that particular time, speculates on the future price and bids 72 cents.

He speculates in that the price may go up or it may go down by the time he needs the rubber to fill the order. Suppose a dealer sets a price of 70 cents per pound, after making his calculations for a certain time when he intends to pay 5$400 per kilo in Brazilian currency to the producer or seller, this being in accordance with the rate of exchange of 4$200 per dollar. However, when the time comes for covering the sale exchange stands at 3$800 per dollar and he loses 400 reis, or more than 10 cents, per dollar. The case may turn out to be quite the contrary, however, and he may gain as much as 10 cents per dollar. This means that the price of rubber in Brazil varies inversely to the rate of exchange; that is, an increase in the rate of exchange results in a decrease in the price of rubber and vice versa.

To return to our hypothetical transaction, Antonio Gonzalez, of Para, having closed his deal with Jones & Co., of New York, waits for an opportune time to execute his order. He has a leeway of three months, during which he watches the market and exchange closely; when both incline favorably toward his calculated price he buys the rubber. Let us suppose he paid 4$500 per kilo for the 20 tons of rubber, which, according to his calculations, would bring 71 cents a pound. Until he can actually get Brazilian currency for his bills, the rubber dealer does not know what the exchange will really be, for a considerable time may elapse between the buying of the rubber and the date of shipment—and, it must be remembered, he can exchange his bills only when the goods are shipped and he can produce a bill of lading. During this time the rate of exchange may go up or down and he may lose or gain.

The rate of exchange having been agreed upon between Mr. Gonzalez and the concern which buys his "paper" (generally the bank through which the letter of credit was sent), he draws a draft in triplicate at 90 days' sight for the amount warranted him by the letter of credit. Then he attaches all the documents, which comprise the consular invoice and all negotiable copies of the bill of lading. Having sold his "paper" at the prevailing rate of exchange for such drafts, Mr. Gonzalez has received his money, but neither Jones & Co. nor the New York bank has yet advanced any payment in the transaction.

PROCEDURE IN NEW YORK

The bank in Para is required by the terms of the letter of credit to send to its New York branch one bill of lading with the consular invoice attached to the signed draft. A duplicate draft, duplicate bill of lading, and insurance certificate are forwarded to London if the Para bank is a branch of a British concern. All the documents, of course, are made out in the name of the bank which bought the draft. As soon as they reach New York, the bank advises Jones & Co. of the arrival of the draft, and, being accepted, it has 93 days to be matured (three days' grace being allowed in London).

If Jones & Co. should so desire, they may pay cash at any time before the draft is due and receive an allowance of interest according to the agreement with the banker at the time of issuance of the credit. If this is not done the rubber is warehoused in the bank's name until the obligation is met. In many cases when the importer is of good standing the bank delivers the rubber to him before the settlement of account. By this method the importer is permitted to remove the rubber and sell it. This trust agreement in no way interferes with the obligation to meet the draft when due in New York.

Finally, when the draft is due the amount is converted at the current selling rate of exchange for bankers' checks on London. Jones & Co. pay the amount drawn by the letter of credit plus the commission agreed upon, usually one-eighth to one-fourth of 1 per cent per month of the tenure of the draft, and the transaction is ended.

This system of credits in the rubber trade has proved beneficial to both seller and buyer. The seller is sure of obtaining his money immediately on delivery of the goods to the steamship company, and the buyer has the assurance that the goods must be shipped before the seller receives payment.

MARKET GRADES OF RUBBER

On the New York crude-rubber market rubber from the Amazon Valley is graded as follows, with quotations as of August 25, 1923:

Paras:	Price per pound
Upriver—	
Fine	$0.28¾
Medium	.27
Coarse	.23¾
Islands:	
Fine	.27
Medium (not quoted).	
Coarse	.23¾

	Price per pound
Cameta	$0.15
Acre Bolivian, fine	.29
Beni Bolivian, fine	.29½
Madeira, fine	.30
Peruvian, fine	.26½
Tapajoz, fine	.27½
Caucho:	
Upper caucho ball	.24
Lower caucho ball	.22½

On the preceding day (August 24, 1923) prices paid at Manaos for different grades were as follows, exchange being at 5⅛ pence to the milreis, or 10$200 to the dollar, for 90-day drafts, and quotations being in milreis per kilo of 2.2046 pounds:

	Price per kilo
Fine (fina)	5$200
Medium (entrefina)	4$400
Weak fine (fina fraca)	4$200
Virgin coarse (sernamby virgin)	4$000
Coarse (sernamby)	4$000

The last price paid for caucho ball previous to that date was 4$400 per kilo. There is no set relation between prices paid for the different grades of rubber, this depending largely on the momentary demand for any particular kind.

Of the grades enumerated above as quoted in the New York market "Islands," "Cameta," and "Tapajoz" are exported only through Para, as they originate in the lower Amazon Basin. (For origin and distinctive qualities of the different classes of Amazon rubber see "Quality of product," p. 14.)

PREPARATION OF RUBBER FOR SHIPMENT

For shipment abroad the rubber balls are cut up into pieces of irregular size and packed in cases whose dimensions depend on the grade of rubber to be shipped. "Fine" or "medium" is packed 160 or 170 kilos (350 to 375 pounds) to the case; "coarse" or caucho, 150 kilos (330 pounds). Caucho slabs from the Tocantins are packed in cases of 250 kilos (550 pounds) net weight.

The cases, which formerly were of American pine, are now usually made of the wood of the *Hevea spruceana*, itself related to the tree which produces commercial rubber.

TRANSPORTATION AND COMMUNICATION

Transportation in this area is largely dependent on the navigation of the Amazon and the other rivers of its fluvial system, supplemented by such roads as exist and, in one section, by the Madeira-Mamore Railway. Small quantities of rubber have been shipped out from some of the more remote fields by way of the Paraguay River at Corumba or across the Andes to the Pacific at Mollendo. However, these outlets have played an insignificant part in the history of the Amazon rubber industry, and the main artery of trade has always been the course of the great river. In fact, only the construction of projected railways across the Peruvian Andes to navigation on the Maranon or the completion of a line from the Ecuadorian highlands to a navigable point on the Napo could materially modify the present trend of traffic by making accessible promising regions whose development is now greatly retarded by their remoteness from ocean connections.

OCEAN

Both Para and Manaos have regular and frequent steamship connections with the United States and Europe. The leading company engaged in this shipping business is the Booth Steamship Line. The

Lamport & Holt Co. also operates freight steamers between the Amazon Valley and the United States, and the Lloyd-Brasileiro maintains a service between Para and other east-coast ports and New York. The distance from Para to New York is 3,038 miles, which is covered in 11 to 13 days by the slow boats now employed in this service.

Practically all rubber from Amazonia is exported from either Para or Manaos, Iquitos no longer having direct connection with Europe or the United States. Both Para and Manaos are ports of entry and have federal customhouses, and both are equipped with modern port facilities ample for handling any possible development of business. Accounts of these port works, with tables of charges, are found in other sections of this report.

The minor river ports, especially on the lower Amazon, such as Santarem, Obidos, and Alemquer, are supplied with docks at which the river steamers tie up for loading and unloading. The land section of the floating docks at Iquitos collapsed in the early part of 1924, but provisional loading facilities have since been installed.

RIVER

No river system in the world offers such natural facilities for transportation as does that of the Amazon. The main river is navigable at all times as far as Iquitos, in Peru, for steamers drawing 20 feet of water, and boats of 9-foot draft may ascend the river several hundred miles farther—that is, almost to the first foothills of the Andes.

Though the lower courses of the principal tributaries are always open for large river steamers, the navigability of their upper reaches is seriously affected by seasonal differences in height of water and by other factors more or less permanent. The season of highest water is generally from December to April, though this varies from one region to another and by a month or more between the lower and upper reaches of the same river. The period of low water is commonly from June to October, corresponding to the dry season. Exceptions are the northern tributaries from the west, in which the seasons are reversed. The seasonal differences in level are from 15 to 50 feet, naturally depending on the stream and the amount of rainfall for the particular year, but are usually greatest in the Purus and Jurua. Due to this circumstance large steamers are able to penetrate to places during the rainy season which would be inaccessible during the dry months for any craft larger than a canoe or light launch.

Most of the rivers are obstructed at a greater or less distance from their mouths by cachoeiras, or rapids, that form impassable barriers to steamer traffic, though light power launches may pass some of them at flood. There are no such obstacles in the Purus and Jurua, but difficult passes caused by ledges of hidden rocks fix a limit to steamer navigation in these streams at low water. The courses of the smaller affluents of the principal rivers are also in many cases obstructed by snags and fallen trees that make the movement of boats very difficult.

LIMITS OF NAVIGATION

The usual limits for all-the-year navigation on the principal rivers for boats drawing 8 or 9 feet of water are as follows:

	Limit		Limit
Amazon	Puerto Limon.	Negro	Santa Isabel.
Tocantins	Baiao.	Purus	Cachoeira.
Xingu	Victoria.	Jurua	Sao Felippe.
Tapajoz	Sao Luiz.	Huallaga	Yurimaguas.
Madeira	Porto Velho.		

Large areas of good country lie below the limits of navigation given for some streams and border stretches of these rivers that would always be accessible for ocean-going steamers. This is true, among others, of the Tapajoz, Madeira, and Purus.

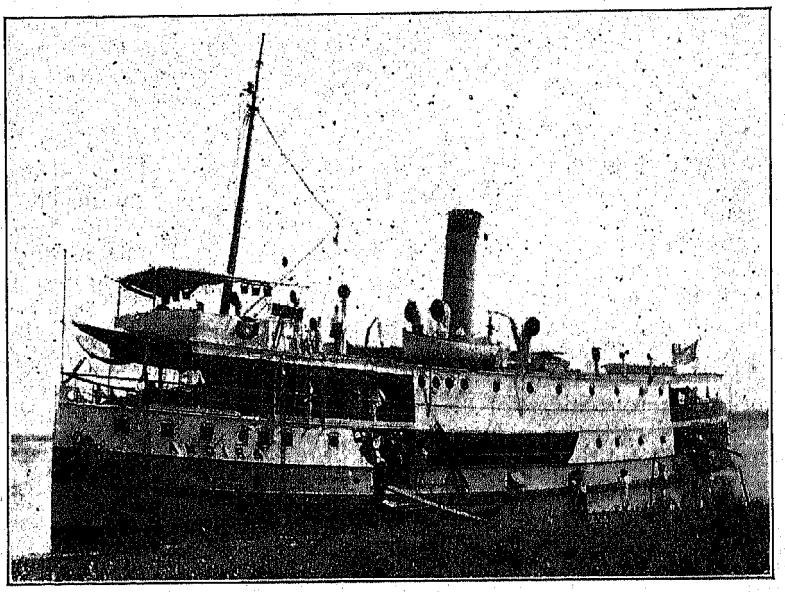


FIG. 8.—A common type of screw-propeller river steamer

Several other rivers are navigable for a considerable distance throughout the year by steamers drawing 5 to 6 feet. Among streams of this class are the Trombetas, Maues, Javary, Putumayo, and Napo. Conditions of navigation on the principal Amazonian rivers are described in considerable detail in the different regional reports.

FREIGHT AND PASSENGER SERVICE

All the larger rivers are well supplied with facilities for transportation. In fact, the fleet of steamers in service is considerably in excess of actual needs, and many boats are tied up at Para and Manaos. The most important shipping company is the Amazon

River Steam Navigation Co. (Ltd.), a subsidiary of the Port of Para. This company, which is subsidized by the Federal Government, operates regular freight and passenger services out of Para, on the Madeira to Porto Velho; on the Purus-Acre to Cachoeira (April to October) and Bocca do Acre (November to March); on the Solimoes-Javary-Iquitos to Iquitos; on the Oyapock to Oyapock; on the Tapajoz to Itaituba; and on the Pirabas to Pirabas; out of Manaos, on the Negro to Santa Isabel and on the Jurua to Cruzeiro do Sul and Villa Seabra. It also maintains supplementary services in the upper Purus and Jurua systems by means of light-draft stern-wheelers. The company has a fine fleet of 31 steamers, with a total tonnage of 9,110. The service offered by these vessels is good.

FIG. 9.—Type of launch used on upper rivers. These are able to pass the rapids in periods of high water

In addition to this company a large number of private interests operate steamers on the rivers, among them Nicolau da Costa & Co., Para; B. Levy & Co., Manaos; Companhia Fluvial (Madeira-Mamore Ry. Co.), Manaos; and Israel & Co., Iquitos. A large planting corporation in the Amazon Valley could probably make satisfactory arrangements with existing shipping interests, but in default of this should be able to acquire at reasonable cost sufficient tonnage to handle its needs.

The common type of vessel on the principal Amazonian rivers is a wood-burning screw steamer, ranging from about 200 to 625 net tons capacity. Sternwheelers of 3 or 4 foot draft are used on the Rio Negro and on the rivers of the Acre Territory. Launches drawing cargo lighters are also much employed on the smaller streams.

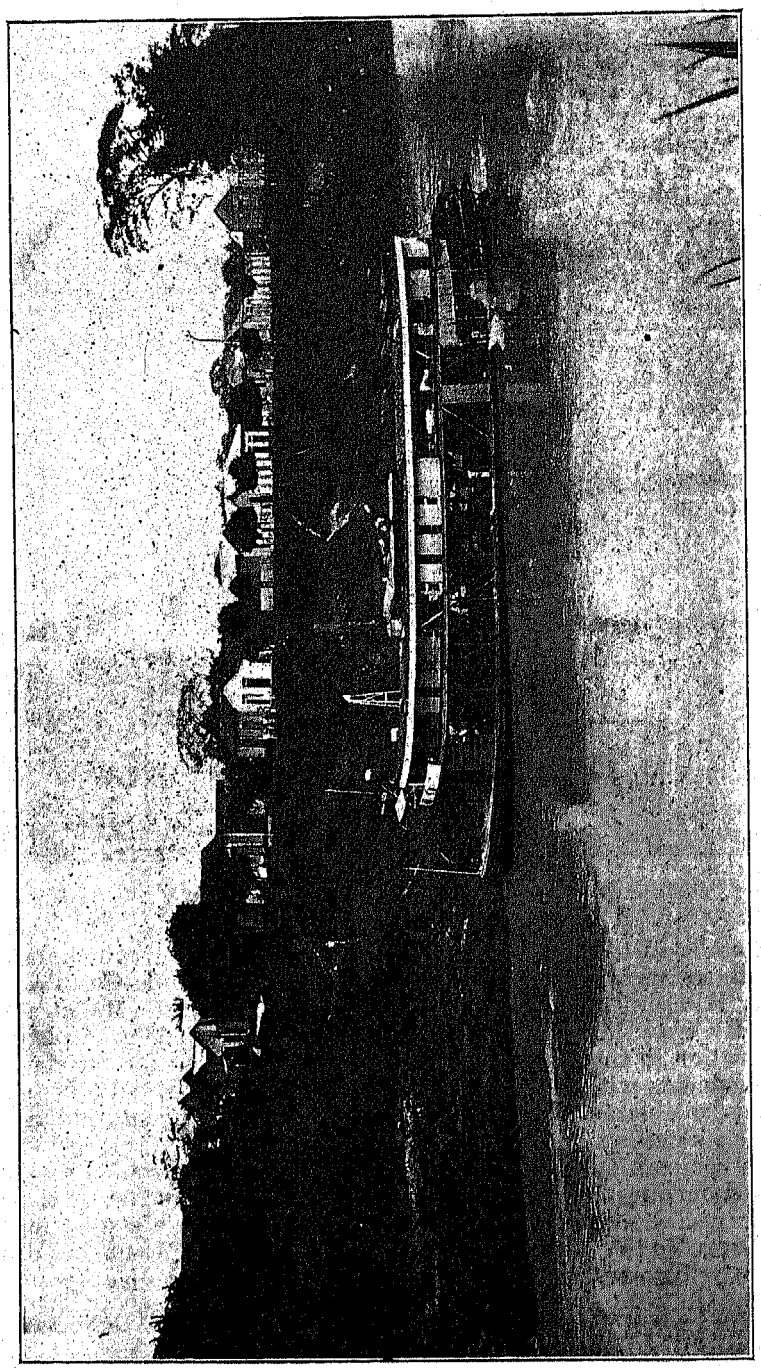


FIG. 10.—Type of stern-wheel steamer (chata) used on the upper rivers of the Amazon Valley subject to seasonal variation in depth of water

DISTANCES FROM PARA AND MANAOS

The following list will give an approximate idea of the distance from Manaos of a number of representative points in the Amazon Valley:[6]

	Miles
Madeira and tributaries:	
Porto Velho (limit of navigation and terminus of Madeira-Mamore Railway)	792
Abuna (mouth of Rio Abuna)	929
Guajara-Mirim (southern terminus of Madeira-Mamore Ry.)	1,012
Cachuela Esperanza (Suarez headquarters on Rio Beni)	998
Riberalta (confluence of Beni and Madre de Dios)	1,054
Purus and tributaries, including Rio Acre:	
Labrea	903
Cachoeira	1,028
Bocca do Acre	1,366
Rio Branco (capital of Acre Territory)	1,665
Cobija (outlet for part of Orton Basin in Bolivia)	1,927
Jurua and tributaries, including Rio Tarauaca:	
Sao Felippe	1,724
Cruzeiro do Sul	2,395
Solimoes (upper Amazon):	
Codajaz	178
Teffe	368
Sao Paulo do Olivenca	752
Benjamin Constant (Remate de Males) (near mouth of Javary)	894
Maranon (Peruvian section of Amazon):	
Iquitos	1,172
Mouth of the Ucayali	1,271
Mouth of the Huallaga	1,487
Negro and tributaries:	
Santa Isabel	423
Caracarai (head of navigation on Branco River)	420

The distance between Manaos and Para is about 925 miles.

Distances from Para of important points in the lower Amazon Basin are as follows:

	Miles		Miles
Manes (Amazon)	733	Sao Luiz (limit of navigation on Tapajoz)	759
Itacoatiara (Amazon)	817	Porto de Moz (Xingu)	318
Parintins (Amazon)	679	Victoria (limit of navigation on the Xingu)	384
Obidos (Amazon)	584	Curralinho	102
Santarem (Amazon)	516		
Boim (Tapajoz)	572		
Itaituba (Tapajoz)	710		

ROAD

Road building as understood in more advanced countries has not progressed far in the Amazon Valley. Such roads as exist are mostly mule trails, though some are also traversable by oxcarts. In nearly all cases roads are built by private initiative, though a road tax is levied in Bolivia, where some of the best routes of this kind are found, especially the Suarez road from Porvenir on the Tahuamanu to Cobija on the Acre.

RAILWAY

The only railway in operation in the rubber-producing areas of the Amazon Valley is the famous Madeira-Mamore Railway, which

[6] It might be remarked at this point that any lack of agreement in geographical or meteorological data presented in this report is due to the necessity of using figures from many different sources. The field party was not equipped to take measurements of this kind.

serves as an auxiliary to river transport in that zone. This railway, which has a total length of 220 miles, was built for the purpose of avoiding the dangerous rapids of the Madeira and its confluent, the Mamore, and with a special view to facilitating the exportation of rubber from Bolivia. The traffic over it is necessarily light, and it is doubtful if even a radical reduction of rates could greatly stimulate the movement of freight. The line is kept in good condition and is well administered. Another railway designed to carry freight around the rapids of the Tocantins was begun several years ago, but after 55 miles of track were laid from the point known as Alcobaca construction was discontinued and has never been resumed.

Of the railway projects in the Amazon Valley, among the most important are those which are intended to link up the upper Maranon in Peru with the Pacific coast and the valley of the Napo in Ecuador with the line of the Guayaquil & Quito Railway. Either of these roads would furnish a short outlet for regions now otherwise well adapted to the planting of rubber.

TELEGRAPH AND CABLE

The Western Telegraph Co. (Ltd.) operates an ocean cable out of Para with connections at Pernambuco for Europe and, via the Western Union cable from Barbados, with the United States. The Amazon Telegraph Co. (Ltd.) has a subfluvial cable between Manaos and Para, with stations at all principal towns, where foreign messages can be sent and received.

The Brazilian Government also maintains wireless telegraph stations at several points, including Para, Santarem, Manaos, Porto Velho, Labrea, and in the Acre Territory at Rio Branco, Xapury, Senna Madureira, Villa Seabra, and Cruzeiro do Sul. Rates are cheap. The long land line taps the zone of the upper Madeira and thence reaches Rio de Janeiro across Matto Grosso by way of Cuyaba.

The Bolivian Government maintains wireless telegraph stations at Cobija, Riberalta, and Villa Bella, which communicate with La Paz and thence with the west-coast ocean cables.

In Peru there are radio-telegraphic stations at Leticia, where the Amazon enters Brazilian territory, Iquitos, El Encanto on the Putumayo, Masisea on the Ucayali, and Puerto Maldonado on the Madre de Dios in the south. These stations communicate with Lima, where connection is made with the regular Pacific cables.

FUTURE AND POTENTIAL PRODUCTION OF WILD RUBBER

FUTURE PRODUCTION

The future production of wild rubber in the Amazon Valley will depend primarily on the trend of market prices. These will, of course, depend in turn on the relation between the future demand for rubber and the production of present or newly planted areas, since wild rubber itself is no longer a determinant factor in deciding the course of the world market. The people of the Amazon Valley hope for a return of something approaching the high prices of boom days, though the better informed realize the improbability of prices

ever again reaching the heights of 1910. However, when the price rises to a point where exploitation is profitable many persons occupied otherwise turn again to the collection of rubber.

There would have to be a considerable increase in price before any appreciable increase in production would be effected, and even then this would be slow. At the height of the boom period (1910–1912) the exports of the Amazon Valley were 45,067 metric tons (44,346 long tons). At that time the industry was probably better organized than it is to-day; that is to say, there were more men working, more estradas were open (many of which have been allowed to grow over), and the proprietors were in better financial condition. To-day the Amazon Valley lacks both capital and men. In order to increase production materially it would be necessary to collect the surplus labor of the valley, to import labor from Ceara and Maranhao, and to locate and build supply stations and stores. Roads and trails would have to be cleared of jungle growth. The capital is not available to do this quickly, no matter how sharply the price rises. It would be done eventually out of profits, assuming good prices continued, but this would require time.

In most localities the trees have been tapped so long and are in such poor physical condition that no increase can be expected from them. Consequently any great increase would have to come from virgin fields and from the destruction of Castilla trees.

POTENTIAL PRODUCTION

Many estimates have been made of the number of rubber-bearing trees in the Amazon Valley. The most commonly quoted figure is 300,000,000, and presumably this refers to Heveas only. This is merely a wild guess, for there is no way to approximate the number. There still remain large areas, particularly in the Brazilian State of Matto Grosso, which have been incompletely explored, and some are wholly unexplored. Enough is known, however, to warrant the assertion that they contain enormous numbers of fine trees of both Hevea and Castilla. Unfortunately these areas are difficult of access, and would require a large capital outlay in the opening of roads and trails and the purchase of mules and other equipment to get supplies in and the rubber out.

Taking all these factors into consideration it would appear that a sufficiently high price, extended over a few years, might bring the exportation up to that of 1912. In that year the price in Para ranged from 4$220 to 5$280 per kilo, corresponding to $0.62 to $0.78 a pound at par. Since the tendency to increase production is shown when the price rises to 4$000 per kilo in Manaos or Para, it is difficult to say what price would be necessary to bring production back to this highest point, bearing in mind the somewhat different conditions that prevail to-day—as, for example, the higher cost of imported supplies. Under present conditions of working and financing, our opinion is that it would have to be around 8$000 per kilo in Para and Manaos, corresponding at the average rate of exchange for 1923 to $0.37 U. S. a pound.[7]

[7] Since this paragraph was written the price of rubber has risen, and on June 19, 1925, spot upriver fine Para was quoted at $0.63 in New York. Consular reports show that in correspondence with this there has been a noticeable increase in the collection of rubber in the Amazon Valley.

Considering the number of trees that have been destroyed by the machadinho method of tapping and the tapping surface of those now being worked, and the number of extra men needed, it would require unusual prices and conditions to double, or possibly treble, the highest production ever reached. Some writers have made extravagant claims as to the potential production of wild rubber, one even going so far as to say that, given sufficient labor, it could be increased twentyfold. A little reflection and calculation will show that such an estimate is not likely to be realized.

UNEXPLORED RUBBER AREAS

Probably the greatest area of virgin or untapped rubber trees in South America is in the highlands of northern Matto Grosso east of the Madeira and Guapore Rivers and in southern Amazonas and Para. Very little of this area has been explored away from the rivers. The writings of explorers who have traversed parts of it and verbal reports of people who have penetrated the country all point to the existence of an enormous number of rubber trees which have not yet been exploited—and which can not be exploited until better means of transportation are provided. Some of the area is occupied by unfriendly Indians, and all of it is reported to be rough and hilly, with the rivers and streams full of rapids to impede launch and canoe travel and transport.

In this connection the following extract from the preamble of Dr. O. Labroy's A Borracha no Brazil is interesting. This preamble was written by the superintendent of the Defesa da Borracha in 1913, but the statements are almost as true now as then:

> It is perfectly verified that the forest rubber tree exists not only in the valley of the Amazon, but also in the north in the valleys of the Gurupy, Turyassu, and Pindare and other small rivers which empty directly into the ocean at 1° west longitude of the meridian of Rio de Janeiro, and to the south in the highlands [planalto] of the Parecis and center of Matto Grosso and in the upper valley of the Paraguay River, or to approximately the sixteenth degree of south latitude.
>
> In the Parecis the telegraph line in course of construction between Cuyaba and the Madeira River traverses the most extensive and dense rubber land (seringaes) of Brazil. According to information furnished by Colonel Rondon, in charge of the construction of this line, the station of Vilhena, situated at 2,730 feet in altitude, in lands completely dry, with a cool and salubrious climate, perfectly capable of being colonized by any people of south or central Europe, is located at the beginning of a forest which extends west to the Madeira and from north to south for hundreds of miles. In this forest the predominant tree is the *Hevea brasiliensis*, there being seen a large number of specimens of colossal proportions, evidencing an age of more than a century.
>
> On the Gurupy and the western strip of land of Maranhao, between the Gurupy and the Pindare Rivers, native rubber trees are equally abundant, but their exploitation is difficult, due to lack of communications and to the presence of uncivilized Indians.
>
> It appears without doubt, therefore, that Brazil possesses not far from 300 million forest rubber trees of an exploitable age.

There is little doubt that in other places in this area the *Hevea brasiliensis* comes close to being the predominant tree. Col. Raimundo Monteiro da Costa, of the Brazilian commission accompanying our party, stated that on the upper Marmellos (between the Gy-Parana and the Roosevelt) on areas worked by him in years past there are natural prairies (campos geraes) in which clumps of forest are found that are almost pure stands of *Hevea brasiliensis*.

POSSIBILITIES OF PLANTATION DEVELOPMENT

Little governmental assistance or encouragement has been given in the matter of planting Heveas by the development of experiment stations whereby actual problems could be studied. The nearest approach to an experiment plot is a small planted area at Manaos called the Seringal Miry, the cost of which has been defrayed mainly by private individuals and firms. A certain amount of experimental work was undertaken with a view to determining proper cultivation methods and developing better systems of tapping. In the past few years, however, little has been done along this line.

A few years ago the Club da Seringueira was formed in Manaos and a publication started with the intention of arousing interest in planting Hevea and introducing better methods on the old seringaes. Due to its efforts some planting started, but the low price of rubber, and resultant depression, caused the club to disband.

PLANTED AREAS NOW EXISTING

Small patches of planted *Hevea brasiliensis* are found in many places in the Amazon Valley. These vary from a few trees up to as many as 20,000, the latter being the largest single area encountered. These planted Heveas are usually spoken of as "plantations," but in the whole valley there is nothing that compares with the plantations of the East.

The trees have, for the most part, been planted either in unsuitable soil or too close together and have usually had no care after planting; that is, they have been allowed to grow up in bush and forest. It is not possible to compare them in size or rate of growth with Eastern plantation trees which have been grown under careful cultivation routine. In no case are conditions identical or even closely enough related to make an accurate comparison.

In practically every instance the planted trees are smaller in size than trees of corresponding age on the Eastern plantations. Some older trees observed, however, were comparable in size and appearance. The apparent slower growth might be due to several factors, of which the following are the most important:

FACTORS AFFECTING GROWTH

(*a*) *Long, dry summer season.*—The dry period of six months, with the not unknown occurrence of three months without any rain at all, would undoubtedly have some effect on the rate of growth of young trees. In those countries of the Middle East which have a pronounced dry season—for example, Ceylon and Burma—the tapping stage is delayed one or two years over that of Malaya and Sumatra with their more uniform rainfall.

In the Amazon Basin the trees have usually been planted in the forest or among other vegetation, but in such cases there is always soil moisture sufficient to keep the young plants growing. What the young plants really suffer from is lack of sunlight, and this would retard growth as much as would lack of moisture. It does not appear, then, that the slow growth can be attributed altogether to the dry season.

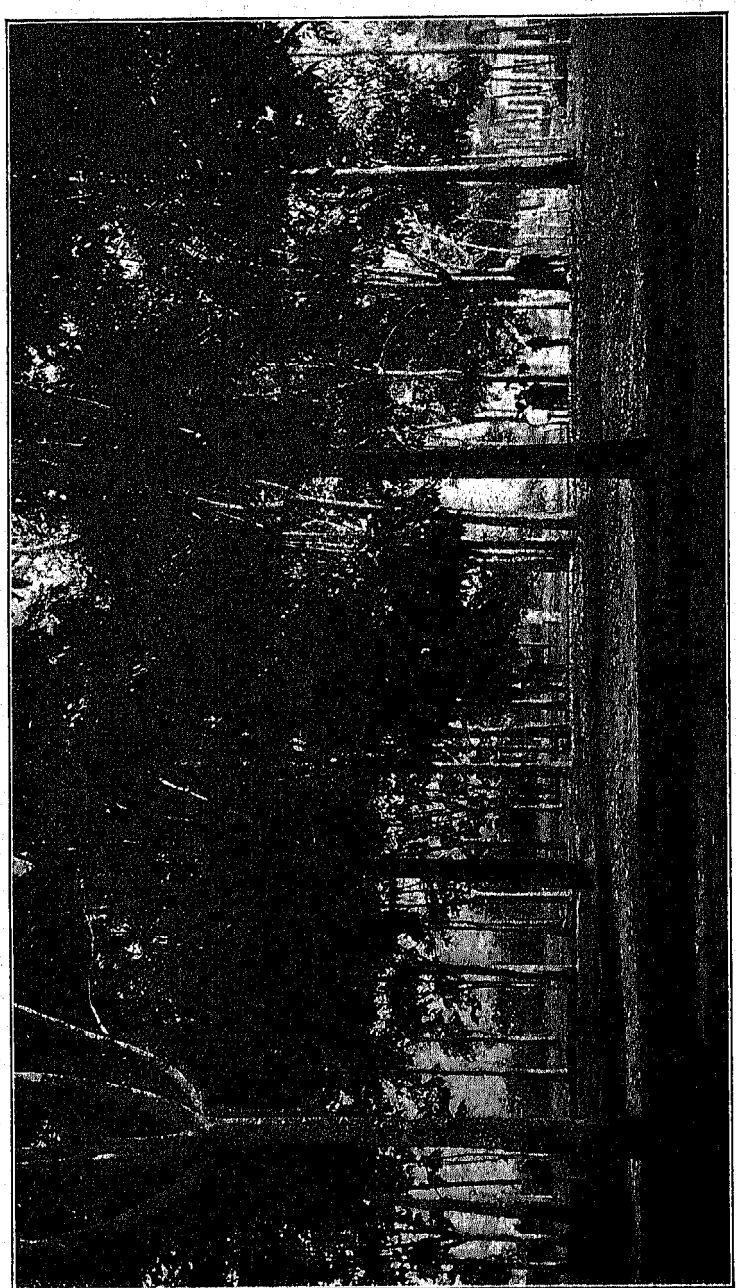


FIG. 11.—Seringal Miry. Planted trees near the city of Manaos

(*b*) *Soils in which planted.*—Generally the trees have been planted in soils not suitable for their best development. A few have been planted on the high, well-drained uplands, but the majority are on the flood plains on land either subject to occasional light overflows or having a high permanent water table. Trees planted on such land, unless too sandy, should have a rapid development the first few years, but when the taproot reaches a hard subsoil or the permanent water level the growth will be retarded.

(*c*) *Lack of knowledge as to best planting methods.*—It is highly probable that instead of gathering seeds and germinating them young seedlings were pulled up from beneath the mother tree and simply transplanted. In this case there would be no way of knowing the actual age of the young seedlings, and strong and weak plants would be planted promiscuously. It is well known that in the germinating of seeds on the Eastern plantations there is great irregularity in the vigor of the young plants, and for planting purposes only the most vigorous are chosen. When seeds are planted in the field (at stake) always two or more are planted and only the most vigorous plant allowed to grow.

It may also have happened that the plants were not set out at the beginning of the rainy season whereby the roots would have become firmly established and growth started before the drier weather came on, which would have a tendency to retard growth.

Judging also from observations of the character of other work performed in the valley it is highly probable that no planting holes were dug in the hard soil, but simply a hole made with a sharp stick and the roots forced into it. In other words, there is a lack of knowledge as to how trees should be planted.

(*d*) *Lack of proper upkeep after planting.*—Planting in the forest among other trees, or else in a garden among coffee, cacao, fruits, or other commercial crops was done on the theory that as the rubber tree was a forest tree it would thrive only under such conditions. This view wholly overlooked the fact that in the forest the rubber tree is subjected to the merciless competition of nature and that relatively few have survived this competition, notwithstanding the enormous crops of seed produced by the Hevea and scattered broadcast, when the seedpod flies open, in its endeavor to perpetuate itself. In those few cases where the trees were set out on cleared ground the land was allowed to grow up in grass and underbrush. It is well known in the East that such conditions greatly retard or stunt the growth of young trees even with the more uniform rainfall existing there.

It is highly probable, therefore, that these last two reasons (*c* and *d*) have had as much to do with the slow development of the Amazonian planted Heveas as the dry season or the character of the soil. With proper methods of soil preparation, seed selection, care in planting, and proper upkeep afterwards there seems to be no inherent reason why the planted Hevea in a large part of the Amazon Basin should not be in every way comparable to that of the Middle East, with the possible exception that, due to the more marked dry season in the Amazon, to reach the tapping age might take a little longer.

PLANTED RUBBER EXAMINED

Planted trees were examined at the following places. An effort was made to obtain as near as possible the ages of the trees for purposes of comparison.

ISLANDS AND PARA

Para.—In the neighborhood of the city of Para (Belem) itself there are scattered patches of planted Heveas, some of the areas having been planted originally with as many as 5,000 or 6,000 trees. An illustration of the general condition is typified at the two places, Japacary and Sumauma. Here trees 11 years old, planted about 15 by 18 feet, on heavy silt soil, much of it continuously wet, were completely overgrown with vines and secondary jungle. The larger trees (about one-half the total number) averaged around the size of 6-year-old Eastern plantation trees, and the balance of 2 to 5 year old trees. The bark on all was very thin, being not over 5 millimeters (millimeter=0.03937 inch).

On Outeiro Island we found a few trees, the remnants of plantings 20 years ago. Originally a large number of trees had been set out, but in 1922, when the price of rubber was very low, most of them were cut down and fruit trees substituted. The rubber stumps measured 16 to 18 inches in diameter, corresponding to a girth of 4 feet 2 inches to 4 feet 7 inches. The trees were planted in a yellow clay having a heavy admixture of iron pebbles. The surface of the ground was covered with these. The growth of the remaining trees was poor; the bark very thin, all showing the unsuitability of the soil.

Near the Para waterworks, in a district called Utinga, a few acres of planted trees, set out more or less 18 feet apart, had a very healthy appearance as far as leaves were concerned. They averaged slightly over 2 feet in girth; the largest one in the lot was 3 feet 6 inches. No one could tell us the age of these trees, but they undoubtedly were much older than their size indicated.

OTHER PLANTINGS IN THIS SECTION

The area served by the Braganca Railway has practically no wild rubber. In this area the only trees seen were planted trees, and their growth and bark indicate that soil conditions are very unfavorable for their best development. The bark, always thin, was usually hard and corky on the outside, with practically no exudation of latex when pricked.

At the Government Experiment Farm located at Igarape-assu, 93 miles from Para, there are a number of trees along the roads and divisions between fields. These trees were planted in 1907, and at the time of the visit of the field party (August, 1923) were therefore 16 years of age. In general, they were of very poor appearance, and averaged about the size of 4 and 5 year old trees on the Eastern plantations. A few were of larger size—about equal to 8-year-old plantation trees. The trees that had been tapped were badly mutilated, but when pricked furnished a fairly good flow of latex.

Gurupa.—Gurupa is located on the terra firme (upland) on the right bank of the Amazon a few miles below the mouth of the Xingu. There are quite a number of planted trees around the town. These are on poor, sandy soil, with gravel and rock close to the surface. The oldest of the trees are 30 years of age; the average girth of the largest of these was 5 feet 8 inches, ranging from 4 feet 2 inches to 8 feet.

A patch of 12-year-old trees grown up in brush averaged 2 feet 2 inches. All the older trees and many of the younger ones at this place were infected with mistletoe, but on only a few of them was it sufficient to cause damage. On the other hand, the trees were badly attacked by a leaf disease, *Catacauma Huberi*, and some were practically leafless. The trees were said to be poor yielders, which is easily explainable by their physical condition.

LOWER AMAZON, SOUTH

A great many planted trees were measured, the ages of which were fairly well known.

Cacoal Imperial.—On the low varzea land, right bank of Amazon River, near Obidos. Trees interplanted with cacao, and now overgrown with vines, weeds, and grass. Most are planted 12 by 15 feet in rows. Some, however, are only 8 to 10 feet apart. In age they ranged from 11 to 26 years and in average girth from 2 feet to 6 feet.

Besides the above, there are several thousand planted trees of various ages completely overgrown with jungle which were not examined. These trees were planted by Paul LeCointe.

Boa Fe.—About 40 miles below Manaos. On low land near river bank. One hundred trees planted close together, 40 years old, average 8 feet 7 inches in circumference. One or two were 9 feet 6 inches.

Taboleiro.—Eight hours' travel upriver from Maues. A small clump of *Hevea brasiliensis* on hillside at river bank, high enough not to be influenced by moisture from river. Age 27 years. Trees had large crowns of rich-green leaves, very healthy and vigorous in appearance. Very thick bark, some measuring 1 inch and several ¾ inch. The girths of these trees ranged from 3 feet 4 inches to 6 feet 10 inches, with an average of 4 feet 8 inches, at 3 feet from the ground.

Furo de Ramos.—Between Maues and Parintins. About 100 trees were planted here in 1859 on low ground subject to annual overflow. Some of the trees have died. Those remaining range in girth from 3 feet 1 inch to 6 feet 6 inches, with an average of about 5 feet 10 inches. These have been tapped spasmodically during at least 50 years and are still vigorous-looking trees.

THE TAPAJOZ SECTION

Santarem.—A plot of 5 acres on a farm owned by an American, 5 miles from Santarem on low land on the Amazon. Trees 14 years old, planted in rows 8 by 17½ feet and interplanted with pineapples. Soil very poor for rubber, being sandy, with water at 4 and 5 feet in the rainy season and 12 feet in the dry season. Some of the trees badly infected with a fungus disease on the leaves; others have

leaves riddled with holes, probably caused by a caterpillar or insect. Measurements of 3 rows of tapped trees, these being typical of all, showed a range of 1 foot 6 inches to 3 feet 6½ inches, with an average girth of 2 feet 4 inches.

Alter do Chao.—On right bank of Tapajoz near Santarem. A lot of 13 trees said to be 30 years old planted in the back yard of the village schoolmaster. Soil is a friable black sand for about 10 feet and a yellowish sand and clay below. Trees are about 300 feet from the river at high water and probably secure moisture from it. Seeds derived from the Jauamaxim, an affluent of the Tapajoz above the cachoeiras. These trees were as fine specimens of rubber trees as could be found anywhere. They have full, heavy branches, with a dense crown of beautifully healthy dark-green leaves. They have been tapped for years and are still extraordinarily high yielders. They ranged in girth from 4 feet 3 inches to 8 feet, with an average of 6 feet 9 inches.

Near by was a plot of about 10 acres, in similar sand, 12 by 12 feet (average). The oldest trees were planted in 1914. All were small for their ages but of a very healthy appearance, and all were being tapped. For the first four years they were interplanted with corn, mandioca, and bananas. The average girth of the best specimens of the oldest trees were 2 feet 9 inches, ranging in size from 2 feet 4 inches to 3 feet 6 inches.

ARAMANAHY ON THE TAPAJOZ

Aramanahy.—(*a*) On the right bank of the Tapajoz about 12 miles above Alter do Chao. Trees are planted in sand at the foot of a slope near the river; upland, not inundated, but trees near the river may get moisture from that source, since the best trees are usually near the river. Ages of the oldest trees not known exactly, but are about 40 years. Seeds came from around the cachoeiras of the Tapajoz. Many younger trees from dropped seeds were growing, but their ages were unknown. All are beautifully healthy trees, as at Alter do Chao. The largest of the 40-year-old trees averaged 8 feet 1 inch in girth, ranging from 6 feet 9 inches up to 12 feet 3 inches.

(*b*) A plot of trees planted in 1881. Now 43 years old. Planted roughly in rows about 8 feet 6 inches by 9 feet. Growth very irregular. Some measured as much as 10 feet in circumference and the small ones no more than 18 inches. The larger trees averaged 7 feet in girth, varying from 4 feet 9 inches to 10 feet.

(*c*) A patch of 9-year-old trees, the average size of which was 2 feet 10 inches.

(*d*) A patch of 200 trees 12 years old. Average size 2 feet 8 inches.

(*e*) A small patch of closely planted trees (6 feet 6 inches by 10 feet 8 inches), 17 years of age. Very uneven in size; girth measurements ranged from 1 foot 9 inches to 6 feet 4 inches, with an average for all the trees of 3 feet 4 inches.

(*f*) Another lot of same age belonging to same owner but planted 9 feet 6 inches by 13 feet 2 inches. Much more uniform in growth and appearance. Girth measurement ranged from 2 feet 9 inches to 7 feet 9 inches, with an average of 4 feet 5 inches.

(*g*) A lot of about 8 acres, 24 years old. Planted about 20 feet apart. Girth of trees, average 5 feet 8 inches, of largest one 9 feet 4½ inches.

None of the above trees were on varzea land or subject to overflow, but on poor sandy soil along the margin of the river. All had an extraordinarily good crown development and healthy appearance.

There are several thousand trees planted in scattered places in the forest and second growth on the hills between Aramanahy and the high plateau which is about two hours' travel away. One lot of these inspected by us was 12 years old. They were grown up in forest and were about the size of 4 to 5 year old Eastern plantation trees.

BOIM ON THE TAPAJOZ

Boim.—Conditions here very similar to the above two places, except the land is a plain. Some of the trees were close to the river, but most were well back. Seeds came from the plateau 7 miles west of the locality.

(*a*) A small patch close to river. Planted in 1906, started tapping in 1913. Size of trees ranged from 2 feet 9 inches to 5 feet, with an average of 3 feet 11 inches.

(*b*) Small clump of 9-year-old trees in sand near river. All being tapped. Younger trees growing up between them. Known 9-year-old trees ranged from 2 feet to 4 feet 4 inches in girth, with an average of 3 feet 1 inch.

(*c*) Small clump of 25-year-old trees. Planted very close together. Girth averages 6 feet 4 inches, ranging from 4 feet 4 inches to 9 feet.

(*d*) A small lot of 28-year-old trees, over 100 yards from the river bank. Average girth 7 feet, ranging from 4 feet 2 inches to 11 feet 6 inches.

(*e*) A small lot, age unknown, but considered to be about 40 years old. Average girth of best trees was 6 feet 9 inches, ranging from 4 feet to 9 feet 10 inches.

(*f*) A small lot, age uncertain, but supposed to be around 25 years old. Average girth 5 feet 9 inches, ranging from 4 feet 8 inches to 6 feet 11 inches.

(*g*) Sixteen 24-year-old trees, planted close together. The average girth of the largest trees was 7 feet, ranging from 4 feet 3 inches to 8 feet 6 inches.

(*h*) A patch of trees planted in 1918, approximately 10 by 12 feet. First tapped in 1923. Average girth 1 foot 8 inches, ranging from 1 foot 4 inches to 2 feet 2 inches.

(*i*) A lot of 7-year-old trees planted in clumps, more or less 9 feet apart. Average girth 1 foot 8 inches, ranging from 1 foot 4 inches to 2 feet 2 inches.

(*j*) A plot of 19-year-old trees, very irregular in size. These averaged 3 feet 4 inches in girth, ranging from 1 foot 9 inches to 5 feet 2 inches.

All of the older trees at Boim have very thick bark, some samples being 1 inch thick. The yields varied; some very high and others poor. All are *Hevea brasiliensis*.

PLANTINGS ON OTHER RIVERS

Tauary River.—About 4 miles up the Tauary River (which is a tributary of the Tapajoz) are several patches of planted *Hevea brasiliensis*. They are planted on the river bank in a poor, sandy, and very unsuitable soil. One lot of trees 40 years old, planted about 15 feet apart, was irregular in size and badly disfigured by tapping. The largest had a range in girth from 4 feet 5 inches to 7 feet 8 inches, with an average of 5 feet 11 inches.

Lower Xingu.—There are several small patches of planted trees on the lower Xingu. The only lot inspected by us was at Itapinima, near Souzel. The oldest of these trees were 19 years old. They are planted in very poor soil close to the river and are rather inferior looking, but no specific evidence of disease was observed. According to the owner some of them were very high yielders. The largest averaged 4 feet 6 inches in girth, with a range of 3 feet 9½ inches to 6 feet.

UPPER AMAZON, NORTH

Manaos.—There are a few planted Heveas around Manaos, the ages of some of which are known. The trees had a good appearance and fairly good bark, but in all cases where the age was known definitely the trees were smaller than trees of corresponding age in the plantations of the East.

In the outskirts of Manaos, at Seringal Miry, there are about 2½ acres of planted Heveas, started in 1915 as a sort of exhibition place and experimental plot. The trees are planted 30 by 16 feet, or 90 to the acre. The trees had been tapped not less than three years ago with the knife known as the Amazonia mesquita. In general, the bark, both virgin and renewed, was thin. The trees, 8 years old at the time of our visit, had an average circumference of 2 feet 9 inches, measured 3 feet from the ground.

At this same place 6 trees 30 years old had an average girth of 6 feet 2½ inches at 3 feet from the ground. Another tree in a garden near by, planted July 7, 1912, had a circumference of 4 feet 5 inches.

MADEIRA

Below are given measurements (taken 3 feet from the ground) of trees at various points in the Madeira district:

Urucurituba, west bank of the Madeira River, 62 miles from Manaos. Trees over 20 years old. They are interplanted with coffee and cacao, and their girth varies from 2 to 5 feet. The tapping surface up to over 8 feet was cut to pieces by the machadinho, and was a mass of burrs and corrugations. The bark, however, was thick, and gave a good flow of latex when tapped with a knife.

Rosarinho, 66 miles from Manaos. One hundred and fifty trees planted on terra firme (upland), 28 years old. Growing in a maze of cacao and other trees. Tapping surface cut to pieces up to 10 feet. The largest trees averaged 5 feet 6 inches in girth and about 75 feet in height. Young trees growing from seeds of the older trees were tapped when 20 to 22 inches in circumference.

Diamantina, east bank of river, 206 miles from Manaos. Five hundred planted trees 12 years old. Planted irregularly, close together, with a young forest of fruit trees, palms, etc., growing up under the rubber. Measurement of typical trees gave a girth average of 3 feet, ranging from 2 feet to 4 feet 9 inches. Tapping surface up to 10 feet a mass of burrs and nodules.

Democracia, west bank of river, 299 miles from Manaos. A few planted trees on alluvial land, 12 to 15 years old. Representative trees ranged from 3 feet 2 inches to 5 feet 6 inches, giving an average girth of 4 feet 2 inches.

Conceicao, west bank of river, 322 miles from Manaos. One thousand planted trees, the oldest being 25 years old. Four hundred trees tapped. Tapping surface of all badly disfigured. Trees planted 8 to 10 feet apart. Measurements of a few of the best trees ranged from 3 feet 11 inches to 7 feet 11 inches, with an average of 5 feet 2 inches.

Santa Laura, east bank of the river, 363 miles from Manaos. Planted trees 25 and 15 years old. Younger trees had never been tapped. Some were good trees, but many undersized, planted close together, and no care taken of them. The older (25-year) trees were good. Measurements of a few representative 25-year-old trees ranged from 4 feet 2 inches to 7 feet 6 inches, with an average of 5 feet 3 inches; of 15-year-old trees, from 2 feet 1 inch to 5 feet 7 inches, with an average of 3 feet 4 inches.

Porto Velho. Thirty trees planted in 1913 around the residence of the manager of the Madeira-Mamore Railway. Hard, rocky, red soil, very similar in appearance to that around Rawang, Selangor. Leaves healthy and tops have good development, with low branching. Have all appearance of good Eastern trees. Measurements ranged from 1 foot 10 inches to 3 feet 7 inches, with an average girth of 2 feet 10 inches.

ACRE TERRITORY

Near Rio Branco there are 8 or 10 acres of planted *Hevea brasiliensis* started in former years as an experiment by the Government but since abandoned. The soil is sandy and on account of its proximity to the river would not ordinarily be chosen for rubber. The plot is grown up in grass and underbrush, with a few native fruit trees scattered through it. Trees are planted 4 meters (13 feet 2 inches) square. The oldest trees were said to be 12 years old. The girth measurement of two rows, representative of the lot, at 3 feet from the ground ranged from 9 inches to 3 feet 10 inches, with an average of 1 foot 3.7 inches.

In the outskirts of Rio Branco, on the south side of the river, there are some trees 6 to 8 years old. With few exceptions these are planted close together (12 by 15 feet), interplanted with fruit trees, and the whole grown up in grass and weeds. Girths at 3 feet from the ground ranged from 1 foot to 2 feet 10 inches, with an average of 1 foot 9 inches.

At a seringueiro's house on the Seringal Porvir on the Acre River a rubber tree measuring 5 feet 5 inches was observed. This tree was planted in 1910 as a small sapling pulled out of the forest. Having had the opportunity to secure sufficient sunlight it was able to develop.

BOLIVIA

Planting of 80,000 trees in the forest was started on the Hacienda Candelaria on the Madre de Dios by the owner, Señor Salvatierra, about 20 years ago. Many of these did not live, and the growth of the others has been extremely slow. Trees that were pointed out as being 5 years old were completely smothered by the jungle. Some were 15 to 18 feet high with a girth measurement of 2 to 2½ inches, thus corresponding in size to a stump 1 year or 18 months old on the Eastern plantations.

On the property "Conquista" of Seiler & Co. on this same river there were Heveas 2½ years old planted with sufficient spacing in a cotton field. Some of these were only slightly smaller than trees of corresponding age in the Middle East.

PERU

Many trees were planted several years ago at different places, but as the price of rubber continued to drop the owners lost interest and allowed the trees to be destroyed or else paid no attention to them, with the result that they were overgrown by other vegetation.

Near Iquitos the Government established a small experiment plot on which some Heveas were planted from seed said to have been brought from the Middle East. This has been allowed to fall into a state of neglect, but some of the trees have a very good appearance.

During our travels in Peru we encountered only one man who retained enough interest in the matter to continue planting, and that was at Oromina on the Huallaga. The owner of the property stated he had 30,000 trees planted, of various ages, and was continuing to plant. The trees were small for their age but had a very good and uniform appearance. One lot of 9-year-old trees exhibited the most uniform growth of any similar number of trees seen in the Amazon Valley. These trees were planted 12 by 12 feet and apparently had had no special care. The average girth measurement of these trees was 2 feet 6 inches, or about the average size of 6-year trees in British Malaya. They exhibited a good bark, with a good flow of latex when tapped, and had a healthy appearance.

TOPOGRAPHY

On account of the vast extent of territory embraced in this survey only its outstanding topographical features can be considered here. Detailed descriptions of individual localities will be found in the regional reports.

The Amazon Basin consists of a saucer-like depression, more or less elliptical in form, bounded on the north and south by an encircling rim of hills (high enough in places to be called mountains and rugged in outline) and on the west by the Andes Mountains. Its widest point is near the sixty-fifth meridian of west longitude, this passing through western Brazil and eastern Bolivia. Here its north and south limits are roughly from 3° north to 15° south latitude. The Amazon River, which corresponds to the axis, lies north of the center of the valley.

CHARACTERISTICS OF THE MAIN VALLEY

The valley proper may be looked upon as a low plain intersected by the innumerable streams which form the draining system. The whole area has a low elevation relative to sea level. The city of Para at the eastern end is 38 feet and Iquitos, some 2,000 miles up the Amazon and near the western end, is only 350 feet above sea level. Tides from the ocean are felt at Obidos, more than 500 miles from the river mouth. The elevation of Porto Velho, 600 miles up the Madeira River, is 320 feet. Within the basin few points higher than 500 or 600 feet are to be found until the high lands forming the rim are encountered on north and south. In parts of the Acre Territory and that section of Bolivia near the common boundary of Brazil, Peru, and Bolivia, the elevation is higher, ranging from 700

FIG. 12.—Typical varzea, or land subject to periodic inundation, along the river banks

to 1,200 feet. Mountains are found in the highlands around the rim up to several thousand feet in altitude, these latter being on the north side. At the western end the valley abuts rather abruptly upon the high outlying spurs of the Andes.

In the stretch of country along the Amazon River between the cities of Para and Manaos every type of topography in the whole Amazon Basin can be seen. In the delta the land is low and large areas are subject to inundation. Above Gurupa, the Amazon River is confined to a definite valley from 15 to 30 miles wide, the lowlands of which are subject to inundation. High plains and ranges of hills are then almost always in sight to Manaos, sometimes on one side of the river only, sometimes on both. These hills for long distances are at the water's edge, and at no place are they more than 20 miles from the stream. The tributaries of the Amazon differ only in degree, their valleys being narrower. Some of these, particularly the Rio Negro in Brazil and the Ucayali in Peru, have flood plains as wide as or wider than the Amazon.

CHARACTERISTICS OF THE CHIEF TRIBUTARIES

The tributaries of the Amazon River on the north side of the valley flow in a general southerly direction, and those on the south side in a northerly one. Except in the west the rivers are broken up by rapids (cachoeiras) when they debouch from the higher land onto the Amazon plain, and these form the limits of steam navigation, though in periods of high water some of them can be passed by launches and small steamers. The rapids are much closer to the main stream as the eastern end is approached; that is, the rapids of the Moju, Tocantins, Xingu, and Tapajoz are closer to the Amazon than are those of the Madeira and the Purus.

The valleys of the larger rivers, in general, are quite wide, and the rivers, having a low gradient or fall, flow in wide sweeping curves in their flood plains. In these plains natural channels, locally known as paranas and furos, and lakes form a continuous connection with the river, so that the water, instead of flowing through one main channel, flows through a veritable labyrinth on its way to the sea. In periods of high water much land is inundated, but the area subject to flooding is very small in proportion to the total area of the valley. In the delta region of the Amazon the proportion of flooded land is greater than in the interior, due to its general low elevation above sea level. On many of the rivers, particularly the Tocantins, Xingu, and Tapajoz, high bluffs extend to the banks of the river, and, except near their mouths, there is little flooded land.

TERRA FIRME AND CAMPOS

Much of the terra firme is level plain, as that between the rivers Tocantins, Xingu, Tapajoz, Madeira, and Teffe, in Brazil, and in Bolivia and Peru. Some is cut by the many rivers and creeks into undulating and rolling land, and farther back from the main streams, as the general elevation rises, the land becomes rougher and can be classed as hilly and mountainous. Much of the land of the upper Madeira region and Matto Grosso is of this type.

In certain parts of the valley, especially on the north side of the Amazon River above the rapids of the tributaries, are large areas of open grassland, locally known as campos. On the south side such areas, of varying extent, are also encountered, particularly in the States of Para and Matto Grosso, and a small tract in the State of Amazonas between the Madeira and Purus Rivers. Some of these open grasslands are utilized for stock raising, as on the island of Marajo and the campos of the Branco River area north of Manaos. The soil is not suitable for agricultural purposes, and would not be for rubber planting.

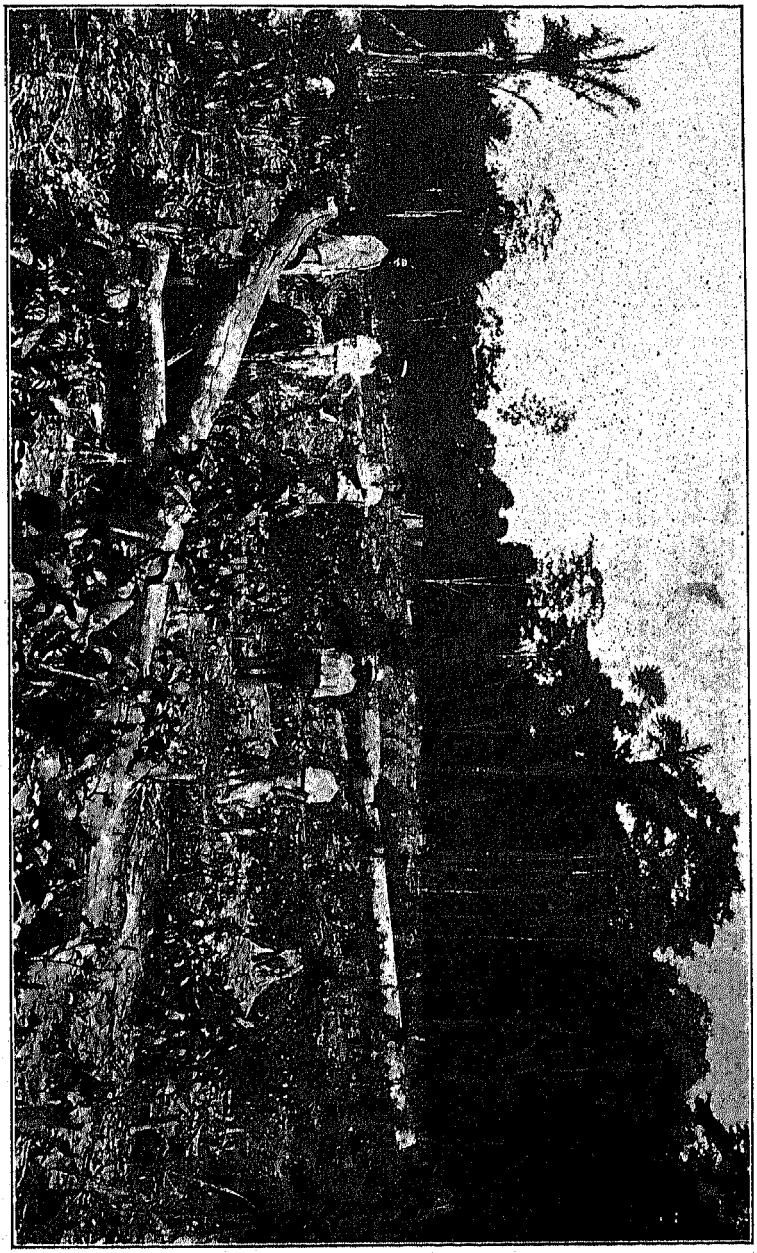


Fig. 13.—Light upland forest, Peru

FIG. 14.—Democracia, Madeira River. Clearing land for planting; not yet burned

SOILS OF THE AMAZON REGION[8]

Soils are a product of the environment in which they have developed. The principal features of natural environment of the central Amazon region—that is, the climate, the native vegetation, and the geology—show little variation from place to place. In general, therefore, the soil characteristics throughout the valley are remarkably uniform.

While this is true, slight differences in minor features of the environment may produce important variations in the soil character. Thus, two other factors of the natural surroundings, those of topography and the size of the particle of the material from which the soil has been developed, show considerable change.

Variation in topography especially may bring about wide differences in soil character. From this standpoint, the soils of the central Amazon region can be divided into two distinct classes, namely, the alluvial, or flood-plain, soils (varzeas), and the soils of the uplands (terra firme).

THE ALLUVIAL SOILS

Alluvial soils are those formed by the deposits made by rivers. The material carried by the Amazon is derived from upland erosion and caving bluffs. The upland deposits, of a brownish or grayish color, come chiefly from the surface, inasmuch as gullying is not common. Since deposition two changes affecting their color have taken place; these are the accumulation of a thin layer of organic matter on the surface soil and a more or less complete deoxidation of the iron compounds in the subsoil brought about by a high water table.

From a practical standpoint the alluvial soils can be divided into three groups—river-bank soils, soils deposited behind the river banks, and soils of the river terraces.

RIVER-BANK SOILS

The river-bank or natural-levee soils on the margins of the river channels vary in width from a few feet up to a quarter of a mile. The soils are brown, and predominantly very fine sandy loams in texture. Silt loams and fine sandy loams are found rather frequently, but sandy loams, coarse sandy loams, sands, and coarse sands are very rare. A typical section with a soil somewhat heavier than the average consists of a surface of about 20 inches of brown silt loam. Slight segregation of the iron has taken place, but not to the extent of producing gray or completely deoxidized spots. Lying beneath this is a 10-inch bed of sandy loam, light brown in color. Under this is a clay horizon, wholly free from compaction or induration, which is at least 30 inches in thickness. In the lower part of this layer segregation has progressed to a considerable extent, with some gray material present. In many cases, however, especially where the texture is very fine sandy loam to a depth of 60 inches or more, the color is brown below 12 inches.

[8] By C. F. Marbut, chief, Division of Soil Survey, Bureau of Soils, and C. B. Manifold, soil surveyor, Bureau of Soils, Department of Agriculture.

ALLUVIAL SOILS BEHIND THE RIVER BANKS

The alluvial lands behind the narrow belt of natural levee comprise by far the largest areas of the alluvial plains. At the present time they are little utilized for growing crops. They are lower than the river-bank soils and are the first to become inundated by the annual rise of the river and the last to be free of the flood. Some large areas lie lower than the average level of the river and are covered permanently with water, forming the so-called varzea lakes.

The characteristics of these soils were noted in only a few places. Usually they are light gray in color from the surface downward for many feet, or they have a brown surface horizon, generally consisting of a thin coating of recently deposited material. Where the deposition has been rapid the soil and subsoil may be free from gray, in which case the color will resemble that of the river-bank soils. They are predominantly heavy, ranging from the silt loams to clay loams and clays, especially in the upper layers. The subsoils grade into materials which represent the sandy river-bed deposits that were laid down when the channel occupied that particular place at a former cycle of its sidewise shifting.

Where covered with grass, these heavy alluvial lands are utilized to some extent for grazing. The livestock on them, however, is always in great danger of starvation or drowning when annual floods are exceptionally high.[9]

ALLUVIAL SOILS OF RIVER TERRACES

Nearer the upland limits of the alluvial lands of the central Amazon Basin are areas of higher levels, relative to the river, than those of the river banks and the lower lying lands behind them. Because of their elevation, such lands are not subject to annual inundation for so long a period, and those bordering the uplands are subject to overflow only at the extreme high floods.

These soils are better drained at the present time, and consequently have had a chance to develop and are comparable in color and some other respects to the upland soils. They are more characteristic of the upper than of the lower portions of southern affluents of the Amazon, and of the main river itself, and were noted along the following streams: Madeira, Beni, Madre de Dios, Pacanova, Acre, Abuna, and Purus. The profile of these soils consists roughly of a surface foot of brown soil, a foot or more of reddish material (usually a silty clay), and 5 or more feet of a moderately friable mottled clay.

THE UPLAND SOILS

The lands subject to overflow, while extensive, do not cover so large an area as is generally believed. Even if the inevitable floods did not make the future of the alluvial lands doubtful, it would still remain true that the development of the Amazon depends primarily on the use made of the upland soils, because they comprise 90 per cent or more of the land area.

[9] For the disadvantages as well as the advantages attending the use of these lands for grazing see LeCointe, L'Amazonie Bresillenne.

With the exception of the very small portions on steep hillsides, the upland soils of the central Amazon Basin are well developed and, when well drained, light in color. They contain a low percentage of organic matter and therefore of nitrogen. In this respect they are comparable to the uncultivated soils in forest-covered lands throughout the warm temperate and tropical regions of the world. The percentage of organic matter in the soils is somewhat higher than in southeastern United States, for example; but this seems to be due principally to their heavier texture and in part to the greater activity of insects, especially ants, in the Amazon region, by mixing the surface organic matter with the upper layers of the soil, for chemical analyses of the forested soils of the Amazon uplands show a content of organic matter in the upper 8 inches no higher than 3 per cent, while a grassland loam in the United States will average perhaps twice that amount. The timber-land soils throughout the world are known to lose organic matter at a rapid rate when placed under cultivation unless special effort is made to maintain it by constant additions. It is believed those of the Amazon Basin will not, when cultivated, be an exception to this rule.

Besides the low percentage of organic matter in the soil, the layer of vegetable débris on the surface is thin when compared with the luxuriance of the forest growth. This consists of a layer of loose leaves, with some twigs, of a very few inches in thickness, and usually much less of partially decomposed and finely divided organic matter still retaining its brown color. Enough organic matter is supplied to the surface of the land by the forest cover to fill the soil if nature provided any means of incorporating it therein. This she fails to do except to a very slight extent by action of insects and worms. The work of these, though large in the aggregate, is wholly inadequate to incorporate and maintain a supply of organic matter as compared with that supplied by the growth of grass.

COLOR OF THE UPLAND SOILS

The different horizons of the virgin soil of the uplands show the following colors: (*a*) Surface soil, brown; (*b*) soil next below surface, generally yellow, but sometimes this layer is very thin; (*c*) below yellow horizon, a layer of deep red to yellowish red—replaces (*b*) when latter is absent; (*d*) mottled clay below red horizon; the soil is clay or sandy clay, gray-blue or white in color, with spots of brown or reddish iron oxide.

(*a*) *Brown horizon.*—The surface virgin soil, usually varying from 6 to 8 inches in thickness, has a darkish brown color, due to the organic matter it contains.

(*b*) *Yellow horizon.*—Varies in depth from a mere film to one of great thickness. If the soil contains a high percentage of sand, rapid weathering is greatly favored and the layer is thick. If, on the other hand, there is present a high percentage of clay, the layer may be thin or absent.

(*c*) *Red horizon.*—Lies beneath the yellow horizon. Generally the material of this red horizon is heavier than that of the surface. When the yellow horizon is very thin, the red layer may reach a maximum thickness of 10 feet.

(*d*) *Mottled clay horizon.*—Usually several feet in thickness, often more than 25, and sometimes extending to the water table in river bluffs that exceed 50 feet in height. It is a clay or sandy clay, gray-blue or white in color, with spots of brown or reddish brown iron oxide, hence the name. The iron oxide is probably due to segregation and oxidation of the iron that was formerly present in the unchanged parent rock in some form other than an oxide. At the top of this clay horizon mottled red material predominates.

STRUCTURE AND CONSISTENCY

The term "structure" refers mainly to the size of the aggregates of soil particles, resulting in a coarse-grained or fine-grained crumb structure or the absence of it. In a region with high rainfall, such as the central Amazon Basin, there is either an absence of any aggregation of soil particles, known as single grain structure, or an aggregation into large granules or "crumbs," known as nut structure. In size they are as large as hazelnuts or peas, but are always irregular in shape and of uneven surface. Nut structure occurs only in soils made up of relatively fine-grained material; it is not a characteristic of very sandy soils.

In the Amazon region single-grain structure does not seem to be of common occurrence. This is in part due to the fact that the soils are practically all virgin or uncultivated, and such soils the world over rarely are characterized by single-grain structure. It is well known, however, that all soils developed under the influences of a heavy rainfall and an arboreal vegetation tend to take on this structure soon after their cultivation has been begun unless the farmer keeps his soil well supplied with organic matter. It is the presence of a granular structure of some kind and the absence of a single-grain structure that gives a soil what is generally known as good tilth.

Closely associated with structure in soils and often confused with it is a condition designated "consistency," which may be described as the "feel" of the soil, that is, whether it is friable, tough, plastic, loose, or compact. The soils of the central Amazon Basin are predominantly friable and moderately loose down to the mottled-clay horizon. The thickness of this friable layer ranges from a few inches to 6 or 8 feet, being in the mature soil usually about 5 to 6 feet. No soils were found which were difficult for the soil auger to penetrate; neither was there occurrence of a well-defined hardpan nor large areas of soils with plastic, tough, or hard clays.

THICKNESS AND TEXTURE

The loam soil in the uplands attains a maximum thickness of about 10 feet and an average of 7 to 8 feet. This figure refers to the combined thickness of the brown, yellow, and red horizons as they have been described above and does not include any part of the horizon with segregated iron. It is the zone of complete oxidation and aeration. This weathered zone (not merely the affected zone) in the central Amazon Basin is thicker than that of soils in the warm temperate portions of the United States.

The prevailing texture is a loam, with silt loam and very fine sandy loam as important occurrences. Sands were encountered in very few places. The region differs widely in this respect from that of the southeastern Cotton Belt of the United States, where a surface soil of sand is present over large areas and the predominant texture is not heavier than a light sandy loam.

RELATION OF SOILS TO RUBBER TREES

Hevea brasiliensis, as already stated, needs a deep, friable soil and one well drained—or at least one in which the ground water level lies, for a considerable part of the year, at a depth of several feet. A soil however rich in the elements of plant food would not be a good one for the growth of this tree unless its needs regarding the physical character of the soil are met. The fundamental and least changeable requirement in a productive soil is a favorable physical character, for if such a soil lacks the proper food elements these can be added by man.

The requirements of the principal rubber-bearing tree of the world are based on its habit of growth. They can be determined (1) by the experimental growth of these trees under a wide range of soil and other conditions, and (2) by the study and interpretation of the experiments that nature has been making under the control of merciless competition. This consists primarily in determining the geographic distribution of the tree and correlating that with the distribution of various factors of environment. Since we are concerned in this report with the soil and topographic factors only, it will suffice to compare the distribution of the Hevea tree with that of different soils and topography.

ORIGINAL HOME OF THE HEVEA

The regions where true *Hevea brasiliensis* is found in great numbers on the uplands are those drained by the Beni, Madre de Dios, Abuna, Acre, the upper Jurua, the upper Purus, and parts of the southern tributaries of the Madeira and of the lower Amazon. In them the tree attains its greatest size and most perfect development, yields the finest quality of rubber and the largest quantity per tree, size being considered. This seems to be the original home and the section in which the environment is most favorable. Correlated with this distribution of Hevea are soils that are predominantly heavy loams, silt loams, clay loams, and very fine sandy loams, with a yellow horizon that is thin or absent entirely, and the red or yellowish-red horizon chiefly of friable clay, and never compact or hard. The weathered zone is relatively thick, and the top of the mottled-clay zone is free from induration or an accumulation of large iron concretions.

The upland region from which the *Hevea brasiliensis* is absent, or if present does not produce a good grade of rubber, is confined largely to the area covered by yellow soils or those in which the yellow horizon is thick, where the texture is lighter than a sandy loam or heavier than a silt loam, the red horizon thin, and the top of the mottled clay shallow or compact. In parts of this region also the soils are red, but the red horizon is thin and the top of the

mottled clay lies usually within 3 feet of the surface—often within 2 feet. This region includes also a section of country that is less completely dissected, and has therefore a higher percentage of flat land. While the drainage of this land is not poor, yet it is not so complete as in the more rolling regions described above.

ISLANDS AND PARA

The alluvial soils of the islands of the Amazon delta and adjacent mainland are either heavy silt loams with clay subsoils or clay soils from the surface downward indefinitely. They are underlain universally by poorly drained subsoils. There is practically no differentiation into a well-drained, higher-lying, and somewhat coarser-textured river-bank belt of the delta region and a heavier, more poorly drained area lying at some distance from the river. In this region all the soils are poorly drained, all relatively heavy, and all lie but a very few feet above the water level of the river—often less than 2 feet. The head of the delta, as defined, is just below Gurupa.

The uplands of this district are partly forested and partly grass-covered. The soils of the wooded area (probably all of it second growth) are rather darker than the usual Amazon Valley soils and are sandy loams in texture. The subsoils are yellow and somewhat heavier than the surface soils. The yellow is less pronounced than in the more sandy yellow soils in the Cotton Belt of the United States, but it is entirely comparable to the yellow soils of the Amazon region as a whole. The yellow zone passes downward into a reddish zone, and this rather rapidly to the mottled zone so universally present in the Amazon country. A slag-like iron-oxide horizon is present throughout the whole upland region of these islands, in both the forested and the grassland areas. It lies more than 10 feet deep, except where erosion has taken place.

THE MAINLAND SOILS

The forested soils of the mainland east of the Para River, including the belt crossed by the railway from Belem to Braganca, are essentially identical with these insofar as they occur on rolling or undulating land and are well drained. East of Castanhal, on the Braganca Railway, there are considerable areas of flat land with poorly drained soils, but with this exception these soils are yellow sandy loams capped with a surface soil of light sandy loam, or loamy sand in extreme cases, with a moderate percentage of mainly unassimilated organic matter. The slaglike iron layer seems to be present under the whole region, and on slopes where it has been exposed by erosion it has broken up and forms a very "gravelly" soil.

The grasslands of the island of Marajo and the mainland north of the Amazon are apparently, when well drained, identical with the timberland soils in general except their darker gray color and high content of organic matter. The greater part of this area, however, is poorly drained.

No chemical analyses of the delta soils have been made. Their physical characteristics are favorable to cultivation and to plant life. They seem to have good water-holding capacity. As a whole the upland soils must be regarded as of moderate productivity.

LOWER AMAZON, SOUTH

A second area studied extends along the south side of the Amazon River from the Parana de Ramos to the Moju River, southeast of Para. It includes a portion of the Maues River and the Tapajoz, Xingu, and Tocantins Rivers up to and including the lower edge of their cachoeira belts.

The parent material from which these soils were developed is almost entirely the deposits of unconsolidated matter laid down in this part of South America during the Tertiary Period.

ALLUVIAL SOILS

Alluvial soils form a considerable body in the western part of the area, extending from the Parana de Ramos west beyond the Madeira River. The other large area of alluvial soils is in the east, extending from the Xingu River to beyond the Moju. In the eastern part there is a daily period of flooding over extensive tracts, due to the influence of the tide. Along most of the tributaries from the south there is very little alluvial soil; either the upland extends to the edge of the river or a narrow belt of flood land lies on one or both sides. There is considerably more alluvial land along the Tocantins than along the other rivers.

There are a few river-bank strips of agricultural importance. At Barro Alto, along the Parana de Ramos, is a high, old, partially oxidized river bank. The lower part of the surface 8 inches of brown silt loam shows some segregation of iron oxide, also gray spots or deoxidation. The material below is the usual red and gray mottled clay, becoming heavier with depth and carrying some imperfect iron concretions at about 5 feet. This horizon extends to the edge of the present water level at 15 feet, the clay becoming more compact and brighter mottlings with iron concretions harder and more perfect.

At Urucurituba, on the Tapajoz, is a low, well-developed river bank. The deep horizon of brown, fine sandy loam passes into yellowish-brown, fine sandy loam at about 30 inches and into soft, plastic, light-red and gray mottled clay at 6 to 7 feet. This rests on a formation of diabase extending across the river.

UPLAND SOILS

Well-developed soils predominate in all parts of the terra firme except where local topographic features such as steep slopes and poor drainage have interfered with normal development. These mature soils are light colored, due to the small amount of organic matter they contain. Where the original jungle has been cleared and second growth accomplished, the organic content is higher than in the virgin forests. In these second-growth forests dark soil often extends to a depth of 12 or 16 inches. Their area, however, is relatively small.

All the soils studied in this region were forested. It is reported that areas of open campos (grassland) country are located inland back from both banks of the Tocantins River in the vicinity of Baiao. They most likely resemble the campos lands north of the Amazon River.

Except for the sandstone, limestone, shale, and crystalline formations found as the cachoeira belt is approached the parent material is mostly unconsolidated, with some semiconsolidated beds and cemented gravel and sand at depths ranging from 25 to 40 feet below the surface. Gravelly iron concretions and slaglike masses of iron formation are found throughout the area.

Almost all the soils studied have a rather thick, reddish-yellow horizon. They extend along the Amazon River and up the various tributaries until approaching the cachoeiras. All the light-textured soils have thick yellow horizons, while the heavier plateau soils are invariably reddish yellow.

Soils having a thick red horizon are of local occurrence mostly in the vicinity of the cachoeiras near crystalline formations and also on slopes where weathering and erosion are active. They occupy a higher elevation above sea level than most yellow soils and also a more broken topography.

CHARACTERISTICS OF AREA BELOW THE RAPIDS

The area below the cachoeiras can be separated into four rather distinct topographic divisions, with soil features characteristic of each, as follows:

1. Extending back from the lower Amazon, and in many places along the tributaries, are rather low, undulating to slightly rolling uplands, seldom reaching an elevation over 50 to 60 feet above the river. In great part the soils are light textured, with a thick yellow or light-brown horizon. They are not so fine as the sandy soils north of the Amazon.

2. Back of this area and inland is a narrower belt ranging from rolling to roughly rolling. The texture here is not so uniform but inclines to be light. Sandy loams, fine sandy loams, and loams are present. The stream dissection is sharper, with well-oxidized, somewhat immature slope soils. The yellow horizon is thinner, passing into light red below 3 to 5 feet.

3. The most distinctive and clearly defined areas are the high plateaus which are bordered by the belt of rolling topography. These plateaus have an elevation of 200 to 300 feet above the rivers, and extend inland, almost level to undulating, with little dissection until cut into by larger streams. The soils are uniformly fairly heavy, averaging heavy silt loams. They are also characterized by a thick, reddish-yellow horizon. Notwithstanding the smoothness of the topography there are relatively few areas that are poorly drained.

4. The area in the cachoeira belt is roughly rolling to rough broken country. Unequal weathering of formations of varying hardness has tended to produce a sharply dissected section. Narrow plateaus occur on the tops of ridges, with young soil mixed with parent material on the slopes. Rock outcroppings on these slopes are rare. The low portions occupied by the drainage systems are usually wet, poorly drained areas where their width is greater than the stream bed.

In order to secure closer correlation, the soils will be discussed in more detail, using the larger rivers as topographic units.

MAUES RIVER

Much of the area north and east of the town of Maues, through which the Maues River passes into the Amazon by the Parana Uraria-Ramos, is low alluvial land. Some low upland is located on the right bank of the Parana Uraria. At Sao Joao the soil is a rather heavy dark-brown loam underlain by heavy yellow loam to a depth of 4 feet; below this it becomes slightly more open in structure and a little darker colored, having a red cast in the lower part. At 25 feet begins the gray and purplish-red mottled clay.

From the point where the Maues River forks and the Paricatuba River branches off, about 25 miles south of Maues, the channel is entirely within rolling upland. Where the soil is shallow a deep-red horizon is present, but on the older, more level areas the reddish-yellow horizon is quite thick. At Taboleiro, at an elevation of about 50 feet above the river, a thick reddish-yellow zone underlies a thin brown coarse loam surface to a depth of 10 feet. Beneath this horizon are formations of iron concretions in a rich red heavy loam. The bed is broken at 30 feet by a layer of sand. The lower plains, as examined at Mocajatuba, on the right bank of the Maues River, resemble in color and texture the low uplands near the Amazon. It is reported that by going up the Maues River 70 to 100 miles above Maues one enters a higher, more broken country, with soils where deep-red horizons predominate.

East of the mouth of the Parana de Ramos, extending back from Romanso, on the right bank of the Amazon, is the high plateau of Serra de Parintins, reaching an elevation of about 400 feet. The top of the plateau is almost level, with very little stream dissection. The soil is typical plateau soil, with a heavy yellowish-brown silt loam surface and thick reddish-yellow horizon of rather loose, soft, silty clay and clay. Where clearings have been made by burning, the surface is dull gray and bakes somewhat, on account of the loss of practically all the humus through burning. Numerous large slag masses of iron concretions, 6 or 7 feet in diameter, are common on the steep slopes, especially near the foot.

TAPAJOZ RIVER

The Tapajoz River is outstanding in that its valley is much narrower than that of the other lower Amazon tributaries. Immediately adjacent to the flood plain on both sides lies a relatively low, rolling, rather sandy upland, and beyond this the high plateau not yet thoroughly dissected. The right-bank plateau is about 5 miles southeast of Santarem, extending in an irregular line south for an unknown distance. The boundary of the left-bank plateau was found about 8 miles southwest of Boim. Topography, vegetation, and soils are almost identical to those of the right-bank plateau. The texture remains fairly heavy and the lower part of the soil profile maintains its reddish-yellow to brown color, continuing to a depth of 8 to 12 feet. Drainage is good, for the moisture apparently passes into the soil quite readily.

Most of the soils of the lower upland belt bordering the river are of light texture and comparatively thick yellow horizon. The uni-

formity of these features is not so general as along the lower Amazon, due to a greater variation in topography and geological formations in this region. At Alter do Chao, Aveiro, and Itaituba beds of iron sandstone fragments and quartz gravel are found at a depth of 4 to 8 feet below the surface. On the Pichuna River, 3 miles above Repartimento, there is developed at 4 feet below the surface a tight, compact horizon of mottled red and gray silty clay, approaching a hardpan. In numerous localities, especially on the lower Cupary River and at Alter do Chao and on south along the right bank of the Tapajoz River toward Aramanahy, there are fairly light-textured areas having a thin yellow layer which passes into the thicker red horizon below.

The soils adjacent to the first cachoeiras (rapids) of the Aruan River contain much partially weathered iron sandstone, forming a soil which is quite unproductive. At Periquito, on the first cachoeira of the Tapajoz River, the high rolling upland is chiefly from weathered igneous rocks. The soil has a light-brown silty-clay surface, passing into plastic clay beneath. The color of the subsoil to 5 feet ranges from yellow on the flat areas to bright red on the steeper slopes. Marked fertility is indicated by the presence of a heavy, thrifty forest cover.

XINGU RIVER

The right bank of the Xingu River from its mouth to the cachoeiras is a low undulating to slightly rolling plain, with some narrow areas of flood plain on the upper part. The uplands resemble those light-textured, light-colored soils of the low rolling plains along the Amazon River. Where the surface layer is a light loam or a sandy loam instead of loamy sand, the horizon with a distinct yellow color is thin. Light-brown friable material having a reddish cast extends to a depth of 10 or 12 feet. Beneath this is a zone of loamy sand, underlain at 18 feet by yellow and red mottled, hard, friable sandy clay loam. The red mottlings are gradually forming into iron concretions.

The left bank of the Xingu has no flood land except near the mouth of the Tucuruhy River. A high plateau (about 120 feet above the river) follows the left bank from a little above Guara, opposite Souzel, to the lowland of the Amazon. It is reported to extend a long distance inland. The texture is not quite so heavy as on the plateaus along the Tapajoz River. The forest growth, physical appearance, and structure of the soil would indicate this to be a very productive plateau.

The road from Victoria to Forte Ambe passes over three rather distinct soil belts. The widest is the one extending from Victoria to Boa Vista; this is similar to the light-textured areas with thick yellow horizons along the lower parts of these rivers. In the more rolling sections the yellow horizon is quite thin, but the light texture of the surface and soil profile remains.

Beyond Boa Vista is found a rather narrow belt of heavy sandy loam to silt loam, darker in the upper portion of the profile, with a thinner yellow horizon passing below into reddish-brown silty clay loam.

Within 5 or 6 miles of Forte Ambe the land becomes more rolling, rising 60 to 100 feet above the level of the river. The surface soil is usually a silty loam or heavier, dark rich brown with lighter brown beneath to a depth of 12 inches. The section below is reddish brown, passing into richer red with depth. The surface, especially on the slopes, contains many gravelly iron concretions. Where the hills have broad flat tops the soil remains heavy but has a lighter color through the section. Iron sandstone masses are present in many places at a depth of 4 to 5 feet. The lowland between these hills is a grayish, silty, very poorly drained type. Shale outcroppings at the foot of the hills along the river at Forte Ambe have had no opportunity to develop any extent of soil.

TOCANTINS RIVER

The lower Tocantins is mostly flood land. The upland studied at Abaete has a dark-brown sandy loam surface, a light-brown horizon extends to a depth of 2 feet below the surface, and reddish-brown compact silty clay mottled with brown and yellow below. Beds of gravel and iron sandstone material are found within 5 to 8 feet of the surface.

Low upland begins near Cameta on the left bank and some distance below Baiao on the right bank; these soils are light in texture, ranging from loamy sand to sandy loam. At Cameta the soil is more shallow, passing into reddish-brown and yellow mottled silty clay at 3 feet. At Baiao the surface material is lighter and the yellow horizon thicker, extending to a depth of 10 feet. At Nazareth dos Patos on the right bank the soil is similar to the low, sandy type.

Ten to twenty miles below Alcobaca the area along both sides of the river becomes roughly rolling. At Coqueiro, near Alcobaca, along the left bank, in the lower part of the rolling upland, a dark-brown top layer of very fine sandy loam is found, with a thin, light-brown horizon beneath. From a depth of 14 inches below the surface, on down, the profile is light-red silty clay, becoming darker red with depth and slightly lighter textured. The native vegetation, together with the great number of very large trees here, indicates a very productive section.

A brief study along the Moju River at Fabrica shows that in that low, undulating area the predominating soil is light textured, with a very thick light-yellow horizon. It appears to be quite leached and presumably low in its content of mineral plant food.

GROWTH OF RUBBER TREES

In this area the *Hevea brasiliensis* is found growing wild on a wide range of soils. Its adaptability to certain soils can therefore be more accurately studied by noting the degree of vigor it shows and the size to which it develops.

There are few localities where the physical structure of the soil will seriously interfere with the growth of a rubber tree. Some lands, as above Repartimento on the Pichuna River and Abaete on the lower Amazon, have quite decided physical obstructions present in the form of tight clay zones or semiconsolidated gravel beds within 10 feet of the surface. Extreme lightness of texture and apparent

lack of mineral plant food are also serious drawbacks for a rubber tree to overcome. Sandy, droughty areas as many of the alluvial soils of the lower part of the river, or stony sandy areas as near the cachoeiras on the Aruan River, or light yellow unproductive soils as along the lower part of the Moju River, do not seem to be favorable to the Hevea.

In general it may be stated that the finest wild rubber trees are found on the high plateau of the Tapajoz (except the northern section) and Tocantins Rivers. Studies along the plateau of the Xingu River are not complete with regard to rubber trees. These plateaus all have heavy soils with high moisture-holding capacity, yet are loose and friable enough in the lower profile to offer no obstruction to the development of the long tap root of the rubber tree. Of the upland soils, those on the high plateaus with the moderately heavy soil and a reddish-yellow subsoil appear to be superior to the lighter textured soils with yellow subsoils. From observation it is noted that they tend to be more productive, as shown in more luxuriant forest growth. These plateau soils will seldom be found at an elevation less than 200 feet above the level of the mouth of the river.

LOWER AMAZON, NORTH

The Amazon Valley from the Andes to the sea cuts through the belt of unconsolidated geological formation. This belt is much wider south of the river than north. Its maximum width from Manaos to the sea is not more than 50 miles, and at Monte Alegre and places below the older consolidated formations come close to the river on the north bank, reducing the width of the unconsolidated rock on this side to a very narrow belt.

The soils derived from both the consolidated and the unconsolidated material on the islands of the north side of the river are sandy in character, with a low percentage of organic matter. The surface soil where examined ranges from a coarse sand to a light sandy loam; the subsoils are sandy loams, both being yellow in color. This yellow zone extends to considerable depths except where erosion has worn the surface down, in which case the top sandy soil may be directly over the mottled clay horizon with iron oxide concretions, fragments of which may make the soil gravelly. It is apparent, using the practices on the nearest comparable soils in the United States as a basis for a conclusion, that any sort of intensive agriculture for a long period of time would be possible on these lands only by the use of fertilizer in some form.

The effect of the dry season was more marked in this region than in those sections of the Amazon Basin where the soils are heavier in texture. This may be due in part to a scantier rainfall or a longer dry season, but, whatever the cause, the result would tend to make the area less favorable for agriculture than districts where the rainfall is heavier.

The sandy upland soil of this region is, or was originally, covered with forests. These forests do not show the luxuriant growth of those on the better soils south of the river. In many places the original forest growth has been cleared and some of these tracts are now covered with grass. In others, as at Macapa, the campos seems to be the southern extension of the natural grasslands that cover such

large areas in the section of Brazil bordering on the Guiana highlands. It is quite apparent from the description given above that this region would not be very suitable for the planting of rubber.

UPPER AMAZON, NORTH

The alluvial belt bordering the north side of the Amazon (here called the Solimoes) from Manaos westward is wider than from Manaos eastward, rendering the uplands bordering it on the north more difficult of access.

An examination of the land at the Brazilian experiment station near Manaos reveals a surface soil that is sandy and yellow in color, with a sandy but heavier subsoil 10 to 12 feet in thickness. Below this lies the usual mottled clay horizon with iron-oxide segregations. The soil is similar to that found at Itacoatiara, but is heavier in texture. The unconsolidated uplands belt which forms the central basin in this section of the Amazon widens out from Manaos westward. The crystalline rocks, therefore, which presumably supplied the materials of which the young deposits consist, lie much farther to the north than is the case east of Manaos; the nearer to these rocks the greater the sand content of the soil.

Codajaz, on the north bank of the main river, the only other place in this section where it was feasible to examine the soils, lies several hundred miles west of Manaos and therefore farther removed from the crystalline formation. It has a surface soil of dark silt loam that is rather heavy in texture; the subsoil is oxidized to a depth of only 14 inches. The usual mottled clay zone is present and is the top of the geological formation that is not yet profoundly changed by the soil-making forces. Where the bottom of the weathered zone lies in a layer of heavy material, this mottled horizon is tough and more or less plastic, even though the weathered material immediately above it is friable.

From the examination of the soils in the above two places it is believed that much, if not all, of the upland area can be considered as containing soils not well suited for the growth of Para rubber. However, in as much as the rainfall is heavier in parts of this region than in the district from Manaos to the sea, crops growing on the sandy soils would not feel the effects of the drought conditions that seem to be so manifest there, and for this reason Para rubber would stand a better chance of success here than north of the lower Amazon.

MADEIRA

The alluvial valley of the Madeira, like that of the other Amazon tributaries and of the Amazon itself, is relatively narrow, so that the upland is touched by the river at many points between its mouth and the foot of the rapids at Santo Antonio. Between Manaos and Theotonio Falls above Porto Velho the upland soil section was examined at some 15 localities.

The upland is everywhere low, at no point attaining an elevation of more than 50 feet above high water until the hills in the vicinity of Porto Velho are reached, and these are not more than 100 feet high above the same plane. These lands are true upland, however, and while quite smooth in topography they are well drained and the soils well weathered to a depth of several feet.

THREE CLASSES OF UPLAND SOILS

In general the soils on the uplands along the Madeira-Mamore Rivers may be grouped into three rather broad, somewhat ill-defined classes:

1. Soils with a thin yellow layer beneath the brown or darkish surface, usually moderately heavy, with fairly heavy red clay or mottled red and gray clay at 3 feet or less. These occur mainly on the rather low uplands from the mouth of the river to an unknown distance, not as far as Democracia on the left bank, and a shorter distance in the direction of Diamantina on the right. They appear again at Humayta and probably occupy the flat grasslands extending along the Madeira–Purus watershed southward. They occupy the brushy campos-like country along the railway above and below Abuna Station.

2. Soils with a thick yellow horizon beneath a darkish surface layer of medium texture, the yellow layer being heavier than the surface but not tough, hard, or plastic. These soils seem to occur along the east bank of the Madeira from somewhat below the mouth of the Machado downward to Ideal and possibly farther. They are found on the left bank at Democracia and probably above and below that place for some distance. They are similar to the soils at Itacoatiara in physical character and presumably also in chemical composition, just as the heavier soils of group 1 are similar to the soils at Amatary, on the left bank of the Amazon east of Manaos.

3. Soils with a thick yellow horizon beneath the thin darkish surface; this and the upper part of the yellow horizon being quite sandy, often a sand, and the lower layer of the yellow material relatively light in texture. Such soils are found on the right bank of the river from the mouth of the Machado southward as far as the region was traversed. They are much like the soils along the north bank of the Amazon and on the benches below the high plateau from Parintins eastward.

GROWTH OF RUBBER TREES

No native Hevea trees were found on the uplands anywhere along the Madeira-Mamore belt as far south as the region was studied except a few trees on Saldanha Creek, a right-bank tributary of the Pacanova about 20 miles south of Guajara-Mirim. These were found growing on sandy soils but so near the alluvial land of the creek that they could have been seeded from trees growing on that land.

It would seem that soils in group 1 would not be favorable to the growth of a tree with a long tap root like the Hevea. The tree should grow fairly well on soils of group 2, but they seem to be only moderately fertile. They can not be considered as highly productive soils for crops of any kind, though the heavier members of the group, like the soil at Democracia or on the Marmellos, with proper management, must be classed as moderately productive soils.

The sandy soils of group 3 under intensive agriculture would require fertilization after a few years of use.

UPPER AMAZON, SOUTH

The upland soils of the south side of the upper Amazon (Solimoes) were examined in a number of places. Two general classes were encountered. Soils at Mamia are typical of the first class. Here a 6-inch surface soil, composed of silt loam of the usual darkish color, is underlain by a yellowish horizon a few inches in thickness. Beneath is a red-clay horizon, tough and plastic but not hard. In the forest a short distance from the river the surface soil contains some fine sand. Soils similar to those at Mamia were found at Caiambe, Bocco do Jutahy, Sao Paulo do Olivenca, and at Belem (Para), although those at Ipixuna are more sandy. All these soils have a thin horizon of well-drained and aerated material overlying a stiff subsoil and are similar to those on the lower Purus. For growing Para rubber they can be classed as midway between those that have thick friable red horizons and the more sandy soils found north of the river.

The soils at Teffe can be taken as typical of the second group. Here the surface soil is darkish sandy loam and the subsoil is a friable yellow to reddish-yellow clay loam, well drained and aerated and uniformly oxidized to a depth of more than 5 feet. The surface of the rolling plain on which this soil lies is 50 feet or more above high water in the river. A great many large Brazil-nut trees grow on it, indicating a good soil. The lands at Fonte Boa and Tabatinga near the Peruvian boundary are very similar. On the whole they can be classed as more nearly allied to the Acre and upper Purus soils than are those at Mamia. Consequently, they are better adapted for the production of rubber.

PURUS RIVER

Along the upper Purus, between the mouth of the Acre and Labrea, soil sections were examined at many places. Here narrow benches occur, especially on the left bank, which have a soil uniformly shallow to the mottled-clay horizon. Beyond these the uplands, usually more than 100 feet in height, contain a soil generally thicker, though at Sao Miguel the raw clay is a rather tough horizon about 3 feet beneath the surface. The intermediate layer is generally yellow with a thin red horizon overlying the raw-clay bed; the depth of the latter is 4 to 5 feet. This soil is intermediate in character, apparently, between that on the Acre, upper Abuna, Madre de Dios, and Orton and that on the lower Madeira and other places where the upland is low and very smooth or flat and the raw-clay horizon lies at shallow depth. In general, the thin red horizon below the yellow and above the raw clay is not soft and easily penetrable, but is rather hard and faintly cemented with irregularly shaped iron-oxide accumulations. Such soils are not considered desirable for Para rubber.

From Labrea to a short distance below the mouth of the Tapua the low bluffs on the right bank have shallow soils as a rule. The higher uplands were not examined. A short distance below the Tapua and at Nova Olinda, some 5 miles beyond, the upland is about 75 feet above water. The soils are reddish and the raw-clay layer lies deeper than in most places on the Purus. Such are better than Purus soils in general.

From Nova Olinda down the river to the vicinity of Ipiranga the soils are generally shallow and heavy. The upland is low and rather flat. The drainage of considerable areas seems to be imperfect, if not poor. The soils in this region appear to be very much like those on the lower Madeira and in the campos region on the Madeira-Purus watershed.

An area at Ipiranga is more deeply weathered and not so heavy. The intermediate soil layer is reddish though not deep red. The soils seem to be of good quality, but their extent is unknown.

ACRE TERRITORY

On the lower Abuna, in the State of Amazonas, the upland along the river is flat and generally low, often not more than 25 feet above high water and never more than 45 feet. It is reported that the surface becomes more rolling soon after leaving the river.

The soils are predominantly yellow to a depth of 2 or 3 feet, the red-clay horizon beneath is thin, and the mottled red and gray only partially weathered clay lies at a comparatively shallow depth. The soil sections were examined at the mouth of the Rio Negro, about 40 miles above the mouth of the Abuna, at Cachoeirinha La Paz, and at Maravilha. On rolling upland near Maravilha the soil is reddish, but on the flatter land here and a few miles up the river the yellow horizon is about 3 feet thick. The upland stands 60 to 70 feet above water but is well dissected by small streams. A few miles above Mucamba the soil is still yellowish but with a reddish shade, and the heavy spotted, unweathered clay lies deeper than 6 feet.

ABUNA RIVER

From this point up to Sao Luiz, on the Abuna in the Acre Territory, about 60 miles southeast of Rio Branco, the capital of the Territory, the soil is red or reddish beneath the dark-colored, thin surface horizon and a thin yellow layer. The topography is rolling. The soil texture is a clay or silt loam and the mottled-clay layer lies at considerable depth. The uplands of imperfectly drained and aerated soils constitute apparently a relatively small part of the total area of the country.

Between the Abuna River at Sao Luiz and the Acre River at Nova Olinda, a few miles below Rio Branco, the same soil conditions exist as are indicated by the conditions along the Abuna. The well-drained soils are usually found on rolling land and the poorly drained on smooth land. In neither group are the soils very sandy, though fine sandy loams may be found in both.

The area of heavy soil with raw mottled clay at shallow depth found at Sao Luiz is less than half a mile in width. Thence along the trail for a distance of approximately 15 miles the soils belong chiefly to the well-drained and well-oxidized group. Following this, for a distance of 10 miles, the trail runs over country in which the prevailing soil is imperfectly but not poorly drained. It continues along a flat-topped narrow watershed ridge for part of this distance, heads of ravines lying on either side not far away. This stretch is succeeded by another 6 or 7 miles across, identical with the first 15 miles.

Beginning 32 miles west of Sao Luiz and extending to the Iquiry River, the land is flat, the valleys small and shallow, and the surface predominantly smooth. In narrow belts along the small streams and on a considerable part of the surface elsewhere the slope is sufficient for good drainage of soil and subsoil. From the Iquiry River to the Acre the soils are of the better-drained and well-oxidized group, but on the whole a little more sandy than farther east.

ACRE RIVER

In the basin of the Acre River, from its mouth to the Bolivian boundary and as far south into Bolivia as studies were extended—about 20 miles—the soils are well drained.

In the vicinity of Rio Branco the upland is rolling. The soil section has a very thin yellow horizon beneath a thin brown surface layer, with friable red clay below, extending to raw clay at some 6 or 8 feet. The section is essentially like that at Trinidadcita and Sena, Bolivia. On a trip eastward from Itu to the Acre, a distance of perhaps 30 miles, a belt 4 or 5 miles in width was crossed near Itu in which the soil is poorly drained, but at no other point in the whole trip were even small areas like this found. The country is rolling and the soil is a brown loam underlain by a deep red clay loam, with raw clay at more than 5 feet. South of Cobija the surface is rolling, drainage good, forest growth heavy, and a considerable area near the town and for 6 miles south of it in cultivation, with good crops of corn, rice, mandioca, and pasture grasses.

Along the Acre River below Rio Branco the soil section was examined at 8 or 10 localities. At Porto Acre (Acre Territory) and at Floriano Peixoto (Amazonas) the soils on the flat terrace-like upland along the river are usually shallow, the raw mottled, rather heavy clay occurring at less than 3 feet as a rule; those on the high uplands are deeper, the raw clay lying 6 to 8 feet below the surface, and the subsoil is reddish yellow or red. As a rule the yellow layer is thin and the red color the predominant one in exposures. The textures are loams, silt loams, or very fine sandy loams. In general, the upland soils are essentially identical with those on the upper Acre.

Soil of this character extends along the Purus in Amazonas below the mouth of the Acre for a short distance only. By the time the mouth of the Inauhiny is reached the soils, even on the high uplands, have become decidedly yellow, though the raw clay still lies at a good depth, usually more than 5 feet.

BOLIVIA

From the mouth of the Beni at Villa Bella upstream to Cachuela Esperanza, a distance of about 15 miles, the upland consists of some low stony hills underlain with gneisses. The soils are shallow and stony and the topography rather uneven. As on the Madeira and the Mamore, the belt in which the crystalline rocks are exposed is confined to narrow strips adjacent to the flood plain, the higher upland, not far from the valley on either side, being underlain by the usual unconsolidated fine sands and clays of late geological age, such as occur throughout the central Amazon Basin. Above Cachuela

Esperanza the crystalline rocks disappear within a very short distance and the usual type of Amazonian upland reappears.

Examinations were made a few miles below the mouth of the Orton, at several places at and near Riberalta, at La Florida, San Pablo, Trinidadcita, Conquista, and Sena—the last-named being about 100 miles in an air line up the Madre de Dios River from Riberalta, the capital of the Beni Province of Bolivia. The soils are so nearly alike at all these places that a description of the section at Trinidadcita will suffice. This is a point on the Madre de Dios River a little more than half way from Riberalta to Sena.

This section consists of a brown surface layer about a foot in thickness, a loam or silt loam, with a small amount of fine sand. The color is not so dark as at some places on the Madeira, but is the clear brown indicative of good drainage and aeration and is as dark as the average virgin timber-land soil. The lower part of the surface foot becomes yellowish and the yellow color increases slightly for a few inches, but it soon changes to reddish and the section thence to a depth of 4 to 5 feet consists of red clay, the upper part yellowish red, the lower red. Near the bottom small iron-oxide pellets begin to appear and for the next 1 to 2 feet they are present to a greater or less extent. They lie in a bed of red clay and do not form a compact layer or hardpan. This horizon changes at 6 or 7 feet to a reddish clay with segregations of iron-oxide but not well defined pellets, and below this comes, in a few inches, the usual mottled clay.

Rubber trees that produce a high-quality product are found throughout the forests of this region from a short distance above Cachuela and for a long distance above Sena. The vigorous appearance of the wild Heveas in this general region and the good quality of the rubber obtained from them make it certain that the environment is a favorable one for the tree.

PERU

Soil studies in Peru embraced the area extending along the Amazon (here called the Maranon) River from the Peruvian boundary at Leticia west to the mouth of the Santiago River beyond the Pongo de Manseriche; also the region along the Huallaga as far as the mouth of the Yanayaco River, then eastward along the Yanayaco River to Santa Sofia, across to Paz de Victor, down the Chambira Creek to the Lagoon of Huairanga and the Ucayali, thence following down that river to its mouth.

The studies were confined to the flood plains and those portions of the upland which touched the various rivers, also the upland area between Santa Sofia and Paz de Victor.

ALLUVIAL SOILS

As the general topography of this portion of the Amazon Basin is similar to that in Brazil, a like occurrence and development of alluvial soils can be expected.

The same circumstance and range from higher flood plains to varzea lakes was noted. The higher flood plains or terraces tend to show more mature development and less influence of water-logging than those of the lower rivers. This is due chiefly to the fact that

the periods of flood are shorter because of the smaller volume of water furnished by minor streams during the rainy season. This condition and the sideward development of the rivers have led to the formation of strips of highland along the river banks, called restingas in Brazil. They may occur both on the river banks and in places some distance from the rivers. The first belt is lighter textured and more completely oxidized along active rivers and varies in width from 30 to 1,300 feet. The belts are separated from each other by narrow lower areas, either swampy or standing with water during the greater portion of the year. The restingas themselves are flooded only during the highest period—some years not at all—and when flooded remain inundated only a short time and with a shallow covering of water. They, therefore, are adaptable for agricultural development. The areas farther back from the rivers are flooded each year, but not for so long a period as on the lower Amazon. The difference does not seem to have had any noticeable effect in the development of these soils as compared with those of the lower rivers.

The alluvial soils along the Huallaga River differ from those on the main Amazon in having a distinctly red cast throughout the section. Considerable areas of this type extend along the right bank of the Huallaga River, above the line of prolonged inundation. In addition to their more complete oxidation, as indicated by the reddish cast, the texture is generally lighter. A section examined at Puerto la Mar consists of a 2-inch layer of a mixture of brown very fine sandy clay and organic matter. The 24 inches beneath are brownish-red very fine sandy loam. Extending on down to 6 feet is a brownish-red zone of loamy sand and fine sand. At 6 feet begins a layer of reddish-brown silty clay having some iron spots of segregation, then a foot below passes into a light, fine sandy loam.

UPLAND SOILS

One of the most striking variations from the soils of the Brazilian Amazon is the absence of the cellular slag-like mass of iron oxide. A certain amount of segregation and induration of the iron oxide has taken place, but has not developed beyond the formation of thin plates in the parent material. Along with this absence of slag is found less looseness and more toughness in the consistency of the material below about 3 feet than in Brazil.

The most common texture noted throughout the area is loam, with sandy loams next in prominence. Considerable silt loam and also fine sandy loam are found. The greatest depth of sand noted was a surface layer of 8 inches at Yurimaguas. Silty clays seldom occur on the upland, and clays never. With respect to texture, the area is practically identical with that studied in Brazil.

The topography is quite uniform, ranging from undulating ridge tops to sharply rolling. No areas rising more than 100 feet above the river were encountered until the Andes were reached.

The depth of the weathered zone, where oxidation is fairly complete, seems to be somewhat less than in Brazil. Incomplete oxidation is often found 24 to 36 inches below the surface, while in a

fully mature soil little indication of incomplete oxidation, as expressed by mottling, is found under 6 to 7 feet. The weathered zone may extend to 8 or 9 feet.

COLOR OF THE UPLAND SOILS

The surface 2 or 3 inches is mostly brown in color, slightly darkened by the presence of organic matter. The horizon below in most cases is a lighter brown than the surface, usually a slightly yellowish brown, and may be several feet thick, but generally is confined to a depth of about 6 inches. Below this a reddish shade begins to appear in the brown and continues to change gradually to a brownish red or deep red. The texture becomes heavier as the depth increases. This horizon may continue for 2 feet with little variation or extend on for 10 or 12 feet, while beneath it changes into a heavier-textured material with gray mottlings. As the depth increases the gray color becomes more prominent and the red mottlings darker. In many places they become purplish red mixed with the dark red. This horizon usually extends through 8 feet before it is broken by a layer of packed loose sand varying from gray to red, which may continue for 2 to 6 feet, being usually underlain by a compact clay layer—mostly gray, with some brown and rusty brown markings. No hardpans are encountered in the soil. Some rough, tough, plastic subsoils occur. The presence of a greater amount of mica in the subsoils makes them seem more friable than those of the lower Amazon.

The yellow soils in this region are limited almost entirely to the broader, flat stretches on the north bank of the Maranon (Amazon) River above the mouth of the Pastasa. Here, on the tops of the broad ridges, the surface is mostly a brown heavy silt loam; no mottling or iron concretions occur within 5 feet. Areas are also noted on the low plateau extending along the east bank of the Huallaga River at Lagunas and about 50 miles south from that point averaging 7 to 8 miles in width. Included in the plateau are many areas with soils belonging to the red group. The yellow soils also occur isolated on the more level lands, whose surface is usually a rather loose sandy loam.

The country extending back from Yurimaguas is included in the type with thin yellow horizon. This belt of roughly rolling territory exists for 5 miles inland, then flattens out into what is reported as being slightly rolling yellow soils.

SOILS OF THE RED TYPE

The occurrence of soils with thick red horizon is quite widely distributed. A few well-developed areas are found along the plateau which follows the south side of the Maranon River east of the mouth of the Ucayali and at various points on the north side, also along the Ucayali River, where studies were made. The place of the yellow horizon is occupied by a light-brown or brown zone in most cases. The development of this type is more complete west of the mouth of the Ucayali extending along both sides of the Maranon River, and it predominates from here on up to the Andes. In places the red silty clay extends to depths of 12 feet before any

mottling occurs. The topography through this area of red soils is slightly rolling except where cut into by drainage. However, the red type is well developed on some quite level stretches.

The roughly rolling country adjoining the Andes is quite distinctly grouped under the red soils. The parent material from which much of it is formed is well-weathered sandstone containing considerable red color. Some yellowish brown is also included. Together with the fact that the dissection is very sharp and therefore oxidation very active it can be expected that these soils will develop as they have. Near the base of the hills there appears to be some influence caused by weathering of limestone layers, which are also included in the sedimentary rocks forming this portion of the mountains. There is scarcely any development of yellow horizon in this region.

Those soils having a thin yellow or light-brown layer and a red horizon not exceeding 3 feet in thickness make up the greatest portion of the area studied. They are mostly of heavy loam to fine sandy loam for 3 to 5 inches, with a lighter brown layer of 12 to 16 inches beneath. This grades into a light-red horizon, which in 15 to 30 inches passes into red and gray mottled heavy-textured material. The red gradually changes to gray as depth increases in the mottled zone. No formation of united iron oxide concretion was noted in any section. In the lower part of the mottled layer some soft concretions and rusty spots are found. This type makes up the greater part of the region examined in crossing overland from the Huallaga to the Ucayali. It occupies the slopes and less level areas. Some of the completely oxidized type is also found. The surface is usually a loam, with a tough, plastic subsoil in many places.

GROWTH OF RUBBER TREES

No *Hevea brasiliensis* is found on the uplands along the Maranon River. The only region visited by the field party in Peru where this tree was found on the uplands was that lying between the upper waters of the Yanayaco River and Chambira Creek on the trail crossing from the Huallaga to the Ucayali. "Weak" rubber only was found on the lowlands of the Maranon and Huallaga Rivers and also on the uplands adjacent to the Andes. "Fine" rubber was not noticed on the flood plains of the Huallaga, although it may possibly occur there, as it was found about 35 miles up the Yanayaco on the lowlands of that river and the Ucayali.

The trail crossing from Santa Sofia to Paz de Victor on the upland was mostly along rubber estradas. Many of the trees were found growing on old flood plains, probably preferring the lower places because of the greater amount of moisture. Perhaps one-fourth or one-third were located on true tierra firme. As the partially developed red groups of soils predominated, more trees were growing on that particular type than on others. A few were noted on the flatter, yellow class. Although the surface soils are rather light, the subsoils are heavy. This did not hinder the growth of large trees and undoubtedly was beneficial because of high water-holding capacity. On the first day some 85 trees were counted within a strip 100 feet wide along the trail. Most of this trail was through lowland. The

second day was over upland of the "immature red type"; 77 trees were counted. On the last day the trail was through territory having considerable areas of yellow soil; 58 trees were noted in that day's travel. Approximately the same distance was traveled each day—12 to 15 miles.

CHARACTER OF LANDS MOST SUITABLE FOR RUBBER

Most writers in treating of the character of lands most suitable for rubber in Amazonia state or infer that rubber plantations can be established only on the islands of the delta or on the banks of the Amazon or its larger tributaries, and the conclusion to be drawn is that they have the varzea lands, or those subject to periodic inundation, in mind.

On account of the richer nature of the alluvial soil and constant moisture *Hevea brasiliensis* does sometimes attain large dimensions there and have a luxuriant growth, but more often it does not. This is due either to a tight clay below or to a constant water-logged condition of the soil, or at times a pure sandy soil. The wild and planted trees on the islands and lowlands of the delta are very poor specimens compared with the trees of the uplands of the upper rivers. Even the native jungle in the delta region is decidedly inferior to that of the uplands.

In our observations, covering thousands of square miles, we found nothing to indicate that better development of the tree may be expected on low swampy ground. In the first few years growth may be better on the lowland, but in the long run the tree planted on suitable upland will be superior.

Assuming, however, that such lands were suitable, certain adverse conditions immediately present themselves, among which may be mentioned insalubrity of climate, difficulty of drainage, and restricted area.

CONDITIONS TO BE AVOIDED

1. The low areas adjoining the rivers are more likely to be unhealthful. Stagnant water allows mosquitoes to breed, with the possible dangers from malaria. For some months of the year part of the land is covered by the periodic overflows. There is more atmospheric humidity. The islands, especially, have a reputation for unhealthfulness, the truth of which is seen in the condition of the inhabitants. On the other hand the uplands are usually, or at least can be made, very healthful places.

2. On account of the rise of the water during the rainy season, either covering the land or being but a few inches below the land level, it is impossible to satisfactorily drain such areas. The result is that during several months of the year the tree has to exist in a water-soaked soil and the balance of the year in wet soil, with the chances for the development of serious root disease greatly multiplied thereby. It is believed this would also cause branch and leaf disease to be worse than on the higher and drier lands.

3. A fact completely overlooked by the advocates of planting in the river valleys is the relatively small extent of continuous areas that

could be utilized. In the aggregate these varzea lands, which are fertile agricultural lands, cover an enormous territory. However, if it were desired to plant 5,000 or 10,000 acres in rubber it would be difficult to find a continuous tract of that size. To do so at all (on varzea land) would require stringing the plantation up and down the river for miles, on narrow restingas, with lakes, swamps, and canals alternating, and with all the difficulty of supervision of labor, collection of latex, and economical and rapid handling that such a condition would entail. For small places, say of a few hundred acres, many suitable varzea sites, as far as area is concerned, can be found.

JUNGLE GROWTH A GUIDE

The general rule can be followed that the heavier the jungle the better will the land be for rubber planting, unless the land is too hilly or too rocky. Natural pasture or open lands (campos geraes) in every case seen can not be considered. Due to soil or climatic conditions they are unfavorable for tree growth.

The lands most suitable for plantations are, therefore, the forested uplands (terra firme) in close proximity to navigable rivers.

CLIMATE

In all the vast area covered by the Amazon Valley there are very few meteorological stations and in only two or three instances have these been in operation over a long period of time. Some of the stations compiled data one, two, or three years and then ceased to function. Most of them record only rainfall. In the interior of Amazonas, Para, and Matto Grosso, which include the rubber-bearing areas, there are but 11 stations, or one to each 155,000 square miles. Eastern Peru and Bolivia have not a single meteorological station, and the only figures obtainable are the records made by individuals in years past. The data presented in this report are therefore fragmentary and incomplete and give merely a general idea of conditions.

The climate of the Amazon Basin may be designated as "tropical." This term frequently is misunderstood by those not familiar with the Tropics; it does not mean an extraordinarily high temperature, either continuously or for short periods. The Amazon Valley does not deserve the maligned reputation it has borne as having an especially hot, humid, and unhealthful climate, rendering it almost uninhabitable. It has, on the contrary, for an equatorial region, a relatively pleasant climate and one of the least deadly for the colonist or traveler of any of the tropical countries.

In a general way it may be said that the climate of the whole basin is very uniform. Local causes in different parts of the valley modify it somewhat, resulting in a heavier or lighter rainfall and a greater difference in temperature between day and night.

Compared with countries situated in the Temperate Zones the temperature is permanently high, but it rarely passes 93° F. in the shade and never reaches 105° F. Even this high temperature is somewhat compensated for by good air movement. The average

temperature at night may be taken as around 78° F. at Para (Belem) and 72° at Iquitos, these two cities being located at the extreme east and west ends of the basin.

TEMPERATURE

Temperature observations over such a large area naturally give different results corresponding to the localities where taken. In a general way it may be said that, due to the low elevation of the eastern border on the Atlantic Ocean, the predominant winds from the east and northeast are able to penetrate without hindrance and extend throughout the whole area. These winds, through the active evaporation which they promote, contribute very greatly toward preventing the temperature from reaching an excessive height, even for long distances inland. The temperature is highest in the lower Amazon region, where, however, it never exceeds an annual mean of 83° F.

The temperature gradually drops as one encounters the Andes Mountains at the western border of the valley. This is also true in ascending the tributaries of the Amazon on the north and south sides until the highland or rim encircling the basin is encountered; here the difference between the temperature of day and night is greater than in the basin proper.

The mean temperature, with absolute maximum and minimum, at four important centers on the Amazon River, namely, Para or Belem (lat. 1° 27.5′ S., long. 48° 29′ W., alt. 41.5 feet), Taperinha—on the Amazon near Santarem—(lat. 2° 30′ S., long. 54° 42′ W., alt. 65.6 feet), Manaos (lat. 3° 8′ S., long. 60° 1′ W., alt. 147.6 feet), and Iquitos (lat. 3° 44′ S., long. 73° 8′ W., alt. 328 feet), is as follows:

TABLE 4.—MONTHLY MEAN TEMPERATURE, PARA, TAPERINHA (SANTAREM), MANAOS, AND IQUITOS

Months	Para, 1914–1919 [1]			Taperinha, 1914–1919 [2]		
	Mean	Mean maximum	Mean minimum	Mean	Mean maximum	Mean minimum
	° F.	° F.	° F.	° F.	° F.	° F.
January	77.9	86.4	71.9	77.5	83.1	72.3
February	77.2	85.6	71.9	76.6	82.6	71.9
March	77.7	86.0	72.5	77.2	83.1	72.5
April	77.9	86.5	72.7	77.2	83.3	72.5
May	78.8	86.5	72.8	77.0	83.5	72.3
June	78.8	88.2	71.8	76.5	84.9	71.4
July	78.6	87.8	71.2	77.0	86.2	70.3
August	78.6	87.8	71.4	78.3	88.9	71.1
September	78.6	88.2	70.9	79.7	89.8	72.1
October	79.2	88.5	70.9	79.7	90.3	72.7
November	79.7	89.1	71.2	80.4	90.4	72.8
December	79.2	88.2	71.9	78.8	87.1	72.5
Year	78.4	87.4	71.8	78.1	86.0	72.1
Absolute		94.3	64.4		96.3	65.3

[1] Goeldi Museum, Para.
[2] Directoria de Meteorologia, Rio de Janeiro.

TABLE 4.—MONTHLY MEAN TEMPERATURE, PARA, TAPERINHA (SANTAREM), MANAOS, AND IQUITOS—Continued

Months	Manaos, 1911–1919 [1]			Iquitos, period not stated [2]		
	Mean	Mean maximum	Mean minimum	Mean	Mean maximum	Mean minimum
	° F.	° F.	° F.	° F.	° F.	° F.
January	80.0	88.7	74.7	75.0	78.0	71.9
February	80.4	88.9	74.7	72.3	75.9	69.8
March	79.9	87.8	74.5	73.2	75.2	71.2
April	80.0	87.6	74.8	72.8	74.3	70.8
May	78.4	87.8	74.8	72.8	74.1	71.6
June	80.2	88.0	74.8	71.2	73.7	68.7
July	80.9	89.1	74.5	70.5	74.1	66.9
August	81.7	91.0	74.8	70.3	74.1	66.5
September	82.7	92.8	75.0	71.9	74.1	69.8
October	82.0	92.3	75.7	72.7	74.3	70.5
November	82.4	91.6	75.5	73.4	75.0	70.8
December	80.8	89.8	74.8	73.4	75.5	71.2
Year	80.9	89.6	74.8	72.5	74.9	70.0
Absolute		101.5	66.2		[3] 100.4	[3] 62.6

[1] Directoria de Meteorologia, Rio de Janeiro.
[2] Booth & Co.
[3] Samuel Young, mayor of Iquitos, 1924.

For two somewhat adjacent stations in the southern area, Pennapolis (Capatara), Acre Territory, Brazil (lat. 10° 16′ S., long. 67° 53′ W., alt. 600 feet), and Cobija, Bolivia (lat. 11° 1′ S., long. 68° 47′ W., alt. 985 feet), the following temperature data are available:

TABLE 5.—MONTHLY MAXIMUM AND MINIMUM TEMPERATURE, PENNAPOLIS (CAPATARA) AND COBIJA

Months	Pennapolis, 1909 [1]		Cobija, 1909–1910 [2]	
	Absolute maximum	Absolute minimum	Absolute maximum	Absolute minimum
	° F.	° F.	° F.	° F.
January	90.5	68.9	92.5	66.8
February	88.7	69.8	89.9	66.5
March	89.8	64.2	89.4	63.0
April	97.0	67.8	89.8	64.8
May	90.8	51.6	88.3	51.0
June	96.6	53.4	88.5	54.3
July	95.2	56.3	89.9	55.1
August	101.6	54.5	94.2	53.8
September	102.1	59.5	96.8	59.6
October	100.6	62.1	95.6	60.6
November	97.7	65.6	93.7	62.8
December	96.3	61.7	92.0	63.7
Year	102.1	51.6	96.8	51.0

[1] Diccionario Historico, Geographico e Ethnographico do Brazil, Imprensa Nacional, Rio de Janeiro, 1922, p. 148.
[2] Met. Zeitschrift, 1911 and 1912, pp. 416 and 430.

For Porto Velho (lat. 8° 44′ S., long. 64° 0′ W., alt. 322 feet), on the Madeira River, the mean maximum temperature for the period 1908–1921 was 98° F., the mean minimum 60.6°; the absolute maximum 104° and the absolute minimum 56° F. At Yurimaguas (lat. 5° 53′ S., long. 76° 30′ W., alt. 388 feet), on the Huallaga River,

Peru, the mean maximum for 1917 was 84.6°, the mean minimum 72.5°; figures on the absolute range of temperature for this year are not at hand.

HUMIDITY

Accurate humidity data are meager. In some places records for only one or two years are available, and while these are given in the table below they are of little value in determining a mean. Naturally the humidity is highest in the rainy season. In the dry season during the hot part of the day the humidity is comparatively low; at night the air becomes saturated in most localities, with a heavy precipitation of dew.

The Amazon Basin has less atmospheric humidity than the rubber-growing regions of the Orient; the air has a distinctly drier feel. In consequence the European is able to do more work and for longer periods at a stretch here than there. In any part of the Amazon Valley the European can go out on any day, at any time, with a light straw hat or even bareheaded without danger of sunstroke. In nine months' travel in the Amazon Valley at no time did the atmospheric humidity cause the depressing "muggy" feeling so frequently felt in the lowlands of British Malaya and Netherlands India.

Relative humidity figures for a few stations are given in the following table:

TABLE 6.—RELATIVE HUMIDITY

Stations	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cen.*
Belem (Para) [1]	1895-1901, 1907-1910	92.3	93.8	92.3	91.5	89.1	86.1	86.1	86.1	85.2	84.2	85.0	87.
Manaos [2]	1911-1919	86.5	86.5	81.1	81.9	82.4	79.6	77.1	75.0	73.0	74.5	75.9	79.
Taperinha [2]	1914-1923	87.3	90.7	90.5	90.9	91.7	90.4	88.0	85.2	81.4	79.0	79.8	83.
Capatara (Acre) [3]	1909	91.0	92.0	90.0	91.0	87.0	85.0	82.0	70.0	74.0	82.0	83.0	85.
Senna Madureira (Acre) [2]	1916-1917	98.0	98.0	98.0	98.1	98.3	98.0	98.0	97.8	98.2	98.0	98.0	97.
Obidos [1]	1903-1906, 1916	80.7	81.2	84.7	85.3	83.6	79.3	73.6	69.2	70.8	65.0	62.4	78.
Cobija (Bolivia) [4]	1910	69.0	75.0	85.0	78.0	73.0	67.0	58.0	49.0	56.0	61.0	64.0	74.

NOTE.—The observations at Senna Madureira were taken at 7 a. m. and 9 p. m. and therefore are not representative of the hot part of the day.

[1] Paul LeCointe, L'Amazonie Bresilienne.
[2] Directoria de Meteorologia, Rio de Janeiro.
[3] Diccionario Historico, Geographico e Ethnographico do Brazil.
[4] Met. Zeitschrift.

RAINFALL

Compared with many tropical countries the total annual rainfall can not be considered heavy. The torrential downpours common to other equatorial regions are quite unusual here. The area south of the Amazon River, taken as a whole, compares favorably in total rainfall with the best rubber-growing sections of the Middle East though the precipitation is not so evenly distributed as in Malaya, Sumatra, or Cochin China.

The annual rainfall is heaviest near the eastern border of the valley and the western edge in Peru and Bolivia. Between these extremes the rainfall varies according to locality, being lightest along the Amazon from Gurupa to Manaos. The rainfall on the north side of the Amazon, until near the western edge, is decidedly less

than south of the river. Thus, at Boa Vista on the Branco River the average rainfall is only 55 inches. Farther west, however, at Sao Gabriel on the Rio Negro, not far from the Colombia-Brazil border, the annual rainfall average is 87 inches. During the seasonal rains there seem to be no definite hours of the day at which the rains occur, though perhaps the afternoons and nights witness a larger proportion than the mornings.

Available records indicate that the rainfall is very erratic from year to year. Thus, at Porto Velho, in a 15-year period the extremes are 49 inches for 1914 and 153 inches for 1920. At Taperinha, on the Amazon near Santarem, the extremes over 10 years are 49 inches for 1915 and 102 inches for 1923. Differences like these, except in lesser degree, appear in the records for the various localities, so that it is hardly probable that the variation is due to faulty measurements. A table of average annual rainfall for representative localities follows.

TABLE 7.—AVERAGE MONTHLY RAINFALL AND WET DAYS

Stations [1]	Period	Jan.	Feb.	Mar.	Apr.	May	June	July
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Belem (Para)[2]	1894-1911	11.7	14.2	15.2	12.6	10.3	7.7	6.5
Salinas	1910-1919	4.8	12.1	17.7	15.1	9.3	5.2	3.2
Taperinha (Santarem)	1914-1923	6.7	11.6	11.9	12.0	10.8	6.7	4.4
Obidos [3]	1903-1906, 1918	9.5	6.8	12.4	8.8	6.1	3.7	1.9
Parintins	1910-1919	6.9	8.5	13.7	10.1	8.7	5.5	4.2
Manaos	1911-1919	8.3	8.0	8.1	8.4	6.6	3.9	1.8
Boa Vista	1910-1915	.6	2.4	3.7	5.1	8.3	13.0	9.5
Coary	1910-1919	9.5	10.3	10.7	9.9	8.6	5.2	3.2
Sao Gabriel	1910-1919	6.9	8.8	7.4	5.0	12.7	6.8	7.5
Sao Felippe	1910-1919	11.6	13.6	13.3	10.4	7.0	2.3	2.6
Remate de Males (Benjamin Constant).	1910-1919	14.7	11.2	15.2	11.6	10.6	5.9	5.7
Porto Velho [4]	1908-1922	14.6	13.5	15.0	8.9	5.0	1.2	.6
Iquitos (Peru) [5]	(6)	3.3	4.9	9.7	10.0	9.9	10.6	6.1
Cobija (Bolivia)[7]	1909-1910	7.9	8.7	15.0	7.3	2.3	1.1	.5

Stations [1]	Period	Aug.	Sep.	Oct.	Nov.	Dec.	Year	
							Rainfall	Wet days
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Number*
Belem (Para)[2]	1894-1911	4.7	3.4	3.1	2.5	5.9	97.8	252
Salinas	1910-1919	.8	.0	.1	.1	2.0	70.4	90
Taperinha (Santarem)	1914-1923	1.9	1.5	1.4	2.4	4.8	76.1	199
Obidos [3]	1903-1906, 1918	.6	2.5	2.6	2.9	4.4	62.0	158
Parintins	1910-1919	3.3	1.8	2.7	3.5	4.4	73.4	134
Manaos	1911-1919	1.3	1.4	4.6	4.5	8.2	95.1	183
Boa Vista	1910-1915	7.1	1.7	1.7	.7	1.2	54.9	113
Coary	1910-1919	2.9	3.7	5.8	5.3	8.3	83.3	179
Sao Gabriel	1910-1919	5.4	5.4	6.1	7.6	7.8	87.2	159
Sao Felippe	1910-1919	4.2	7.6	10.2	12.2	11.0	105.9	129
Remate de Males (Benjamin Constant).	1910-1919	6.5	6.5	10.8	10.6	14.2	123.5	174
Porto Velho [4]	1908-1922	2.2	3.6	8.9	11.0	13.9	98.4	(6)
Iquitos (Peru)[5]	(6)	6.4	7.7	7.7	5.4	11.5	93.2	(6)
Cobija (Bolivia)[7]	1909-1910	1.4	2.8	9.4	6.2	11.5	74.0	158

[1] Data for Brazilian stations from Boletim Meteorologico except where stated otherwise.
[2] Goeldi Museum.
[3] Paul LeCointe.
[4] Madeira-Mamore Railway Co.
[5] Booth & Co.
[6] Not stated.
[7] Met. Zeitschrift, 1911 and 1912.

SEASONS

The changes of temperature do not allow of the division of the year into the usual four periods. In all the areas investigated there are, however, two seasons of six months each—the wet, or winter, and the dry, or summer—more or less accentuated and encroaching on each other in different regions and years. The summer, or dry, season is the hottest time of the year, due to the drier condition of the atmosphere. In the winter the rains tend to temper the heat of the sun, and the bodily sensations, at least, register less discomfort from the temperature than during the dry season.

In that part of the Amazon Valley lying in Brazil the seasons are reversed on either side of the river; the rainy months on the south side are the dry months on the north, and vice versa. On the south side the rains ordinarily may be considered to begin about November and continue through April. The months of May to November are the dry months, though usually some rain will fall. Cases are known, however, in certain areas on the lower Amazon where it is not uncommon for three months to pass with practically no rain. In this connection it may be stated to be true of all the Amazon Valley that during the wet season days of dry and pleasant weather will intervene, and during the dry season showers or even heavy rains may fall.

The following table shows the different regions investigated, with their wet and dry seasons, by months. It may be noted from this table that in almost every instance the two general seasons last about six months each.

TABLE 8.—WET AND DRY SEASONS

Areas	January	February	March	April	May	June
Lower Amazon, North	Rainy	Rainy	Rainy	Rainy	Slightly rainy.	Slightly dry.
Lower Amazon, South	do	do	do	do	Rainy	Do.
Madeira	do	do	do	do	Slightly rainy.	Do.
Upper Amazon, North	Dry	Dry	Slightly rainy.	Slightly rainy.	Very rainy	Very rainy
Upper Amazon, South	Rainy	Rainy	Rainy	do	Slightly dry.	Dry.
Acre	do	do	Slightly rainy.	Dry	Very dry	Very dry.
Bolivia	do	do	Rainy	Slightly rainy.	Slightly dry.	Dry.
Peru	Very rainy	Very rainy	Very rainy	Very rainy	Slightly rainy.	Slightly dry.

Areas	July	August	September	October	November	December
Lower Amazon, North	Dry	Dry	Dry	Dry	Slightly dry.	Slightly rainy.
Lower Amazon, South	do	do	do	do	Slightly rainy.	Rainy.
Madeira	do	do	do	do	Slightly dry.	Slightly rainy.
Upper Amazon, North	Very rainy	Very rainy	Slightly rainy.	Slightly dry.	Dry	Dry.
Upper Amazon, South	Dry	Dry	Dry	do	Slightly rainy.	Rainy.
Acre	Very dry	do	Slightly dry.	Slightly rainy.	Rainy	Do.
Bolivia	Dry	do	Dry	Slightly dry.	Slightly rainy.	Do.
Peru	do	do	do	do	do	Do.

WINDS

The Amazon Valley is not subject to the violent winds that manifest themselves in destructive ways in parts of the eastern Tropics and in the Temperate Zones. Strong winds of short duration occur in the interior of the country, as in Bolivia and the Madeira River region, usually preceding thunder showers; these blow straight, with no twisting effect, and occasionally are strong enough to uproot a few isolated trees in the jungle. Nothing was observed to indicate that winds were any more frequent or strong than those in Malaya or Sumatra, and nothing was seen or heard of to equal the violent storms that occasionally do considerable damage on the west coast of Malaya. Gusts of wind are not infrequent on the river and at times cause some inconvenience to shipping.

In the section of the Acre Territory investigated there is no regularity in the time of occurrence of winds, but the highest come during the last of August and the first of September. It was observed here that in large cleared spaces a light breeze was often stirring which on the hottest days greatly alleviated the heat.

The general direction of the winds in the Madeira River region is north and east. Winds from the west are rare. On the rivers and cleared spaces a breeze frequently blows, and winds have occurred strong enough to uproot isolated trees and unroof houses. No considerable area of devastated forest, however, was observed or heard of, and it is not considered that winds of sufficient violence to damage rubber trees need be feared.

Strong winds occasionally blow in the country along the Lower Amazon, North, but are not of such violence as seriously to threaten stands of trees with the strong root system of the Hevea. It is said that such winds occur on an average of about fourteen times a year at Obidos. Thunder storms are much less frequent than at Para despite the constant high electrical tension that prevails.

Along the Lower Amazon, South, a persistent wind blows from the east and northeast during part of the year, strong enough to modify somewhat the character of the vegetation along the rivers, by forming waves, which, together with the current, tend to undermine the banks. The influence of this wind, however, is not felt inland.

THE FRIAGEM OR VIENTE DEL SUR

In the eastern parts of Bolivia and Peru and the southern part of the Amazon Basin in Brazil a wind from the south and southwest, sometimes lasting 10 days, occurs at intervals, usually between the months of March and August, although it has been felt as late as December. This wind is known all over the Amazon Valley as the friagem and in Bolivia as the viente del sur or, commonly, the sur. It is supposed to originate in or to be in some way caused by the Andes, snow covered at this time of the year, and brings a distinct drop in temperature, sometimes to 50° F. or below. Occasionally it is accompanied by cold rains, and usually causes much discomfort among the poorer classes, and a few deaths from pneumonia among the rubber gatherers. It is said to be colder in Bolivia than in the Madeira River region of Brazil.

On the Madidi River, a tributary of the Beni in Bolivia, at an elevation of 525 feet above sea level, a drop in temperature from 91° to 52° in a few hours' time has been observed. In this region this peculiar wind is said to occur on days that are very calm and hot, a few hours after the sun has passed its meridian, and is preceded by a falling barometer. During this time the temperature may go down very rapidly and a complete saturation of the air with moisture occur, although at ordinary temperatures the air is dry.

In the valleys of the Tapajoz and Xingu (Brazil) cold winds sometimes blow in June and July. These are supposed to originate in the highlands of Matto Grosso and correspond somewhat to the friagem, although not so cold. They are often felt as far as the lower Negro River on the north side of the Amazon, and in Manaos and Para.

SOURCE OF SEED FOR PLANTING

The Amazon Valley has one great advantage. It is possible to obtain seeds from known high-yielders and to plant large areas with selected seed from such trees only. In every district there are always certain mature trees, well known to the seringueiros, which consistently give much higher yields than the average. Many such trees even bear special names, given them by the seringueiros.

Practical seringueiros in the lower Amazon region divide rubber trees into three classes, namely, preta, branca, and vermelha. Preta and branca always refer to the *Hevea brasiliensis*, or seringueira verdadeira, and vermelha to other species, which may be guyanensis, pauciflora, collina, benthamiana, or what not. Whether or not there is any botanical justification in the distinctions between the preta and branca varieties of the brasiliensis can not be said, but practically there is, because it is constantly made by the seringueiros. It would appear, so far as our knowledge of the matter goes, that this has not yet been worked out from a scientific botanical standpoint.

The preta variety is generally the largest, tallest, and the fastest growing. The bark has a flat, scaly appearance, rough but not corrugated or corky. It has more the appearance of flat flakes or scales. In the forest the lower part of the trunk above the tapped surface is more often covered with moss than the others. Its bark is soft, easily cut, and when cut presents a distinctive brownish to violet color. The bark is thick and has a large number of latex tubes, and these extend inward from very close to the outside bark. A slight scraping of the bark will produce a flow of latex. The branca variety has a light-colored bark when cut. It is harder, and the tree is a poorer yielder. It is more commonly encountered than the preta.

It would follow from this that only seeds of known trees of the preta variety should be used for plantation purposes. By a careful selection of seed and careful cultivation with selective "thinning out" based on individual yields as the trees age, it should be possible to greatly increase the yield over that obtained when planting with unselected seeds.

POPULATION

The total population of the Amazon Basin is probably between 1,500,000 and 1,600,000. Of these about 1,300,000 live in Brazil, distributed according to the Federal census of 1920 as follows: Para,

800,000; Amazonas, 363,166; Matto Grosso, 40,000; Acre, 92,379; total, 1,295,545. The population of the State of Para in 1920 was given as 983,507 and of the State of Matto Grosso as 246,612. However, nearly 200,000 of the inhabitants of Para live outside the Amazon Valley proper, and it is doubtful if the sparsely settled rubber regions of Matto Grosso have a larger population than the figure shown above.

Only a distant estimate can be made of the total population of those parts of Peru, Ecuador, and Colombia lying within the Amazon Basin. Boundaries are vague, and the only basis for estimating population is the scant local data available. It would appear probable that the population of that part of Bolivia in which rubber is native or where its cultivation is practicable is about 100,000. Of these about half are in the Territory of Colonias, where most of the present rubber industry is concentrated, and the majority of the remainder live in the Departments of El Beni and Santa Cruz. In the vast area of country that extends south from the basin of the Caqueta in Colombia and west of the Brazilian frontier to the valley of the Madre de Dios in southeastern Peru the total number of inhabitants is probably not over 200,000.

As to the cities of Amazonia, Para (Belem), the largest of them, has a population of 180,000. Manaos, capital of the State of Amazonas and commercial metropolis of the upper Amazon regions, has some 40,000. Iquitos, in Peru, probably has between 8,000 and 9,000. Santarem, at the mouth of the Tapajoz, has about 5,000 or 6,000—somewhat more than Cameta on the Tocantins; and Obidos has in the neighborhood of 3,000. The other more important places, such as Riberalta and Cobija in Bolivia, Yurimaguas in Peru, Porto Velho on the Madeira, Teffe and Itacoatiara on the Amazon, Alta Mira on the Xingu, and Rio Branco and Cruzeiro do Sul in the Acre, have populations ranging from 1,000 to 2,500.

LABOR

The laboring element of Brazilian Amazonia consists of a population of mixed blood through the intermarriage of the original Portuguese settlers with the native Indians and the descendants of negro slaves. They are commonly known by the name of "caboclo," though different terms are sometimes applied, as "tapuyo" for persons of mixed white and Indian descent. Among the indigenous population of the States of Para and Amazonas the Indian element predominates over the negro in the admixture, though both elements are encountered everywhere in greater or less degree. This is true also of the large body of Cearenses, or inhabitants of the State of Ceara, who have settled in the Amazon Valley and who constitute such an important element in the Acre Territory. However, the immigrants from the States of Maranhao and Piauhy, who also constitute a numerous section of the population in some districts, have a considerable admixture of negro blood. This is true of a large part of the population in the zone about the city of Para. Very few workers in the interior, outside of the large towns, are of white race. Pure-blood civilized Indians are employed in the remoter regions, but they constitute a very minor factor in the labor supply as a whole.

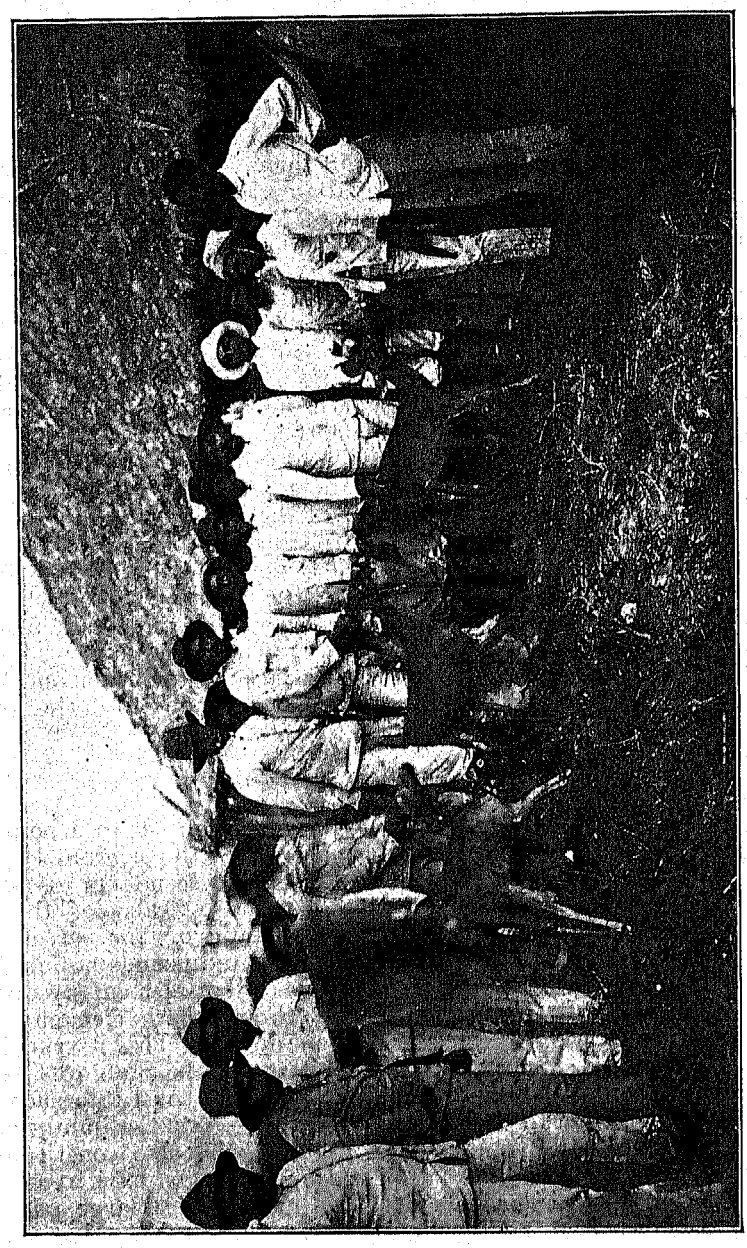


FIG. 15.—Types of Brazilian caboclos

In Bolivia the majority of the rubber workers are "cholos," of white and Indian blood, with the Indian element predominating. A large number of civilized Indians are also employed. The negro element is entirely negligible, but considerable numbers of Japanese were employed for a few years by some of the leading proprietors. In the Bolivian zone along the Abuna and the Acre Rivers Brazilians outnumber the native laboring element.

In Peru and Ecuador the composition of the laboring class is similar to that in Bolivia; that is, it is principally "cholo," or mixed white and Indian. Pure-blood Indians constitute the bulk of the working force in certain districts, as in the Putumayo country.

FIG. 16.—Brazilian children, lower Amazon region

LABOR SUPPLY

It is our conviction, based on careful observation and frequent inquiries, that a labor force of 30,000 for plantation purposes could be assembled without great difficulty within the Amazon Valley. The problem would naturally be easier of solution in some localities than in others, probably being easiest in the State of Para and becoming progressively difficult as the upper rivers were reached.

In Bolivia the concentration of a labor force adequate for initiating a large plantation enterprise would offer a very serious problem. The districts from which additional laborers could be recruited, such as the Provinces of Apolo and Caupolican, in the Department of La Paz, are sparsely populated, and their possibilities in this line would be quickly exhausted.

Though there is a considerably larger supply of available material in the Loreto region of eastern Peru, probably not over 10,000 men could be assembled without very great difficulty. The same condition applies in the montana region of Ecuador as in the upper Napo Basin, and to an even greater degree in those parts of southeastern Colombia, where the cultivation of Hevea would otherwise be possible. In this connection it is impractical to take natives of the

higher mountain districts into the tropical lowlands—first, because of the difficulty of acclimatizing them and, second, because of the aversion of the mountain people to migrating.

POSSIBLE SOURCES OF ADDITIONAL LABOR

The decline in the wild-rubber industry has lessened the demand for laborers, and so has created a potential source from which a very considerable number of men might be drawn for new plantation projects. Moreover, due to the superior living conditions possible under the plantation system, laborers could undoubtedly be drawn from rubber-producing regions where work is slack. Others could be attracted from the castanha or Brazil-nut industry, which is only a seasonal occupation and where conditions of employment often leave much to be desired. Still others could be engaged in the small river towns or drawn away from the desultory pursuit of agriculture and fishing, in which many are engaged for lack of more satisfactory occupation.

BRAZILIAN LABOR FROM NORTHEASTERN STATES

If additional laborers were required for any undertaking in the Brazilian part of the Amazon Basin, the northeastern coast States, the traditional recruiting ground of that region, could be resorted to. These States, with their respective populations according to the census of 1920, are: Maranhao, 874,337; Piauhy, 609,003; Ceara, 1,319,228; total, 2,802,568. To these might be added Parahyba and Rio Grande do Norte, with respective populations of 961,106 and 537,135, or a total of 4,300,809 for the five States. These States, particularly Ceara, are characterized by occasional severe and prolonged droughts, which at times have driven large numbers of the population to emigrate, principally to the Amazon Valley. The possibility of securing any considerable body of laborers from this region depends in great measure on the economic pressure within the area; that is, on the opportunities for making a living at home. In this connection the cessation of work on the vast irrigation project in Ceara, which gave employment to thousands of men, has increased this possibility of obtaining laborers.

There are regular and frequent steamship sailings between Ceara and the other ports of the northeast coast and Para, Manaos, and the main towns of the lower Amazon. The time between Ceara and Para is three days, and between Sao Luiz in Maranhao and Para 36 hours. The second-class fare from Ceara to Manaos is 72$000, and proportionally less to way points. There are two or three sailings per week between Para and these ports. Lloyd-Brasileiro steamers proceed upriver as far as Manaos, calling at the more important points on the Amazon, so that laborers could be brought directly to such places as Santarem and Obidos without breaking voyage at Para.

ORIENTAL LABOR

The introduction of oriental labor has at times been offered as a possible solution for the labor problem in the Amazon Valley. A few hundred Japanese were employed for a time in Bolivia and

proved to be unusually productive rubber tappers, but no effort has ever been made to bring in large numbers of Eastern coolies.

Local and State officials in some quarters might resent the coming of orientals, even under restrictions, and the popular attitude would certainly be unfriendly to them. Moreover, the cost of transporting a large body of Chinese or other oriental laborers to the Amazon Valley, either directly to the Peruvian or the Ecuadorian coast and thence over the Andean trails or via the Panama Canal and Para, would represent a heavy drain on the initial capital investment of a company.

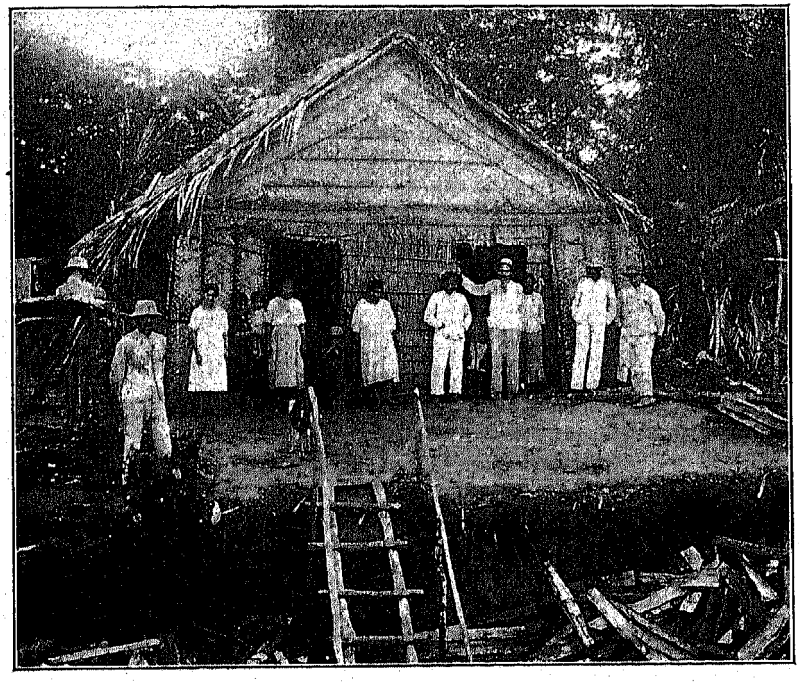


FIG. 17.—Typical home of rubber workers

QUALITY OF LABOR

The labor available in the Amazon Valley and near-by States of Brazil is probably as good as any body of tropical workers in the world, and man for man possibly superior to those employed on the rubber estates of the Orient. Naturally the several classes of labor differ somewhat over the Amazon Valley, due to the varying racial composition of the population, but in certain fundamental characteristics the quality of labor is fairly uniform.

As a rule the worker of the Amazon country is of good physique, inured to exposure, and, under proper incentive, capable of long-continued effort. Most of them, however, suffer from hookworm, and the eradication of this, which is an easy process, would necessarily be a step preliminary to the initiation of a large plantation enterprise.

The laborer of these regions is docile and easily managed, especially when his personal loyalty to his employer is aroused. Though sometimes guilty of overindulgence in the native rum or other local alcoholic drinks on gala occasions, sobriety is the rule among the natives, who, moreover, are little given to brawls even when under the influence of liquor. Crimes of violence are rare, except in the most remote parts of the interior, where there can be little fear of the law, and are then usually the results of jealousy or of some real or imagined affront to the individual's personal "honor." Labor troubles are unknown.

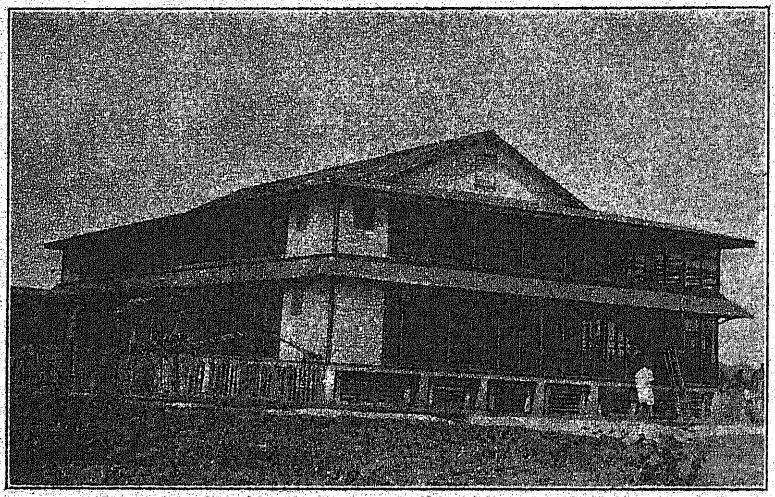


FIG. 18.—Screened house along Madeira-Mamore Railway

INTELLIGENCE AND INDIVIDUALISM OF AMAZON LABOR

In intelligence the Cearense, or immigrant from Ceara, is undoubtedly superior to the other elements of the population, as he is also in resourcefulness and initiative. The other classes of labor have sufficient intelligence to satisfy the requirements of plantation work. The rate of literacy is low, being highest among the Cearenses and in some localities in Peru.

Portuguese is the language of the Brazilian parts of the Amazon Valley and Spanish of the non-Brazilian areas, including Peru and Bolivia. However, most of the Peruvian laboring class speak a form of Quechua language, and the pure-blood Indians, as on the Putumayo, speak a distinct native tongue.

An important characteristic of the body of Brazilian laborers is their strong individualism, which again is most pronounced among the Cearenses and immigrants from other northeastern States. This is partly responsible for the nomadic tendency that is often observed. However, their employment under more satisfactory living conditions than are now possible would doubtless do much to discourage this habit. The individualism of the Amazonian laborer also probably accounts for his preference for task work over work for wages.

LIVING CONDITIONS

The staple items of food among the rubber workers in the Brazilian part of the Amazon Valley are farinha or mandioca flour, dried fish, beans, corn, rice, bananas, coffee, and crude sugar. This is varied in some places with fresh meat or jerked beef, and frequently with native fruits. In Peru bananas or plantains occupy an important place in the popular diet, as boiled yuca or mandioca does in Bolivia. In reaction from the former system whereby practically all foodstuffs were brought from Manaos or Para by the patrão and sold to his laborers, the tendency is for the production of food in the immediate locality. Over large areas it is the rule for the seringueiro to cultivate a patch of ground near his home.

FIG. 10.—Type of native houses in Peru

Housing is a simple problem, the seringueiro everywhere building a rude hut of material at hand. He cuts the framework for his house in the jungle and makes a roof of palm thatch. Split trunks of the paixuba or other palm or palm fronds make the walls, beaten earth or split palm trunks the floor. The furniture is always of the simplest, consisting of cotton hammocks, a rough table, a couple of chairs, and a cheap trunk. For clothing the seringueiro wears cotton trousers, a shirt, and a cloth or straw hat, but seldom goes shod.

STABILIZATION OF LABOR

Wherever possible the seringueiros establish homes and families. However, in the remoter districts the great majority of the workers are single, under which circumstances rivalry for the hands of the few women in the region is a common source of quarrels. Establishment

of homes by the men makes the labor element more contented and steady and would be an important factor in insuring satisfactory employment conditions on a large plantation property.

The laborer of these regions has few pleasures, largely as a result of the isolation in which he lives. These he enjoys only when he gathers with his fellows at the nearest settlement on feast days, or when he has accumulated a balance to spend in Manaos or Para, a condition that is much less common than formerly. He is fond of music and dancing and would take readily to sports such as association football.

As for the general temper of the native Amazonian, he is almost always mild-mannered, kindly, hospitable, and honest. There is

FIG. 20.—Type of native houses in Brazil

much of the child in his character, which is simple and direct, and which makes the personal element such a vital factor in his management.

SYSTEM OF PAYMENT

As explained elsewhere in the report, the wage system is not in practice in the Amazon rubber industry. The rubber worker is paid according to the amount of rubber he collects. This is placed to his credit, and against it are debited the initial advances made to him for transportation, working tools, and other supplies and all subsequent purchases at the property store. If he has a favorable balance at the end of the year he may receive the amount in cash, but it is common for laborers to continue indefinitely in debt to their employer.

Where labor is employed by the day, as in other occupations and industries, the wage paid varies considerably from one district to another. In the State of Para the usual wage for unskilled labor is 2$000 per day plus food, which is equivalent to a total of about 2$500 or approximately $0.25 to $0.30 U. S. currency at present exchange. This represents substantially the prevailing wage in the

coast States of Maranhao and Ceara, from which additional labor might be drawn. On the upper rivers of the Amazon Valley the total daily wage cost is from 4$000 to 6$000.

HEALTH AND SANITATION

The Amazon Valley does not merit the reputation which it holds abroad for unhealthfulness. In the time of the rubber boom conditions largely justified such a charge, but great improvement has taken place since then, and there is now probably no more healthful tropical region in the world. This is borne out not only by our own experience and observations over every representative section of the valley, but by the evidence of foreigners who have resided there for many years with no apparent detriment to their health. The heat

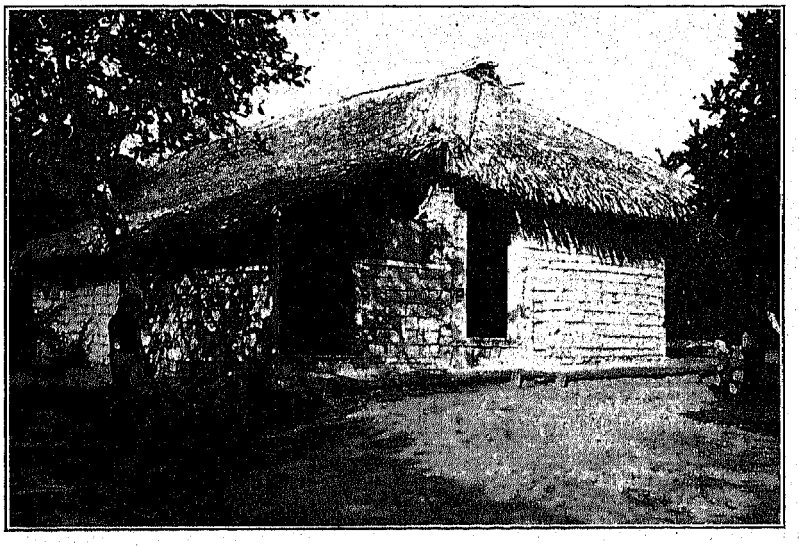


FIG. 21.—Mud and wattle house. A common type throughout the Amazon Valley

of the day is naturally debilitating, but it is by no means constant and is more endurable than the hot days of the American summer. Moreover, the nights are nearly always cool and refreshing, our own party having slept under woolen army blankets almost every night of our stay in the valley.

Health conditions vary greatly between different localities and frequently from year to year in the same district; that is, an otherwise healthful locality may be infected by the arrival of malarial persons from another section of the country, or regions, such as the Acre, where the mortality from fevers was formerly high, may become quite salubrious. As a rule the lands bordering the smaller rivers and streams are more unhealthful than those along the large tributaries of the Amazon. However, there are exceptions, such as the Purus about Labrea. Also, the lands near the cachoeiras, or rapids, are generally disposed to be malarial, as the anopheles mosquitoes thrive in the pools of standing water left among the rocks

after the annual fall of the rivers. Low country subject to flooding is naturally predisposed to be malarial, though the large number of mosquitoes found in such localities may be of the culex and not of the malaria-carrying anopheles variety. The belt along the Amazon itself is comparatively healthful, but the islands or delta country have a bad reputation. The high country bordering the Tapajoz, Xingu, and Tocantins is remarkably salubrious, as is most of the rubber country of Bolivia and Peru.

DISEASES

The outstanding diseases of the Amazon country are malaria and hookworm. The presence of malaria has been commented on above. It exists in virulent and endemic form in certain localities, but by far the larger part of the Amazon Basin is free from it. Hookworm is widespread, it being estimated that 96 per cent of the population of the State of Amazonas and 80 per cent of that of the State of Para are affected. It is the principal factor in weakening the vitality and decreasing the efficiency of the working population but is easily eradicated. It is ascribed largely to the common habit of going barefoot.

Yellow fever has not existed in the Amazon Valley for many years, and beriberi is almost unknown. There is a considerable amount of leprosy, but vigorous efforts are being made to isolate the lepers in special colonies. Due to ignorance of disinfecting methods, ulcers and other forms of blood infection resulting from wounds are common. Digestive complaints are not as frequent as might be expected from the prevailing conditions of life in the forest country.

MEDICAL FACILITIES

Where unhealthful conditions prevail, they are generally due to the natives' complete disregard of even elementary hygiene or to the circumstances that are inseparable from the present working system. Among the conditions which predispose the native to disease are malnutrition, the custom of sleeping without a mosquito net and of going barefoot, negligence in the choice of drinking water, failure to care for wounds, and the inevitable exposure to the inclemencies of the weather.

The Brazilian Federal Government, in cooperation with the State authorities, maintains a sanitary service in Para and Amazonas, with posts for the treatment of natives at several interior points. The Madeira-Mamore Railway Co. also maintains a model service of this kind, with a hospital at Porto Velho. There are good hospitals at Para and Manaos and small regional hospitals at Rio Branco in the Acre Territory and at Riberalta in Bolivia.

VEGETATION

The outstanding features of the virgin vegetation of the Amazon are the forests, known generally as "rain forests" or, by the Brazilians, as mattas virgens (virgin forests). An estimate made in 1911 gave 100 per cent of the Acre Territory, 92 per cent of Amazonas, and 75 per cent of Para as originally covered with forests, the remainder being mainly grassland.

The forests are of the usual tropical type, made up of numerous species, the largest number of which would be classed as small trees or shrubs. Huber [10] estimates that there are 10,000 ligneous species in the Amazon Valley, of which three-fourths are vines and small trees. LeCointe [11] states that it is easy to find specimens of 200 different species on a hectare (2.47 acres) of land. He probably includes in this estimate trees of all sizes.

The same shifting methods of agriculture prevail in the Amazon as in most other tropical regions. This has resulted in the destruction of considerable areas of the virgin jungle, especially around the centers of population and along the main navigable rivers, and in its place is second-growth forest. When young, such forests have the name of capueroes; as the trees in them grow rapidly and they approach more nearly the size of the original forest, they are called capueras. It is often difficult to tell the capueras from the original forest. Inasmuch as the Indians of the valley seem to have engaged in shifting farming even before historic times, it is probable that considerable areas now thought to be original forest are really second growth.

CLASSIFICATION OF TREES BY HEIGHT

The Amazon forests, like those of other tropical regions, can be divided as to height into three tiers or stories—a bottom story composed of small trees, which furnishes the largest number of species and individuals; a middle story; and a top story, composed of only those that are capable, when mature, of reaching great height. The castanheira (*Bertholletia excelsa*), or Brazil-nut tree, piquia (*Caryocar villosum*), cedro (*Cedrela* spp.), or Spanish cedar, and sumaumeira (*Ceiba pentandra*), or silk-cotton (kapok) tree, are among the third-tier trees that stand out as giants of the forest. Though there are many kinds of trees in Amazonia, only a small proportion become large enough to furnish saw timber. From the standpoint of lumbering this is important, for it means that for logging operations on a commercial scale the forests are less complex than a purely botanical census shows.

While numerous species of trees, including palms, are found in certain localities and are known to be absent or replaced by others in other localities, yet our knowledge of the botanical distribution is so incomplete at the present time that it is impossible to make generalizations concerning the uniformity of the composition of the forests. With similar meteorological conditions over the whole region one would expect that the same species of trees found in the lower Amazon would also be met in the upper Amazon or at least be replaced by ones closely related. Species like the Brazil nut and some others not so well known occur over practically the whole of the forested region of the Amazon and over considerable areas form pure or almost pure stands. Until reliable quantitative studies have been made, little can be stated about the relative percentages of the different species that occur in the upper stories of the forests of any particular region. Rough cruises in the forests of French, Dutch,

[10] Huber, J., Mattas e Madeiras Amazonicas, Boletim do Museu Goeldi, Vol. VI, pp. 104–165.
[11] LeCointe, P., L'Amazonie Bresilienne, Vol. II, 1922, p. 7.

and British Guiana show that over considerable areas and under similar topographic conditions from one to eight or ten species form more than 50 per cent of the trees of the upper story. As Guiana forests are similar in character to those of the Amazon, like results might be expected were such cruises made.

CLASSIFICATION OF TREES BY "TOPOGRAPHIC TYPES"

As pointed out by Huber and others, the forests of the Amazon can be divided into two topographic types—those of the terra firme, or high, well-drained land, and known by the Indians as caa-ete (black forests), and those of the varzea, or the alluvial lands subject to periodic inundation, and sometimes known locally as caa-igapo [12] (swamp forests).

The forests of the flood plains are divided into a number of distinct zones reaching from the edge of the river to the terra firme. Thus the first forest zone is known as the imbaubal, for species of Cecropia (imbauba) predominate in it; likewise the next higher zone is characterized by the jauary palm (*Astrocaryum jauary*); in the third zone, that next to the terra firme, the urucuri (*Attalea excelsa*) is prominent. In general, the forests of these zones increase in complexity as the terra firme is approached. Thus over large areas the imbaubas form pure stands, in the lower Amazon often intermixed with the munguba (*Bombax munguba*); in others the pao mulatto (*Calycophyllum spruceanum*) replaces it, and especially in Peru forms pure stands of the "upper story" of vegetation.

Less is known of the terra firme forests. Generally they are more complex in composition than those of the flood plains. Many of the less numerous species of the flood plains are found better developed on the terra firme; such is the case with *Hevea brasiliensis*. On the other hand, many of the species of the terra firme do not occur on the flood plains; among the most important of these are the Brazil-nut tree and the caucho.

DENSITY OF FOREST GROWTH

The forests vary greatly in density in different localities. In some regions the canopy of trees of the upper story closes in or nearly touches; in others the trees are separated so that if the smaller trees of the two lower stories were removed the remaining forest would have a parklike character.

LeCointe estimates that there are about 80 different species of trees to the acre in the Amazonian forests. The number of individual trees of commercial size per acre varies greatly in different localities, but on the average is rather low. In some cases there might be a dozen or more; in others only one or two or none at all.

A census of virgin jungle made on the uplands on the Pacanova River above Guajara-Mirim, in the Madeira region, on land fairly representative of that which would be suitable for rubber-plantation purposes, gave the following number of trees for sizes indicated, measurements taken at 3 feet from the ground: Below 7½ inches in

[12] Sometimes this use of the term is restricted to that part of the flood-plain forests where water is standing the year round.

FIG. 22.—A type of the heaviest Amazon jungle. The large trees are castanheiras (*Bertholletia excelsa*), producers of the Brazil nut

diameter, 87; between 7½ and 12 inches, 53; between 12 and 15 inches, 17; between 15 and 19 inches, 13; over 19 inches, 10; total per acre, 180 trees.

A similar census made at Porvir, in the Acre Territory, between Xapury and Cobija, on representative land suitable for rubber planting, gave the following: Below 7½ inches in diameter, 51; between 7½ and 12 inches, 38; between 12 and 15 inches, 16; between 15 and 19 inches, 8; over 19 inches, 12; total per acre, 125 trees.

Of the above trees there were less than 4 to the acre which measured 27½ inches in diameter and over. The figures, however, can be considered only for the particular areas indicated; in other parts of the valley the jungle is heavier and over large areas much lighter.

Until more quantitative measurements are made and published it is not possible accurately to compare the density of the Amazonian and Middle East forests, but the Amazonian forests, on the average, impress one familiar with both regions as being distinctly lighter than those of Malaya and, particularly, Sumatra.

GRASSLAND VEGETATION

Small areas originally in forest are now covered with grass. This is true in many places on the terra firme, along the rivers, and in the Acre Territory and neighboring parts of Bolivia and Peru away from the rivers. In newly cleared forests, especially in the upper rivers, a grass known as sapa in Brazil and cahanacha in Peru was observed. It is *Imperata brasiliensis* and belongs to the same genus as the lallang grass of the Middle East, but apparently is not so pernicious. This grass seems to be only locally distributed now, though were large areas cleared in the Amazon Valley it might prove more prevalent. The secondary grasslands, when used as pastures, are called pastos, but at the present time cover comparatively small areas.

Primary grasslands of two types occur in the Amazon region. The first type, due either to some characteristic of the soil or to lack of sufficient rainfall, or to both, occurs on the terra firme of the upper northern branches and the middle and upper southern ones of the lower Amazon. Here they cover comparatively large areas and form the so-called true campos of the Brazilians. Another type, generally referred to as campinas, is found in the low-lying bayous of the Amazon and is under water during a part of the year. The grasslands of Marajo Island and the lower Amazon are of this type. Both types are unsuitable for rubber planting.

DISEASES AND PESTS ATTACKING RUBBER

Little systematic study has been made heretofore of the diseases that might attack planted rubber trees in the Amazon Valley. There being so few planted trees, no necessity for such study was felt.

Dr. James R. Wier, pathologist of the Bureau of Plant Industry, United States Department of Agriculture, as a member of that department's commission which collaborated with us, has made an extensive study of the fungi of the Amazon Valley in relation to the planting of rubber. The reader is referred to his report for a detailed discussion of this highly important subject.

The Heveas now standing are the result of a process of elimination whereby the strongest and most vigorous have survived. The result is that, generally, the native trees met with in the forest are relatively free from disease in so far as a cursory examination can disclose. However, diseases similar to those that attack rubber trees on the Eastern plantations do exist in the Amazon Valley, and were a large area planted these would undoubtedly become more manifest.

FUNGUS ENEMIES OF HEVEA

The fruiting bodies of Fomes and other wood-destroying fungi are plentiful in the jungle. Effects resembling those produced by Poria and Ustulina are common, and old Heveas badly attacked by them were observed. The roots of dead trees blown over in many cases were decayed.

No pink disease (*Corticum salmonicolor*) was observed, though from the height of the trees and the fact that our observations were made mainly in the dry season the presence of this or a similar disease might have been overlooked.

Parasitic growths resembling mistletoe are frequently observed on forest trees, including the Heveas. At many places on the damp soils, and particularly on the poor sandy soils along the Amazon River and in the islands, and in similar environment on the lower rivers, the trees are badly infested. In one lot of 100 planted trees near Manaos, 40 years of age, numerous terminal branches were killed or weakened by this parasite, with a resulting loss of leaves. This condition is especially noticeable in the delta and the islands. Also nonparasitic epiphytes were frequently observed. On natural forest trees these different growths are not of great importance, though they may occasionally cause the death of trees. They are more frequently noticed on planted trees standing close together. Under proper plantation conditions they would prove troublesome but not serious, since they could be controlled.

DISEASES OF THE TAPPING SURFACE

It is stated that the tapping of trees by the excision method as practiced on the Eastern plantations causes the tapped surface to be attacked in a virulent manner by a form of cambium rot. Description of it indicates that it attacks only the cortex of the tree and does not enter the wood. Akers [13] states that in 1913 he conducted tapping experiments in many places in the Amazon Valley and that in all cases the disease became so virulent when Eastern systems of tapping were employed that this method had to be abandoned.

At the time of our visit no trees were being tapped by this method, and consequently the condition he describes could not be observed. Individuals who were familiar with his work stated that the trees were overtapped, too much bark being excised, and that this caused the loss of many trees. Whether this overtapping and consequent weakening of the trees had anything to do with the development of cambium rot can not be said. Our opinion is that under proper estate sanitation and the conservative systems of tapping now practiced the damage to be expected from this disease would be much less than pictured by him.

[13] Akers, C. E., The Rubber Industry in Brazil and the Orient, London, 1914.

It is possible that this is the same fungus that attacks both tapped and untapped trees and is the cause of the production of what is known as virgin scrap. In this case areas become diseased at any place on the base of the tree. Latex runs constantly and results in the formation of masses of rubber between the bark and the wood and around the wound. As much as 200 pounds of this rubber has been known to be pulled from an untapped tree. The wound is covered with black (oxidized) rubber, which also hangs on the bark below. The wood is brown superficially, but in a short depth it becomes firm and natural in color. The bark and rubber have a very disagreeable, putrid odor.

LEAF DISEASES

The most serious disease to be considered in the development of rubber plantations is the South American leaf blight (*Dothidella ulei*), which has proved so detrimental to the health of *Hevea brasiliensis* in British and Dutch Guiana as to stop all developments in that line there. However, the damage caused by this disease in the island of Trinidad is not so great as in the Guianas.

Unfortunately there has been no large planting in the Amazon Valley, and there is no experience to guide one in forming a conclusion as to what damage might be expected from this blight. The fungus is known to exist in many places in the basin. On native forest trees its effects are not very pronounced or manifest; it is most frequently observed on planted trees which stand close together. Another host of the fungus is *Hevea guyanensis*. It is not yet clear whether the prevalence and the effects of this disease are more pronounced in some localities than in others, or whether under cultivation methods it would prove as dangerous as usually considered, or prevent the successful operation of rubber plantations in the Amazon Basin.

Other leaf diseases, while not so serious as the *Dothidella ulei*, are present. The most noticeable of these is that caused by *Catacauma huberi*. Leaves attacked by this fungus are characterized by round, hard, black splotches on the under side; the leaf dries out in these places, turns red, and falls. A peculiar thing about this condition is that the leaves of one tree may be rather badly affected, while an adjoining tree may be entirely free. This fungus was noticed on the upper rivers and is very prevalent in the delta and island regions.

INSECT PESTS

On wild trees the worst ravages are caused by a small insect borer (*Captotermes marabitanos* Silv.), called by the natives braca pumilha, which attacks the wood exposed by bad tapping with the machadinho. This insect also sometimes attacks the uncut parts of trees, but this is rare and usually the tree is weak and diseased. A larva called the braca grande is also said to bore into dried parts of the trunk and branches. Many dead trees were encountered that had been killed by attacks of borers.

White ants are plentiful. In their habits and characteristics they resemble the ordinary white ant (*Termite gastroi*) which is such a troublesome pest in Malaya and Sumatra. These ants destroy many

wild Heveas, and it is not uncommon to find old trees with their interiors eaten out by them.

A bad enemy to young planted trees, or to any vegetation, is the small predatory ant (*Aecodoma cephalotes*) known as the sauba. It strips off the leaves of growing vegetation and carries them away, nothing but the bare branches remaining. The ants may strip whole trees in a single night or destroy fields of young crops such as beans, maize, or other foodstuffs. In some localities they are so bad that crops can not be grown until they have been exterminated by a long siege of destruction. These ants are difficult to destroy, for they excavate deep underground chambers and also travel long distances in their search for food.

Outside of the possible danger to be anticipated from the South American leaf disease and the inroads of the sauba ant, in the writers' view there is nothing to indicate that in the matter of diseases and pests any more trouble might be experienced in the Amazon Valley than in the rubber-growing regions of Malaya and Sumatra.

COST ESTIMATES

There are only a few known factors on which to base an estimate of the probable cost in the Amazon Valley of clearing land, planting rubber, and proper upkeep until the trees reach the bearing stage. These factors are the prevailing wages in the different localities, freight rates, cost of supplies and of food (in other words, the living costs of the laborer), and the costs of felling and burning an acre of land as now done preparatory to planting crops or for pasturage for cattle. Capital costs such as building of roads, recruiting of labor, medical superintendence, administration, or, broadly speaking, those costs dependent on management, are very indefinite or wholly unknown, for the reason that no large agricultural project at all comparable to an Eastern rubber plantation has ever been undertaken.

Where areas have been cleared and agricultural enterprises are in progress, such areas are relatively so small and the systems of payment for work so different from plantation usage in the East that no comparison is possible. In order to make any estimate, all that can be done is to base it on the practices customary on Eastern plantations, giving to the different factors a relative weight which in our opinion is fair and equitable.

FACTORS AFFECTING OPENING COSTS

The cost of opening a rubber plantation anywhere in the Amazon Valley depends on several things, chief among which are:

Local conditions:
- Labor supply.
- Accessibility of land to water transportation.
- Cost of land.

Nature of land:
- Topography—flat, swampy, undulating, hilly, etc.
- Nature of vegetation—virgin jungle or second growth.

Opening methods adopted:
Simple felling, burning, and planting, or "clean clearing."
Present system of clearing and planting in Amazon Valley.
Buildings:
Permanent, semipermanent, or temporary.
Food supplies for laborers:
Secured from outside sources.
Produced on the property.
Management.
Unforeseen contingencies during opening.
Favorable or unfavorable health conditions during opening.
Local conditions are discussed in another part of this report. Other factors are summed up below.

TOPOGRAPHY

There is a wide diversity in the topography of land that might be chosen for rubber planting. Since rubber does best on a well-drained soil it is assumed the site chosen would be on the terra firme, or upland. Since there are vast amounts of level and undulating land, and these generally are nearest the large rivers, it is assumed that this type would be preferred to hilly land, which, besides offering more difficulty in the matter of roads and transport, requires more expenditure in the way of soil conservation. In a large tract there might have to be included some hilly land, but in any event this would be no worse than the ordinary hill land of Malaya and Sumatra planted to rubber.

OPENING METHODS

In considering the cost of developing a rubber plantation an important factor to be decided is the character of work to be done. One company might plant up very cheaply by omitting certain kinds of work, erecting temporary or semipermanent buildings, and in general making its expenditures as light as possible. Another company might think such a policy one of poor economy in the long run and would therefore make larger initial expenditures.

One of the factors that enter into consideration is the question of clean clearing, this term being understood to mean the removal of all stumps and roots from the ground, as against the ordinary system of simply felling the jungle and burning. The advantages claimed for clean clearing are a greater freedom from root diseases, a cheapening of weeding costs by either hand weeding or the use of machinery, and a cleaner and better looking property.

It is a moot point whether in the long run the extra expense incurred in clean clearing for the prevention and eradication of disease is justified. In certain areas in Malaya and Sumatra where root diseases were particularly prevalent it was thought to be absolutely necessary to clean clear in order to preserve a sufficient stand of tappable trees. Large expense was incurred in thoroughly cleaning the land before or after planting, but notwithstanding this precaution root diseases still persisted and the percentage of loss of trees from disease was only slightly less than in the uncleaned areas.

Experience seems to have proved, however, that if clean clearing is to be done at all it should preferably be done before planting is started.

It would appear that in South America, where the ravages of root diseases as affecting planted Hevea are not yet very well known from experience, a satisfactory plan would be to plant rather closely, with the possibility of losing a certain number of trees from disease, to be followed by a selective thinning out based on individual tree yields. Should actual experience later make it appear wise to clean clear the land, it could be done at a fraction of the outlay called for when the roots and stumps are green.

Clean clearing makes weeding easier and cheaper. Weeds and grass growing under logs and around the base of stumps are more difficult to eradicate than on cleared land. Also on level cleared land, where no pernicious weeds or grass similar to lalang is present, weeding machines or disk harrows might be used at a great saving over hand weeding.

CLEARING AND PLANTING METHODS

The universal system in use in the preparation of land in the Amazon Basin for planting crops or for pasturage for cattle is as follows: Toward the end of the rainy season the jungle is felled and allowed to remain on the ground through the dry season. It is fired before the beginning of the next rainy season. Planting is then done between logs and stumps with any crop desired, or it is allowed to grow up in grass. The next dry season it is fired again, and this second burning destroys most of the logs and stumps not burned the first time. In this way clearing is done very cheaply but at the expense of the time factor.

The first burn usually leaves a considerable number of logs and stumps on the ground, and in many cases permanent crops like sugar cane or cotton are planted with no further preparation, except that in the case of sugar cane the stubble is burned when the crop is taken off, this burning further helping to destroy remaining logs and stumps.

The rough clearing outlined above is considered sufficient for ordinary crops and for rubber. Cleaning of weeds and brush is usually done by slashing down twice a year with a long knife (machete). In the case of cotton, weeding by hand hoeing is done about three times a year.

TYPE OF BUILDINGS

Permanent buildings such as warehouses, offices, and bungalows for managers and assistants will cost approximately the same, when the respective currencies are translated into terms of American gold, as similar buildings in the Federated Malay States and Sumatra.

In the matter of housing labor there is a great difference between the two regions, and this should not prove as onerous or costly in the Amazon Basin as in the Middle East. The native of northern Brazil is accustomed to very little in the way of good housing. The universal custom is for the seringueiro to build his own habitation, which he does out of material he finds at hand in the forest. On account of the individualistic nature of the native Amazon la-

borer it would probably not be wise to congregate too many in "lines" or barracks, but—at least with families—let each have his own house. At the beginning of development it would be necessary for a company to erect a certain number of houses for its field force.

An accurate estimate of what housing costs for the labor force would be is not possible from data in hand, but it should be much less than in those countries where certain types of houses are prescribed by law and rigidly insisted upon by labor inspectors.

FOOD SUPPLY FOR LABOR FORCE

It is our opinion that any planting development on a large scale to be successful would have to raise its own food supplies, both vegetable and animal, and sell them to its labor force cheaply, or else arrange for the laborer to raise his own food. This would be necessary in order to keep down the laborer's living expense to the lowest point, thereby allowing a lower wage payment. A store would have to be maintained to furnish the labor force with necessary articles; this could be run with a view to making a profit, but always with the object in mind of preventing the laborer from being exploited.

The matter of raising a sufficient food supply cheaply offers no difficulty. The rich alluvial lands in the valleys could be utilized or else catch crops could be raised between the young rubber trees the first year or two.

PRESENT COSTS OF PLANTING FIELD CROPS

The actual cost of felling jungle and planting crops by the methods in use in the Amazon Valley is very low as compared with similar work in many other places. It varies somewhat with the locality, due to differences in wages and in currencies, but on the whole the range is small for such a large area.

It must be borne in mind that the average Amazon jungle is not heavy—not over one-half as heavy as what is known as heavy jungle in Malaya and Sumatra, but to be conservative it is estimated to be on the average about two-thirds as heavy. The undergrowth, however, is generally dense. The cost of felling and clearing land for planting purposes for different sections is given below.

BOLIVIA

On the Madre de Dios near Riberalta in Bolivia it is said to require 25 day tasks (jornales) to fell, burn, and prepare a hectare (2.47 acres) of forest, at an estimated cost of 3 bolivianos per day, paid in merchandise. If cash were paid it would cost about 2 bolivianos per day, or 50 bolivianos per hectare. This would be at the rate of $7.87 U. S. per acre at par or $6.13 at the average rate of exchange for 1923.[14]

In that part of Bolivia near the Abuna River where Brazilian currency is used the work is done at around 200$000 per hectare, or 80$000 to 100$000 per acre, equivalent to $8 to $10 U. S. per acre at the average rate of exchange for 1923.[14]

[14] The average exchange rate for the boliviano in 1923 was $0.303 U. S.; for the Brazilian milreis, $0.103 U. S.; for the Peruvian sol, $0.4135 U. S.

PERU

On the Ucayali and Huallaga Rivers in Peru contracts are given for felling, burning, and cleaning and burning remnant brush at the rate of 100 soles[15] per hectare. This is equivalent to about 40.48 soles per acre and is paid in merchandise. If paid in cash it probably would not be over 30 soles, or roughly $12 U. S., per acre.

In June, 1923, American colonists on the Tomenotti concession on the upper Ucayali were said to be contracting with Chuncho Indians on a basis equivalent to $11 U. S. per acre for clearing and $18 per acre for clearing and planting cotton.

Along the Amazon below Iquitos it costs 120 soles to fell, burn, and plant a hectare of sugar cane, this also being estimated on a merchandise basis. If paid in cash it would be about the same as for the Ucayali and Huallaga regions.

The cost of felling jungle, burning, and cleaning up small remaining brush costs, therefore, around the equivalent of $12 U. S. per acre.

BRAZIL

Lower Madeira region.—At the Fazenda Democracia, which may be taken as representative of the level and undulating land of the lower Madeira region, felling, burning, and clearing to plant sugar cane was being done on contract at the rate of 300$000 to 400$000 per hectare, according to kind of jungle, paid in merchandise. Wages were estimated at 4$000 per day, without food. At the average rate of exchange for 1923[15] this would be $12.50 to $16.68 U. S. per acre. These rates are among the highest encountered for this class of work; if the work were paid for in cash the figures would be considerably smaller.

Acre Territory.—Felling, burning, and planting grass or field crops cost at present on contract from 200$000 to 225$000 per hectare, or roughly 81$000 to 91$000 ($8.34 to $9.37) per acre.

Lower Tapajoz.—Conditions around Santarem may be taken as typical of the lower Amazon country. In this area wages and living costs are cheaper than in the upper rivers. The cost of felling jungle, burning, and cleaning sufficiently to plant sugar cane or other crops is around 120$000 per hectare; making holes and planting sugar cane costs 40$000 per hectare; or a total of 160$000 per hectare, equivalent to, say, 65$000 ($6.70) per acre. For felling and burning alone the cost is 49$000 ($5.05) per acre. If corn or beans be planted the first year, the proceeds of these pay for preparing the land.

At the date of our investigation (April, 1924) the wage rate was based on 2$000 per day, or one-half that on the Madeira in August, 1923.

DIRECT LABOR COST OF OPENING ON EASTERN BASIS

If the same character of work were undertaken in Amazonia as is customary in the East, it is believed the estimates which follow would fairly approximate the actual labor costs per acre for

[15] See footnote 14, p. 104.

felling, planting, and upkeep for 5 years after planting. In these estimates the cost is based on day wages and for clean clearing, as that is the only way to arrive at comparable totals. It is to be remembered, however, that the work in all probability would be done on contract and should cost less than the figures shown. Due to the lighter character of the jungle in the Amazon Valley and the higher efficiency of the labor force, the same operations in the Amazon country would, it is believed, require only about two-thirds as many day tasks as in Sumatra in those instances where indentured Javanese coolies are used for opening.

TABLE 9.—DAY TASKS PER ACRE FOR OPENING AND PLANTING, SUMATRA AND AMAZONIA[1]

Character of work	Day tasks per acre	
	Sumatra	Amazonia
Felling	20	13
Clearing	90	60
Stumping	100	70
Digging soil and roots	63	42
Total opening	273	185
Lining and holing	6	4
Nurseries	10	7
Planting and watering	10	7
Drains and soil conservation	20	13
Roads	5	3
Total planting	51	34
Total through opening and planting	324	219

[1] Brazil, Peru, and Bolivia.

TABLE 10.—DAY TASKS PER ACRE FOR UPKEEP DURING NONPRODUCING PERIOD, SUMATRA AND AMAZONIA[1]

Character of work	Day tasks per acre									
	First year		Second year		Third year		Fourth year		Fifth year	
	Sumatra	Amazonia	Sumatra	Amazonia	Sumatra	Amazonia	Sumatra	Amazonia	Sumatra	Amazonia
Weeding	75	60	45	30	20	15	15	12	.....	12
Upkeep of drains and soil conservation	10	6	10	6	10	6	10	6	.....	6
Upkeep of roads	1	1	1	1	1	1	1	1	.....	1
Supplying	2	3	1	1	.....	.....	.....	.....	.....	.....
Pruning	3	2	3	2	.....	.....	.....	.....	.....	.....
Pests and diseases	1	1	2	1	2	1	2	1	.....	1
Total through nonproducing period	92	73	62	41	33	23	28	20	.....	20

[1] Brazil, Peru, and Bolivia.

Detailed costs based on the above estimates, for Bolivia, Peru, and Brazil, are given in the following tables.

TABLE 11.—WAGE COST PER ACRE FOR OPENING AND PLANTING, AMAZONIA

Character of work	Wage cost per acre				
	Bolivia, at 1.50 bolivianos per day	Peru, at 1.50 soles per day	Brazil		
			At 2$500 per day	At 3$000 per day	At 4$000 per day
	Bolivianos	*Soles*	*Milreis*	*Milreis*	*Milreis*
Felling	19.50	19.50	32$500	39$000	52$000
Clearing	90.00	90.00	150$000	180$000	240$000
Stumping	105.00	105.00	175$000	210$000	280$000
Digging soil and roots	63.00	63.00	105$000	126$000	168$000
Total opening	277.50	277.50	462$500	555$000	740$000
Lining and holing	6.00	6.00	10$000	12$000	16$000
Nurseries	10.50	10.50	17$500	21$000	28$000
Planting and watering	10.50	10.50	17$500	21$000	28$000
Drains and soil conservation	19.50	19.50	32$500	39$000	52$000
Roads	4.50	4.50	7$500	9$000	12$000
Total planting	51.00	51.00	85$000	102$000	136$000
Total through opening and planting	328.50	328.50	547$500	657$000	876$000
Equivalent in American currency	[1] $99.54	[2] $135.83	[3] $56.39	[3] $67.67	[3] $90.22

[1] At exchange of $0.303 to the boliviano.
[2] At exchange of $0.4135 to the sol.
[3] At exchange of $0.103 to the milreis.

TABLE 12.—WAGE COST PER ACRE FOR UPKEEP DURING NONPRODUCING PERIOD, AMAZONIA

Character of work	Wage cost per acre				
	First year	Second year	Third year	Fourth year	Fifth year
BOLIVIA					
At 1.50 bolivianos per day	*Bolivianos*	*Bolivianos*	*Bolivianos*	*Bolivianos*	*Bolivianos*
Weeding	90.00	45.00	22.50	18.00	18.00
Upkeep of drains and soil conservation	9.00	9.00	9.00	9.00	9.00
Upkeep of roads	1.50	1.50	1.50	1.50	1.50
Supplying	4.50	1.50			
Pruning	3.00	3.00			
Pests and diseases	1.50	1.50	1.50	1.50	1.50
Total through nonproducing period	109.50	61.50	34.50	30.00	30.00
Equivalent in American currency [1]	$33.17	$18.63	$10.45	$9.09	$9.09
PERU					
At 1.50 soles per day	*Soles*	*Soles*	*Soles*	*Soles*	*Soles*
Weeding	90.00	45.00	22.50	18.00	18.00
Upkeep of drains and soil conservation	9.00	9.00	9.00	9.00	9.00
Upkeep of roads	1.50	1.50	1.50	1.50	1.50
Supplying	4.50	1.50			
Pruning	3.00	3.00			
Pests and diseases	1.50	1.50	1.50	1.50	1.50
Total through nonproducing period	109.50	61.50	34.50	30.00	30.00
Equivalent in American currency [2]	$45.28	$25.43	$14.27	$12.41	$12.41
BRAZIL					
At 2$500 per day	*Milreis*	*Milreis*	*Milreis*	*Milreis*	*Milreis*
Weeding	150$000	75$000	37$500	30$000	30$000
Upkeep of drains and soil conservation	15$000	15$000	15$000	15$000	15$000
Upkeep of roads	2$500	2$500	2$500	2$500	2$500
Supplying	7$500	2$500			
Pruning	5$000	5$000			
Pests and diseases	2$500	2$500	2$500	2$500	2$500
Total through nonproducing period	182$500	102$500	57$500	50$000	50$000
Equivalent in American currency [3]	$18.80	$10.56	$5.92	$5.15	$5.15

[1] At exchange of $0.303 to the boliviano.
[2] At exchange of $0.4135 to the sol.
[3] At exchange of $0.103 to the milreis.

TABLE 12.—WAGE COST PER ACRE FOR UPKEEP DURING NONPRODUCING PERIOD, AMAZONIA—Continued

Character of work	Wage cost per acre				
	First year	Second year	Third year	Fourth year	Fifth year
BRAZIL—continued					
At 3$000 per day	*Milreis*	*Milreis*	*Milreis*	*Milreis*	*Milreis*
Weeding	180$000	90$000	45$000	36$000	36$000
Upkeep of drains and soil conservation	18$000	18$000	18$000	18$000	18$000
Upkeep of roads	3$000	3$000	3$000	3$000	3$000
Supplying	9$000	3$000			
Pruning	6$000	6$000			
Pests and diseases	3$000	3$000	3$000	3$000	3$000
Total through nonproducing period	219$000	123$000	69$000	60$000	60$000
Equivalent in American currency [1]	$22.56	$12.67	$7.11	$6.18	$6.18
At 4$000 per day	*Milreis*	*Milreis*	*Milreis*	*Milreis*	*Milreis*
Weeding	240$000	120$000	60$000	48$000	48$000
Upkeep of drains and soil conservation	24$000	24$000	24$000	24$000	24$000
Upkeep of roads	4$000	4$000	4$000	4$000	4$000
Supplying	12$000	4$000			
Pruning	8$000	8$000			
Pests and diseases	4$000	4$000	4$000	4$000	4$000
Total through nonproducing period	292$000	164$000	92$000	80$000	80$000
Equivalent in American currency [1]	$30.08	$16.89	$9.48	$8.24	$8.24

[1] At exchange of $0.103 to the milreis.

Combining these figures, the cost of opening, planting, and upkeep through the sixth year would approximate:

TABLE 13.—SUMMARY OF WAGE COST PER ACRE TO PRODUCING AGE, AMAZONIA

Character of work	Wage cost per acre				
	Bolivia, at 1.50 bolivianos per day	Peru, at 1.50 soles per day	Brazil		
			At 2$500 per day	At 3$000 per day	At 4$000 per day
	Bolivianos	*Soles*	*Milreis*	*Milreis*	*Milreis*
Opening and planting	328.50	328.50	547$500	657$000	876$000
Upkeep:					
First year	109.50	109.50	182$500	219$000	292$000
Second year	61.50	61.50	102$500	123$000	164$000
Third year	34.50	34.50	57$500	69$000	92$000
Fourth year	30.00	30.00	50$000	60$000	80$000
Fifth year	30.00	30.00	50$000	60$000	80$000
Total upkeep during nonproducing period	265.50	265.50	442$500	531$000	708$000
Total wage cost to producing age	594.00	594.00	990$000	1,188$000	1,584$000
Equivalent in American currency	[1] $179.97	[2] $245.63	[3] $101.97	[3] $122.37	[3] $163.15

[1] At exchange of $0.303 to the boliviano.
[2] At exchange of $0.4135 to the sol.
[3] At exchange of $0.103 to the milreis.

COST WITHOUT CLEAN CLEARING

If the policy were adopted of simply clearing the land and planting, without taking out roots and stumps and digging the soil, the cost would be considerably reduced, as below:

TABLE 14.—WAGE COST PER ACRE TO PRODUCING AGE, WITHOUT CLEAN CLEARING, AMAZONIA

Character of work	Wage cost per acre				
	Bolivia, at 1.50 bolivianos per day	Peru, at 1.50 soles per day	Brazil		
			At 2$500 per day	At 3$000 per day	At 4$000 per day
	Bolivianos	*Soles*	*Milreis*	*Milreis*	*Milreis*
Opening and planting	160. 50	160. 50	267$500	321$000	428$000
Upkeep for 5 years	265. 50	265. 50	442$500	531$000	708$000
Total wage cost to producing age	426. 00	426. 00	710$000	852$000	1, 136$000
Equivalent in American currency	[1] $129. 08	[2] $176. 15	[3] $73. 18	[3] $87. 75	[3] $117. 00

[1] At exchange of $0.303 to the boliviano.
[2] At exchange of $0.4135 to the sol.
[3] At exchange of $0.103 to the milreis.

The above costs would vary, when expressed in terms of United States currency, according to the fluctuations in the prevailing rate of exchange. The par value of the boliviano is $0.389 and of the Peruvian sol $0.486, so that the average rates for 1923 used in the above calculations are 22.1 per cent and 14.9 per cent, respectively, below the par value of the currencies of those countries.

The fluctuation has been greatest in the case of Brazil. The par value of the milreis is $0.324, so that the average rate ($0.103) for 1923 is 68.2 per cent below the normal or par value. The average rates for the period 1912–1922 are shown on page 25. The average rate for the past 10 years, since the milreis began to fall, is $0.2152, and for the past 5 years $0.1696.

Should the value of the milreis move toward par, the costs as shown for Brazil would correspondingly increase. Should it reach par value, the direct labor costs per acre in United States currency would be approximately:

	At 2$500 wage	At 3$000 wage	At 4$000 wage
Clean clearing	$320. 76	$384. 91	$513. 21
Ordinary clearing	230. 04	276. 04	368. 06

OTHER CAPITAL COSTS

It is not possible to make an accurate estimate of other capital costs involved in opening a plantation, such as staff bungalows, laborers' quarters, hospital, factory, machinery and implements, superintendence, and indirect cost of labor. An estimate based on Eastern data and practice is given on page 118.

On the Eastern plantations experience has shown [16] that the direct labor costs for opening and bringing to bearing is approximately 40 per cent of the total cost. There is no way to ascertain how near this might approximate the ratio in the Amazon Valley, but we believe it would be much higher there.

[16] Figart, David M., The Plantation Rubber Industry in the Middle East.

POSSIBILITIES OF COST REDUCTION

Clearing.—As to the possibilities of reductions from the above costs, in the matter of clearing conditions are very different from the Eastern countries. In many places there are fine old native Heveas in the forests which could be used as sources of seed and which, through the adoption of a different system of tapping and coagulation, would prove a source of revenue. Many other trees, such as the castanheira and sapucaya, furnishing valuable products, exist in greater or less profusion. While opinions may vary (as, for example, on the matter of transmission of root disease), the question would arise as to whether such trees should be removed until at least the Heveas approached the bearing stage. It is highly probable the proceeds from such trees would meet a considerable part of the upkeep charges on the plantation until the rubber came into bearing. If such trees were allowed to remain, the first cost of clearing would be diminished just that much. A company would have to determine for itself whether the advantages to be gained by allowing these trees to remain would overbalance the disadvantages of a possible slower growth by shading the young rubber and the danger of destruction to trees should they later fall over for any cause.

USE OF FELLED TIMBER

With regard to the utilization of some of the fallen trees, timber from an opening or clearing close to the Amazon or any of its larger tributaries below the rapids could be profitably marketed locally or floated downstream to existing mills.

Another item worthy of consideration is the use of wood as fuel for steam-raising purposes on all Amazon steamers as well as in the cities of Para and Manaos. A clearing advantageously located on the Amazon itself or near the mouth of its larger tributaries could by the installation of a quick-loading device, supply an enormous quantity of wood to steamers passing up and down the rivers. At present the only means of loading steamers is by slow hand labor, and a constant supply of wood, with a quick-loading arrangement, would meet with ready response from steamers. While not a great deal of profit could be expected from this source, it would help defray the clearing cost. Wood is sold on the lower Amazon by pieces about 4 feet long at an average price of 25$000 per 1,000 pieces loaded on steamer. One man with an ax cuts about 300 sticks a day. By using a gasoline motor saw he should be able easily to cut over a thousand.

A large proportion of the area under discussion is level or only slightly rolling, and clearing could be done very advantageously by the use of machinery. With steam donkey engines for piling and pulling large stumps and caterpillar tractors for pulling the smaller stumps, large areas could be cleared with a relatively small labor force. With the more active and intelligent Amazon labor, there is no reason why this method should not be successful, even though it may not have proven entirely satisfactory in the Middle East.

OMISSION OF CLEAN WEEDING

Upkeep.—The main reason for clean weeding on the Eastern plantations is to keep out lallang. In the Amazon Valley the analogous pest, sapa (*Imperata brasiliensis*), is not widely distributed and seems easier to eradicate than the lallang of the East, and less danger might be anticipated from its spread. It might not, therefore, be necessary to clean weed at all. In this event strip weeding or simply clean weeding in a circle around the tree might be sufficient, and the grass and vegetation slashed or mowed down at intervals. Since the cost of weeding constitutes the largest item in the upkeep of the nonproducing areas of a plantation, a considerable saving could be effected by dispensing with clean weeding, unless experience should prove it wise to institute it.

OWNERSHIP OF LAND AND LAND LAWS

The subject of land laws is covered in considerable detail in the different regional reports. However, some of the more important phases of the matter may be summarized here.

PUBLIC LANDS AVAILABLE

There is little public land available in Bolivia for rubber-plantation purposes, and any land acquired there would probably have to be purchased from private owners. The only alternative would be in case the Government should declare some of the existing titles invalid or inadequate, and the corresponding properties should lapse to the State. In both Peru and Ecuador there is still a considerable amount of well-situated Government land on which rubber could be planted. In Brazil the situation varies from zone to zone. In the Acre Territory little public land remains. In the State of Amazonas the best lands bordering the Madeira, Purus, and Jurua Rivers are held in private ownership. This is not so true of the lands within reach of the Solimoes which might be suitable for plantation sites, as considerable areas of good terra firme (upland) still remain in the hands of the State. Certain minor rivers are under the control of private rubber interests. In both the upper reaches of the Maues system and the country about the headwaters of the lower right-bank tributaries of the Madeira there are large tracts of public land well adapted for rubber planting, though in some cases their utilization is impractical because of their inaccessibility.

PUBLIC LANDS IN MATTO GROSSO AND PARA

In the State of Matto Grosso the only large block of private holdings is in the zone along the upper Madeira and the Mamore. The vast undeveloped wilderness, rich in native rubber, which extends from about the headwaters of the Gy-Parana across the upper basins of the Aripuana and the Roosevelt, and of the Tapajoz confluents and the Xingu to the valley of the Araguaya, consists almost en-

tirely of State land, but is too remote for any practical development with present transportation facilities.

In the State of Para there have been large acquisitions of public lands by private individuals during the past few years along the north-bank tributaries of the Amazon. However, there is still a large unoccupied area of good public lands, the more desirable zone lying to the south of the Amazon, conditions there being more favorable than to the north of the main river. Though a very narrow strip of land along the Tapajoz, Xingu, and Tocantins is largely held in private ownership, immediately to the rear of this zone there begin vast areas of public lands excellently suited for the planting of rubber and with easy access to water transport.

It is worth noting in connection with this general subject that the public lands of this part of Brazil are the property of the respective States and not of the Union. The exception comprises certain campos lands in the Branco country unsuited for the growing of rubber trees.

FORMS OF LAND TENURE

Naturally the forms of land tenure differ from one country to another and between the several Brazilian States. However, there are certain general resemblances throughout the area under discussion, Bolivia showing the widest divergences from the customary practices in the other zones, due to its emphasis on the number of trees or estradas rather than on the area of land as the basis of property rights.

In order to encourage actual settlement the different governments have been most lenient in the matter of the informal occupancy of public lands, especially when the area involved is relatively small. Lands thus held by direito de posse, a form of "squatters' rights," are common in Brazilian Amazonia, and the governments generally allow a very liberal period for the legitimation of this class of claims, particularly when improvements on the land give evidence of the occupant's serious intentions. Seizures of large blocks of public land by individuals are not countenanced so readily. Foreign interests should investigate carefully the claims of settlers found on land whose acquisition they contemplate, as to ignore the real or imaginary rights of such persons might later inconvenience them in making good the occupation of the property.

The usual method for acquiring land is by purchase, the price in whatever case being quite nominal. In fact, the cost of making the survey may be larger than the original cost of the land itself. However, many of the largest properties in the Amazon Valley are the result of special grants by the different State governments. All three of the Amazonian States, but particularly Para, have very liberal laws providing for grants of land for the encouragement of certain industries, such as the planting of rubber and the breeding of cattle.

SECURITY OF LAND TITLES

The security of titles to lands also varies greatly from one political unit of the Amazon Valley to another. In Bolivia, though the large

proprietors hold definite titles to most of their lands, other holdings are said to be in danger of reversion to the State. In Peru the field party also found certain large properties whose reoccupation by the Government had been threatened for failure to carry out the terms of the original grant, which required the grantee to develop the land within a specified period of time. On the other hand, certain other proprietors, such as those on the Putumayo, are well established, though all titles in that zone are liable to be affected by the triple boundary dispute between Peru, Colombia, and Ecuador.

Titles in the Acre, pending the enforcement of the special regulations already decreed for the purpose, are in a very unsatisfactory condition. Certain claims have acquired by right of age, uninterrupted possession, and development of the particular property a *de facto* legality that in actual practice has all the force of the most formal title.

EXPORT DUTIES AND TAXES

BRAZIL

Amazonas.—The export duty in the State of Amazonas varies according to the river of origin, the schedule of rates being as follows:

Abuna, 4 per cent. Rubber from this zone also pays a tax of 6 per cent for the public schools of the State.
Javary, 7 per cent.
Purus and Jurua, 6 per cent for rubber produced in the zone bordering the Acre Territory.
Remainder of State, 10 per cent.

These duties are paid on the net weight of the rubber and in accordance with the official pauta, or rate, which is established weekly.

On arrival at Manaos, rubber from the interior pays 100 reis per kilo gross weight for "fine," "weak fine," or caucho and 80 reis per kilo for scrap. An additional export duty of 2.26 per cent is collected at Manaos for the municipio, or municipal district, where the rubber was produced.

Para.—The present export duty levied by the State of Para on rubber of the grades "fina" and "entrefina" is 10 per cent ad valorem. To this must be added the following taxes:

State:
"Bolsa" tax (proceeds destined for construction of exchange building at Para), 0.375 per cent.
Industry and professions tax, 0.4 per cent.
Sanitary tax, 1 per cent.
Surtax on export duty, 3 per cent of export tax.
Municipality of Para:
Municipal tax, 1 per cent.
Surtax, 3 per cent of municipal tax.
NOTE.—These taxes apply to shipments of rubber from interior consigned to Para houses for export, but not to actual "in transit" shipments for direct export through Para.
Municipality of origin: This varies according to the municipality, but averages 5 per cent, the rate for Obidos and Alemquer. The rate for Monte Alegre is 100 reis per kilo.

The lower grades of rubber, including "weak" and sernamby, pay an export duty of 22 per cent, the additional taxes being the same as above. The rate on caucho is 12 per cent.

Thus a typical shipment valued at $1,000 would pay the following taxes:

State:	
Export duty	$100.00
Surtax	3.00
Bolsa tax	3.75
Industry and professions tax	4.00
Sanitary tax	10.00
Municipality of Para:	
Municipal tax	10.00
Surtax	.30
Municipality of origin: Export tax	50.00
Total	181.05
Percentage	18.1

Acre Territory and Matto Grosso.—The duty on exports of rubber from the Federal Territory of the Acre and the State of Matto Grosso is 10 per cent.

BOLIVIA

Under the present law rubber exports are taxed in accordance with the following scale: When the London quotation for "fine" rubber is—

	Per cent
25d. to 35d. per pound	2
36d. to 47d. per pound	4
48d. per pound and above	6

However, there was lately before the Bolivian Congress a proposal to change this scale to the following proportions:

	Per cent		Per cent
6d. to 10d. per pound	4	31d. to 35d. per pound	9
11d. to 15d. per pound	5	36d. to 40d. per pound	10
16d. to 20d. per pound	6	41d. to 45d. per pound	11
21d. to 25d. per pound	7	46d. to 50d. per pound	12
26d. to 30d. per pound	8		

AMAZON VALLEY AND MIDDLE EAST COMPARED

A brief comparison of the physical, economic, and political conditions of the Amazon Valley with those of the Middle East, from the viewpoint of rubber planting, follows.

TOPOGRAPHY AND SOILS

1. The rubber lands in Malaya and Sumatra were originally covered with virgin forest. Some areas were later covered with grass, due to the system of "fire agriculture" practiced by the native population. In the Amazon Valley the only land suitable for rubber planting is virgin forest, except some 8,000 acres near Capatara, in the Acre Territory, and possibly other smaller tracts elsewhere.

This soil appears the same as the near-by forest soil, and probably was cleared in times past. The large areas of original grasslands (campos) in the Amazon Basin are unsuitable for rubber planting because of soil conditions, and consequently opportunity to lower capital costs by planting up such lands is lacking.

2. The dominant parent rocks of Malaya and Sumatra are acid igneous and siliceous sedimentary and metamorphic rocks. In the Amazon Basin there are three general kinds of rocks, namely, (*a*) unconsolidated sands, silts, and clays; (*b*) crystalline igneous and metamorphic rock; and (*c*) consolidated sedimentary rocks; the first two classes greatly predominating. In most of the area suitable (from the transportation standpoint) for rubber planting in Amazonia the soils are silts and clays of a texture that will hold moisture and allow a deep penetration of the tree roots. On the upland soils drainage and soil conservation would not be so great a problem as in the Middle East.

CLIMATE

3. Temperature conditions are similar, with some advantages in favor of the Amazon Valley.

4. The total amount of rainfall, in general, is less in the Amazon Basin than in the best rubber-growing areas of the Middle East. However, in some localities, as, for example, in the western end of the basin, the total rainfall is approximately equal to that of the Middle East. The yearly rainfall is not so well distributed in the Amazon region, the rainy and dry seasons being more accentuated.

5. Neither region is subject to typhoons or generally destructive winds.

SEED—GROWTH OF TREES—TIMBER

6. All seed for planting in the Middle East is derived from the descendants of the original trees grown from seed brought from the Amazon Valley. In the Amazon Basin fresh seed for new plantings and buds for grafting from known high yielders are always available.

7. There are no existing planted areas in South America which have been cared for on an equality with those of the Middle East, hence no comparison is possible on the point of growth of trees and yields. There are vast areas of land suitable for rubber-planting purposes in all the South American countries embraced in this report. The localities are themselves the natural home of the rubber tree, and in many of them are now growing fine native trees of the best kinds that could be utilized as a source of seed for new plantings as well as for actual production of rubber. There appears no reason why rubber plantations should not give even better results in South America than in the Middle East.

8. The commercial development of the timber resources is about the same in the Middle East and in the Amazon Valley, neither having as yet introduced steam logging. There is a good market in South America for all the lumber that could be sawed from cleared

land. Also, in places suitable for water transportation, a large amount of wood could be furnished to the river steamers and to the industries in the cities and towns.

DISEASES OF TREES

9. Rubber planted in Malaya and Sumatra in virgin forest soils in many cases was attacked by root diseases originating in the stumps and roots left in the ground. Such diseases caused heavy losses, and to combat them the process of clean clearing was resorted to. This means the removal of all stumps and roots from the ground, which adds greatly to the cost of opening plantations.

In the Amazon Valley it is not known what damage might be expected from root diseases, though it is well established that wood-destroying fungi are present. No authentic case was discovered by the field party of planted rubber trees having been destroyed by this agency, and no diseased roots were noted on such planted trees. It is highly probable that clean clearing as a preventative against disease would not be necessary to the same extent as in the Middle East. There are several regions in the Middle East and in Cochin China where root diseases are reported not to exist, or at least have given no trouble.

10. No leaf disease has yet developed in the Middle East that appears a serious menace to the industry. In South America the leaf disease popularly known as the South American leaf blight exists in sporadic cases over a large area, but it can not be said from experience what effect it would have on rubber plantations in the Amazon Valley.

LABOR AND WAGES

11. Indigenous labor forms a very small proportion of the working force on European-owned estates in Malaya, Ceylon, and Sumatra. An abundant supply of labor is close at hand, relatively speaking. In Malaya and Ceylon labor is recruited in British India, and in Malaya is augmented by a large Chinese immigration. In Netherlands India the teeming population of Java is drawn on.

The Amazon Valley is not so favorably situated in this respect. For large developments a sufficient labor supply would be a difficult matter on the upper rivers of Brazil and in Bolivia and Peru. In such localities the importation of outside labor would be necessary. In the lower Amazon country the problem is not so acute. By mobilizing the present unemployed and floating population of the towns and cities and, if necessary, drawing on the near-by States of Maranhao and Ceara it should not be a difficult matter to secure, say, 30,000 good laborers, sufficient to open and handle more than 150,000 acres.

EFFICIENCY AND DISCIPLINE OF LABOR

12. In the Middle East the most intelligent laborer is the Chinese, and he consequently requires less training and supervision than the Javanese or the Tamil Indian. The South American laborer is much more intelligent and dependable than the Tamil and in this respect is comparable more to the Chinese.

The laborer of Brazil, Bolivia, or Peru is physically able to perform the most arduous labor. He is more independent in spirit, and consequently would be more difficult to control, than the Eastern laborer. The South American laborer could not be worked in gangs on day wages as well as the Eastern laborer but would do excellent work under a task or piece-work system. The Peruvian and the Bolivian laborer is better disciplined than the Brazilian and is more tractable in disposition.

The best class of laborers in the Amazon Basin are the immigrants from the State of Ceara. These people are hardy, ambitious, and inured to hard work. American employers stated they found them excellent workers, some even going so far as to say they secured as much and as good work as from the average laborer of the United States. In any part of the valley results depend almost wholly on management.

BASIC WAGES

13. The basic labor wage scale in the Middle East is 20 cents U. S. for Indians and Javanese and 35 cents for Chinese. Housing, sanitation, etc., under existing legislation, recruiting charges, and other expenses bring the cost up to around 35 cents U. S. per day for Indians and Javanese, whereas this does not apply to the Chinese.

In the Amazon Basin the basic wage depends on locality. In Peru it may be taken as 1.50 soles per day, equivalent to 62 cents U. S. at the average rate of exchange for 1923. In Bolivia it may be taken as 1.50 bolivianos, equivalent to 45.4 cents U. S. In Brazil it varies according to locality from 2$500 to 4$000 per day, equivalent to 25.75 to 41.2 cents U. S.

HEALTH AND SANITATION

14. There is not a great difference in the natural healthfulness of the two areas, but, if anything, the advantages incline in favor of the Amazon Valley. Certain rivers in the valley have a bad reputation for malignant fevers. On the other hand many regions eminently suitable for rubber plantations are free from fevers and are comparatively healthful. Any area can be made healthful by the same methods of drainage and sanitation employed in the Middle East.

In intelligence the native working populations of Brazil, Peru, and Bolivia are comparable more to the Chinese than to any of the other laboring elements of the Middle East. After a preliminary treatment for hookworm and, if necessary, malaria, they require no more medical supervision or attention than would be the case with the Chinese.

CAPITAL COSTS

15. No comparison of costs of production can be made, since there is no actual experience from which to form an estimate in South America, and it is impossible to forecast yields, cost of labor, supervision, supplies, taxes, etc., for so long a period in the future. The

capital costs of bringing European-owned rubber plantations into bearing in the Middle East range from $60 to $500 per acre, with an average around $250. Opening costs of rubber planted on forest soils, with clean clearing, full equipment of buildings, roads, etc., will average $300 per acre. When grass or second-growth lands are opened the cost is less.

In the Amazon Basin the only lands that can be planted are forest lands. Since no planting of any consequence has been done and with the time required to bring a plantation into bearing unknown, there is not sufficient data to permit an accurate estimate to be made. However, there are certain items of expenditure that would not occur in South America, such as recruiting expenses (which are always charged to the laborer and recoverable). There is no governmental supervision of labor, with restrictions regarding the housing of labor forces. Such items as medical supervision and expenses might be less than in the Middle East.

16. In the Middle East the direct labor cost of bringing an acre into bearing is 40 per cent of the total cost. In South America this proportion should be much higher, in our opinion. If taken at 50 per cent, the total costs, based on the estimates used in this report, would be approximately as follows per acre:

BOLIVIA AND PERU

Bolivia.—Clean cleared—direct labor cost, 594 bolivianos per acre; total cost, 1,188 bolivianos ($359.96) per acre. Rough cleared—direct labor cost, 426 bolivianos per acre; total cost, 852 bolivianos ($258.16) per acre.

Peru.—Clean cleared—direct labor cost, 594 soles per acre; total cost, 1,188 soles ($491.24) per acre. Rough cleared—direct labor cost, 426 soles per acre; total cost, 852 soles ($352.30) per acre.

BRAZIL

CLEAN CLEARED

Based on daily wage of 2$500: Direct labor cost, 990$000 per acre; total cost, 1,980$000 ($203.94) per acre.

Based on daily wage of 3$000: Direct labor cost, 1,188$000 per acre; total cost, 2,376$000 ($244.72) per acre.

Based on daily wage of 4$000: Direct labor cost, 1,584$000 per acre; total cost, 3,168$000 ($326.30) per acre.

ROUGH CLEARED

Based on daily wage of 2$500: Direct labor cost, 710$000 per acre; total cost, 1,420$000 ($146.26) per acre.

Based on daily wage of 3$000: Direct labor cost, 852$000 per acre; total cost, 1,704$000 ($175.51) per acre.

Based on daily wage of 4$000: Direct labor cost, 1,136$000 per acre; total cost, 2,272$000 ($234.02) per acre.

The above figures would naturally vary with the current exchange rate and would increase as the rates approached par.

LAND TENURE

17. Land leases in Malaya are perpetual and unlimited as to area. In Sumatra the land laws allow leases for 75 years, subject to renewal for 50 years more.

BOLIVIA, PERU, AND ECUADOR

Little public land suitable for rubber plantations is available in Bolivia, and land for this purpose would probably have to be purchased from private owners. The law of 1906 authorized the sale to native Bolivians or foreigners of a maximum of 20,000 hectares at 1 boliviano per hectare, a special act of Congress being required for grants in excess of that amount.

Peru and Ecuador have large areas of Government land available. In Peru public lands in unlimited amounts may be acquired by purchase at a price of 1 sol per hectare or may be leased up to 50,000 hectares. The National Congress may make extraordinary grants of public lands, fixing a nominal price.

BRAZIL

In Brazil lands are either sold or leased, and in some cases provision is made for gratuitous grants. The area which may be ceded is commonly fixed by law. In Amazonas a person or company may acquire up to 10,000 hectares of State land (at 5 to 6 cents U. S. per hectare at present exchange). Larger grants of indefinite extent may be made by special action of the State Congress.

State lands with no specified limit as to quantity may be purchased or leased in Matto Grosso. Prices of land and lease charges are graduated according to the location of the land.

In Para, under the law of 1921, State lands can be acquired by purchase, lease, or gratuitous cession, special legislation being required for the last named. In case of purchase, prices are graduated according to the size of the area acquired, the minimum being fixed at 2$000, or about 20 cents U. S., per hectare. Provision is made for the perpetual lease of land of indefinite extent.

Little unoccupied public land remains in the Acre Territory, and plantation sites would have to be obtained from private owners. Land titles in many cases are conflicting, and the legalization of titles will not be satisfactory until the Federal Government puts into effect the existing laws governing concessions and property rights in the Territory.

LAND TAXES

18. Taxes on land in the Amazon Basin are much lower at the present time than are rentals in the Middle East. In British Malaya the land rental per acre runs from $1 Straits ($0.54 U. S.) for the first year with a yearly increase up to a maximum of $4 Straits ($2.16 U. S.), subject to renewal every 30 years. In Sumatra the

yearly rental is 50 guilder cents per hectare for the first year, up to 3 guilders in the sixth and following years ($0.08 to $0.48 U. S. per acre).

In Bolivia, Brazil, and Peru the tax (or rental) is only a few cents per acre—so low as to be almost negligible. Special concessions in relation to taxation, covering a long period of time, could doubtless be obtained.

EXPORT DUTIES

19. Export duties, except in Peru, which at present imposes none on rubber, are higher in South America than in British Malaya, where the tax is approximately 1 cent U. S. a pound. Sumatra levies no duties on rubber shipments.

In Bolivia the export duty is based on London prices, and varies from 2 to 6 per cent when prices range from 25d. to 48d. and above. At present, therefore, there is no export duty. There is a proposal before the Bolivian Congress to change the scale to begin at 6d. a pound, with a tax of 4 per cent ad valorem, and to increase it to 12 per cent when the price is 46d. and over.

In Brazil the export duty is one of the principal sources of revenue. In all States it is 10 per cent for "fina" and "entrefina," with a higher percentage for "weak" and scrap. Besides this tax, however, there are municipal, professional, sanitary, and other taxes which run the total up to 18 per cent and above. In order to promote the planting industry the several States might grant foreign capital special concessions that would lower the tax to meet that which is now or might be levied in the Middle East.

POLITICAL STATUS

20. The planting areas in the Middle East lie within regions that are colonies of Great Britain, the Netherlands, or France, so that security of capital depends largely on the policy of the controlling European power. Under these conditions there is reasonable assurance that guaranties will be adequate.

Potential rubber-plantation lands in the Amazon Basin are situated within the sovereign Republics of Brazil, Bolivia, Peru, Ecuador, Colombia, and Venezuela. Of these, only Brazil is a federated Republic, with large powers vested in the component States, of which Para, Amazonas, and Matto Grosso comprise the actual rubber-producing areas. The Acre Territory is directly subject to the Federal authority in Rio de Janeiro. Political security varies somewhat between the States and sometimes from one administration to another. The Federal Government, as well as the three State governments, have expressed an active interest in the investment of foreign capital in the rubber-plantation industry.

The other Republics named have a centralized form of government, with authority concentrated in the national administration. They have indicated a willingness to cooperate with foreign investors by providing the necessary guaranties for capital and by the promise of certain favors or inducements for investment.

OTHER INDUSTRIES AND RESOURCES

Forest and agricultural products in great variety are either worked in the Amazon Valley or are capable of being worked to advantage. Some of them could be developed in connection with a rubber-planting business and others could be exploited independently.

AGRICULTURAL PRODUCTS

FOODSTUFFS

Sugar.—Sugar cane is grown in all parts of the Amazon Valley, but nowhere has sugar production been developed on a large scale. There are many small, primitive mills where the cane is crushed between wooden rollers by hand or animal power and a coarse brown sugar produced; also a number of establishments that work on a commercial scale and with something like modern equipment, such as Itapinima on the Madeira, San Pablo in Peru, and Ivon on the Beni in Bolivia, but the output of these mills is small. Alcohol and rum are important products of the industry. A modern sugar central in the vicinity of the city of Para, where there are large areas of land suitable for the cultivation of cane, should be a profitable venture.

Cacao.—Cacao production, like many other lines of agriculture, has lost much of its original importance in the Amazon Valley, first because of the counter attraction of rubber, second as a result of devastating floods in some of the principal cacao districts, and finally because of the unremunerative prices that have ruled recently. The product is of a good grade, but not well prepared for export. The chief centers of production are the main line of the Amazon from a short distance below Obidos to Manaos and the lower valley of the Tocantins.

FIBERS

Cotton.—Cotton growing in the Amazon country has reached the highest development in Peru, where an excellent grade of cotton from the Ucayali and Huallaga Valleys is exported by way of Iquitos. Beginnings have also been made with a perennial tree cotton on the Madre de Dios in Bolivia, and the growing of cotton is increasing about Santarem and other points in the State of Para. Climate and soil are highly favorable to the growing of cotton in most of the Amazon Valley, but the necessity of clearing the jungle before planting represents a considerable initial expense.

Cordage and other fibers.—Notwithstanding the large number of fiber plants in the Amazon Valley, little has been done to develop an industry for their utilization. Among the few exceptions are the strong tucum (called chambira in Peru), used in making hammocks and twine, and the coarser piassava, which is collected in considerable quantities along the Rio Negro. Still others are used in making hats, cloth, brush, and cordage for local use.

FOREST PRODUCTS

BALATA

The working of the balatas has become an important industry in certain parts of the Amazon Valley, especially in the country to the north of the main river. The extraction of red balata (balata rosada) similar to that worked in the Guianas is concentrated in the upper basin of the Rio Negro and particularly in the zone of its tributary, the Branco. However, the red-balata belt extends west into Colombia and east across the northern part of the State of Para, at least to the valley of the Rio Paru, and probably farther. An inferior product, which is generally known as white balata, but which is not a true balata, is widely found and is exported from Iquitos in considerable quantity.

The abiurana tree (Lucuma, fam. Sapotaceae), whose latex yields a high percentage of gutta, is also widely distributed over the Amazon Valley, but little has been done to develop its commercial possibilities.

OILSEEDS AND NUTS

Probably no part of the world has a greater wealth and diversity of vegetable-oil materials than has the Amazon Valley. These consist not only of a wide variety of palm nuts, including the babassu and curua, but of a large number of other raw materials such as the ucuuba nut. Though some of these plants are found widely scattered from the delta of the Amazon well into Bolivia and Peru, conditions for their economical exploitation are most favorable in the State of Para. Three concerns at Para and Santarem have been engaged in exporting curua and other kernels and a factory is in course of erection at Breves, a few hours upriver from Para, where oils will be produced from a variety of materials. The cultivation of the curua palm should be easy and lucrative, as it flourishes on inferior sandy soil where the jungle is light or altogether absent and the nut produces a high percentage of excellent oil.

Brazil nuts now constitute one of the principal articles of export of the Brazilian part of the Amazon Valley. The development of this industry has in fact done much to compensate for the decline of the rubber industry. Though found over a wide area, the regions of largest production are the zones of the Trombetas, Tocantins, Solimoes, and Negro Rivers. (A detailed account of the industry by Special Agent A. Ogden Pierrot was issued as Trade Information Bulletin No. 259, by the Bureau of Foreign and Domestic Commerce, Washington, D. C.)

TIMBER

The past few years have witnessed a considerable development of the lumbering industry in the State of Para, especially in the delta where the problem of transportation is much simplified. Little interest has been shown as yet in the many fine hardwoods of the country, attention having been concentrated on the medium-weight woods such as Spanish cedar. Soft woods also are being utilized i

increasing quantity for the manufacture of box shooks. Several sawmills in the vicinity of Para supply the Brazilian market, but the exports to Europe are largely in the form of logs. Logs, especially of andiroba and cedar, are even shipped from the Ucayali Basin in Peru via Iquitos.

In spite of the difficulties attending logging in the tropical forest the lumbering industry is capable of considerable expansion, particularly in the more accessible country along the lower rivers.

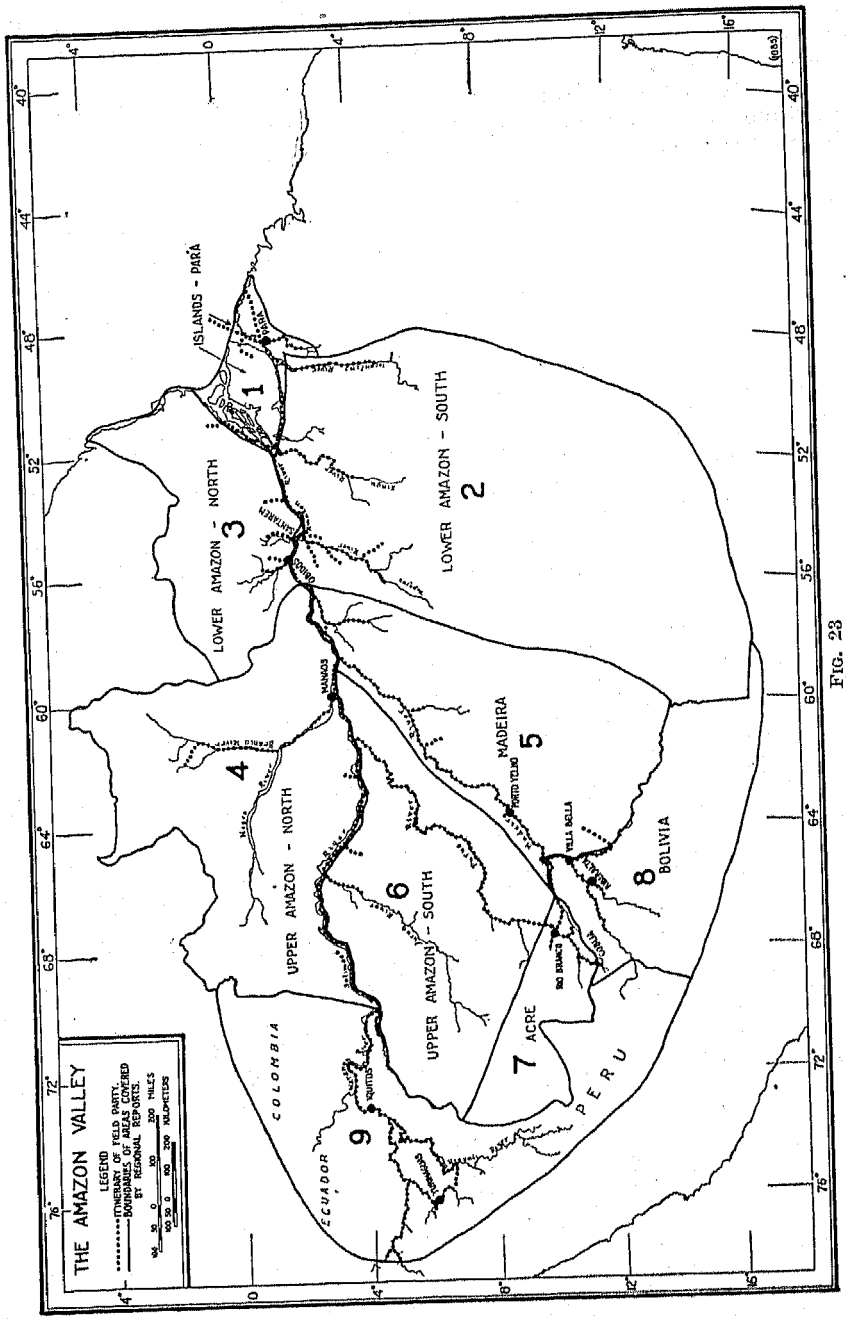

THE AMAZON VALLEY
LEGEND
ITINERARY OF FIELD PARTY
BOUNDARIES OF AREAS COVERED BY REGIONAL REPORTS
MILES
KILOMETERS
ISLANDS - PARÁ
1
LOWER AMAZON - NORTH
3
LOWER AMAZON - SOUTH
2
4
UPPER AMAZON - NORTH
MADEIRA
5
6
UPPER AMAZON - SOUTH
7
ACRE
8
BOLIVIA
9
ECUADOR
COLOMBIA
PERU
MANAOS
PORTO VELHO
VILLA BELLA
RIO BRANCO
IQUITOS

FIG. 23

PART II

1. ISLANDS AND PARA

LOCATION AND AREA

The territory embraced in Region 1 comprises the islands of the Amazon delta and a section of the mainland to the north and south of the river. The largest of the islands is Marajo, approximately 125 miles in length and 17,650 square miles in area. The long island of Gurupa, at the head of the delta, has an area of some 1,790 square miles and Caviana, which lies athwart the mouth of the Amazon, an area of 1,825 square miles.

To the north of the Amazon the region includes the territory extending to the Rio Araquary, and comprehending the two municipal districts of Mazagao and Macapa, with a total area of 29,900 square miles. To the south of the delta, and more particularly to the south of the estuary of the Tocantins known as the Rio Para, the area under consideration comprises the lands lying to the east of the main stream of the Tocantins and within the drainage basin of the Rio Para. The district along the Atlantic littoral from Curuca eastward and that bordering the State of Maranhao are not included.

SECTIONS VISITED BY FIELD PARTY

The field party investigated personally the following sections:

1. Entire zone of the Braganca Railway.
2. The Moju River to the property of the Moju Rubber & Development Co.
3. The campos (open grassland or natural meadow) zone in the vicinity of Soure, island of Marajo.
4. The region between the Moju and the Tocantins Rivers.
5. The course of the Para River to the entrance of the furos, or channels, leading into the Amazon proper.
6. The region of the furos in the Breves and Gurupa districts.
7. The Macapa region on the mainland to the north of the principal mouth of the Amazon, including the campos to the rear of Macapa and the lands bordering the Furo de Sant' Anna near Macapa.

PHYSICAL FEATURES

The topographical features of this region will be considered in two sections: First, the mainland area to the north and south of the delta; second, the islands of the delta.

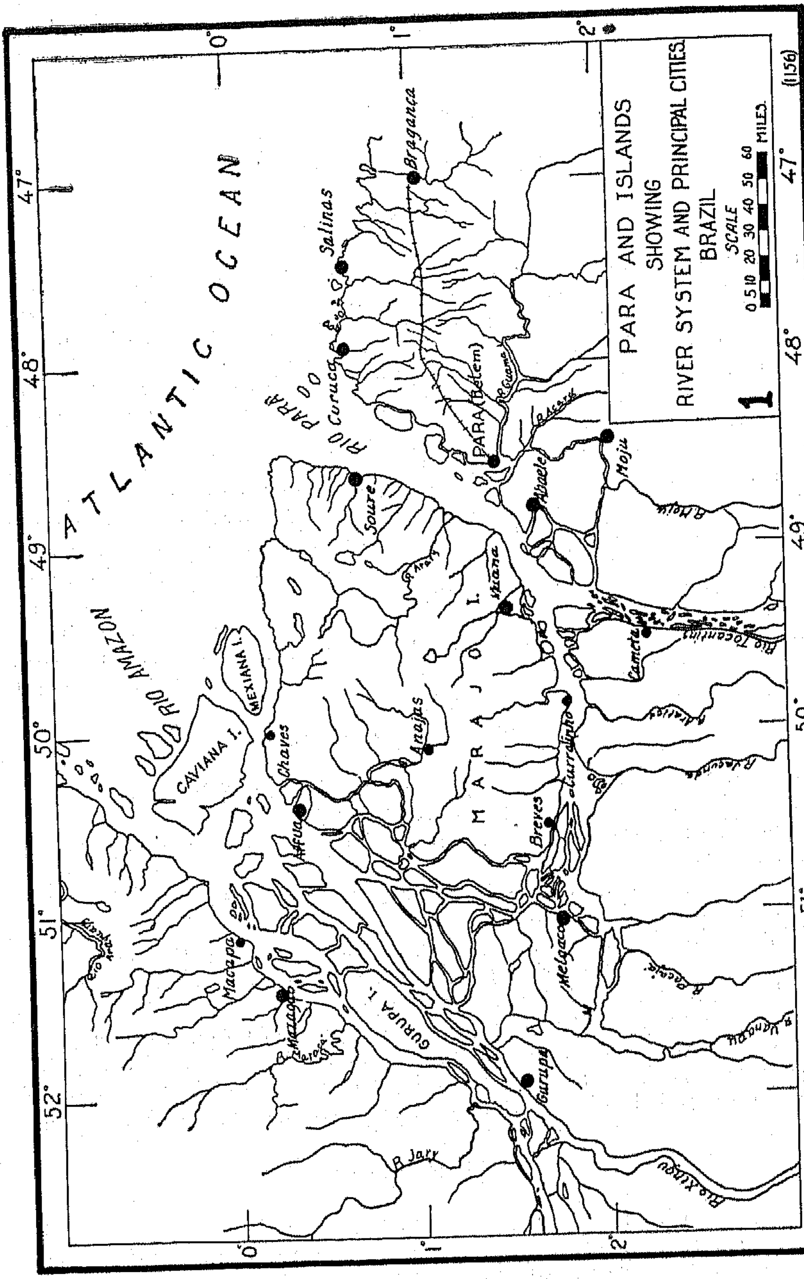

PARA AND ISLANDS
SHOWING
RIVER SYSTEM AND PRINCIPAL CITIES
BRAZIL
SCALE
0 5 10 20 30 40 50 60
MILES
(1156)
ATLANTIC OCEAN
RIO AMAZON
RIO PARA
CAVIANA I.
MEXIANA I.
MARAJO I.
GURUPA I.
PARA (Belem)
Braganca
Salinas
Curuca
Soure
Chaves
Anajas
Breves
Afua
Macapa
Mazagao
Gurupa
Melgaco
Cameta
Abaete
Moju
Curralinho
Rio Tocantins
Rio Xingu
R. Jary
47°
48°
49°
50°
51°
52°
0°
1°
2°

FIG 24

CHARACTERISTICS OF THE MAINLAND

The mainland to the south of the delta is characterized by greater fertility of soil and heavier and more constant rainfall. As a result of these conditions and of the circumstances that a large local market is offered by the city of Para this area has a more intensive economic development than has the mainland on the north side. The predominant topography of the region is flat or gently undulating; there are no high elevations or abrupt depressions. The rivers, such as the Guama and the Moju, are tidal streams for much of their length; moreover, for a long distance from their mouths the banks of these rivers are low, much of the shore lands being flooded at high tide. It is only after a day's ride or more by steamer that higher lands begin to appear, followed eventually by the inevitable cachoeiras (rapids) in the upper courses of the streams. The Abaete and Igarape-Miry districts, which form a rough triangle between the lower reaches of the Tocantins and the Para Rivers, also constitute a low-lying country, cut up by tidal canals and with the general level but little above high tide.

The mainland to the north of the delta consists of a relatively narrow belt of more or less heavy forest bordering the channel, behind which natural campos extend inland an indefinite distance. At Macapa this forest zone is less than a mile wide, but farther west gradually widens until it assumes the magnitude of the usual Amazon jungle. As the Guiana border is approached on the north the country becomes higher and rougher, with the forest predominating.

CHARACTERISTICS OF THE DELTA COUNTRY

The delta section consists of a labyrinth of islands lying between the northernmost mouth of the Amazon, which flows in front of the town of Macapa, and the estuary of the Rio Tocantins, which is known as the Rio Para. The muddy flood of the Amazon pours into the ocean by several channels of great width and depth that flow to the north of the island of Marajo, while part of its enormous volume of water finds its way down through the maze of furos, or channels, to the west and south. These furos connect the course of the Amazon proper with the Rio Para, and in them there is a regular flow and ebb with the tides.

Marajo, the largest island of the delta, deserves a special word because of the peculiar conditions that distinguish it from the other islands of the region. Its western side is in no way different from the general character of such islands as Gurupa, being covered with dense jungle that is regularly flooded and that represents the Amazon Valley at its worst. Rubber is worked here, and several years ago an English company acquired large properties on the Anajas River. Timbering is carried on along the fringe of the island, as is also the gathering of oilseeds. The lands are of great fertility and would yield rice and similar crops in abundance if cleared and drained and diked, but their utilization for anything beyond the extraction of timber and oilseeds is inadvisable from any standpoint. In fact, the population at present engaged in the interior could be utilized to far greater advantage in other parts of the State of Pará

and with far less wastage of human life than in that pestilential wilderness.

The eastern side of the island of Marajo is of a quite different character, being largely open campos country, devoted to the raising of cattle, whose numbers are estimated at 500,000 head. This part of the island undoubtedly represents a survival of the original mainland and is not the result of accumulated alluvial deposits, as is the western end. Its eastern shore rises well above the level of the sea, as is observed at Soure; from this the land slopes westward until it falls into the low dismal marshes known as the Mondongos, beyond which begins the great jungle. The eastern, or campos, side of the island is not subject to flood either by the annual rise of the river or by the tides, though rivers like the Arary are bordered by tidal marshes. However, because of the slight slope of the island large tracts are covered with water during the rainy season. On the other hand, during the dry season the campos are parched, and the pasturage, which is so luxuriant during the intermediate seasons, becomes too sparse for the fattening of cattle.

CLIMATE

TEMPERATURE

The meteorological data given below are those of Para, with the exception noted for the island of Marajo, since these are the only places where such records have been kept over a long period of time. The climate varies little over this area, and the figures for Para are fairly representative of the whole area. The following table of monthly mean temperatures is from LeCointe's L'Amazonie Bresilienne:

TABLE 15.—MONTHLY MEAN TEMPERATURE, PARA AND MARAJO

Months	Goeldi Museum, 1895–1904, 1907–1910	Secretariat of Public Works, 1907	Louro Sodre Institute, 1905–1907	Marajo Island, 1856–1858
	° F.	° F.	° F.	° F.
January	77.8	78.0	78.8	78.6
February	77.0	76.9	77.9	77.5
March	77.6	78.5	78.4	78.6
April	77.8	77.2	79.1	78.6
May	78.5	79.2	78.5	78.9
June	78.4	79.2	79.9	79.3
July	78.2	79.5	80.1	79.5
August	78.5	78.5	79.3	79.3
September	78.6	79.4	80.3	79.9
October	79.3	79.9	80.1	80.2
November	79.6	80.3	80.1	80.2
December	78.9	79.8	79.7	79.5
Year	78.4	78.8	79.3	79.2

The extremes of temperature were:

	° F.
Mean of the coldest month (February)	72.5
Mean of warmest months (October and November)	80.2
Maximum temperature observed 1895–1910 (Oct. 30, 1910)	97.8
Minimum temperature observed 1895–1910 (Dec. 20, 1903)	66.5
Absolute range of temperature	31.3

HUMIDITY

Humidity records as taken at the Goeldi Museum, Para, from 1895 to 1901 and between 1907 and 1910 gave the following monthly averages:

TABLE 16.—RELATIVE HUMIDITY, PARA[1]

Months	Per cent	Months	Per cent
January	92.3	September	85.2
February	93.8	October	84.2
March	92.5	November	85.0
April	91.5	December	87.8
May	89 1		
June	86.1	Year	88.3
July	86.1	Absolute maximum	99.0
August	86.1	Absolute minimum	43.0

[1] Monthly average for periods 1895–1901 and 1907–1910.

RAINFALL

According to the records of the Goeldi Museum the rainfall for the 18 years from 1894 to 1911 averaged per month at Para as follows:

TABLE 17.—AVERAGE MONTHLY RAINFALL AND WET DAYS, PARA, 1894–1911

Months	Inches	Days	Months	Inches	Days
January	11.7	27	September	3.4	16
February	14.2	26	October	3.1	15
March	15.2	28	November	2.5	13
April	12.6	26	December	5.9	20
May	10.3	24			
June	7.7	22	Total	97.8	252
July	6.5	19	Absolute maximum	115.1	(1)
August	4.7	16	Absolute minimum	79.4	(1)

[1] Data not available.

Rainfall at the Fazenda Matinada on the near-by island of Marajo and at the Goeldi Museum is compared below for the years 1915 to 1923:

TABLE 18.—COMPARISON OF RAINFALL, PARA AND MARAJO, 1915–1923

Years	Para	Marajo	Years	Para	Marajo
	Inches	*Inches*		*Inches*	*Inches*
1915	80.4	71.3	1920	116.9	117.7
1916	103.8	98.5	1921	122.9	144.7
1917	110.6	121.7	1922	103.6	96.9
1918	100.0	73.2	1923	107.1	(1)
1919	84.2	53.4			

[1] Data not available.

SEASONS

The rainy and dry seasons at Para are not so sharply separated as on the north bank of the Amazon and in the upper Amazon country. At Para it rains in every month of the year; on the

neighboring island of Marajo some months are absolutely rainless. At Macapa, on the main north channel, the two seasons are sharply divided; during the eight months of the rainy season precipitation is heavy, but the remaining four months are almost rainless. This same condition exists across the river on the northern part of the island of Marajo as far as the mouth of the Soure River.

Though morning rains are not infrequent, as a rule rains in Para and vicinity occur in the late afternoon and evening. During the so-called rainy season a rain may be expected every day between 4 and 6 p. m.

The effect of the annual inundation caused by the flood waters is naturally more pronounced here than in any other part of the Amazon Basin (except on a smaller scale at the far western end). The delta lands in general are low, and in periods of flood great areas are under water. The higher parts of the islands and the terra firme of the mainland are, of course, not covered. Along the rivers the only parts remaining above water are the narrow restingas (natural levees), and on these the cattle and wild animals take refuge until the waters subside. The houses of the inhabitants are built upon piles, and in many cases the water reaches to the floor. Communication at such times is by means of canoes.

When the waters subside in the dry season the forest lands become again normal forests and the treeless areas are transformed into pastures on which cattle graze. Large shallow ponds, often filled with growing vegetation, are left in the lower places of these areas.

POPULATION

The population of Region 1, according to the Federal Census of 1920, was 563,748, or considerably more than half the total for the entire State of Para. Of this number 236,402 were in the municipal district of Belem. The population was distributed according to municipalities as follows:

North mainland:	Population
Macapa	18,387
Mazagao	12,058
Total	30,445
Island of Marajo:	
Affua	9,850
Anajas	11,859
Breves	22,678
Cachoeira	10,547
Chaves	18,461
Curralinho	7,692
Muana	12,579
Ponta de Pedras	6,683
Sao Sebastiao da Boa Vista	4,249
Soure	16,493
Total	121,091

Other islands:	Population
Abaete	24,556
Gurupa	10,901
Melgaco	6,650
Total	42,107
South mainland:	
Acara	12,100
Belem	236,402
Curuca	13,916
Igarape-Miry	15,286
Irituia	9,508
Moju	9,255
Ourem	7,870
Sao Caetano	9,886
Sao Domingos da Boa Vista	16,691
Sao Miguel do Guama	9,125
Vigia	30,566
Total	370,105

However, several of these municipal districts are not confined within the limits of the division under which they are placed. Thus, Breves comprehends a multitude of islands in the zone of the furos, though the seat of administration is on the island of Marajo. The town of Gurupa is on the south mainland and is within the scope of the report on the Lower Amazon, South (Region 2), but the island of that name is within the delta zone (Region 1). Several other municipalities are similarly placed.

CITY OF PARA

The city of Para—or Belem, as it is generally known locally—capital of the State of Para and commercial metropolis of the Amazon Valley, is situated on the Bay of Guajara about 75 miles from the ocean. The bay is formed by the confluence of the Guama and Acara Rivers and is in reality only an arm of the Para River, which separates the island of Marajo from the mainland and serves as the usual passage for navigation between the Amazon and the ocean. Directly in front of the city lies the low Ilha das Oncas, from which it is separated by a narrow stretch of water. The latitude of the Para cathedral is 1° 27′ 11″ S. (The town of Macapa, on the north mainland, is situated almost exactly on the Equator.) The area of the municipal district of Belem is 3,435 square miles, and the population, as shown above, was 236,402 in 1920. The population of the city proper is between 120,000 and 150,000. The highest elevation within the city is only 38 feet.

The electric light and tramways service is operated by the Para Electric Railways & Lighting Co. (Ltd.), an English concern. The city is well covered by several tram lines and the service is very satisfactory. The telephone system is owned by the Para Public Works Co. (Ltd.), also an English enterprise. The water supply is derived from the locality of Utinga, about 5 miles outside the city limits, where two streams have been dammed for the purpose. The water is of good quality, but its distribution is defective. Many of the streets are paved—with cobblestones, there being no asphalt paving.

The city has several good hotels; 4 daily newspapers; 18 elementary schools (30 more within the municipal district), a high school for boys, and a training school for teachers; 2 public museums of high order; a large State theater; and several motion-picture theaters. Among the industries of Para and immediate vicinity are several sawmills, a vegetable-oil mill, button factory, rubber-washing plant, fruit canneries, soap factories, ropewalks, brewery, cigarette factories, furniture factories, and tanneries.

LABOR

The element which is engaged in working rubber on the islands, in taking out logs or collecting oilseeds among the furos (arms or side channels), in caring for the herds of cattle on Marajo or the campos of Macapa, or in agriculture on the mainland is very largely composed of natives of the State of Para. There is a sprinkling of people from Maranhao and Piauhy and some Cearenses. Racially the natives are the usual mixture of white, negro, and Indian, with the negro factor more prominent here than in the country above the

delta. Their characteristics as laborers differ little from those of their fellows farther in the interior, except as they are affected by the special conditions of their environment.

The natural environment of the zone of the islands, especially in the region of the furos, is highly unfavorable to human existence. The low islands that make up the land surface are covered with a dense forest growth and during most of the year are inundated. Even during the summer the land is never dry; the forest remains damp, and much of it is flooded daily by the tide. Between this humid and gloomy jungle and the muddy furos, the native leads a miserable, half-amphibious existence, ill-nourished as a rule, persecuted by mosquitoes, and sleeping in a frail, palm-thatched hut set on the muddy banks or perched a little above the high level of the annual or daily flood. On the mainland living conditions are generally much better.

With the inducement of better living conditions on the upper rivers, it should be possible, without great difficulty, to recruit as many as 10,000 laborers within this area, though a short preliminary period of medical treatment would be required before some of them could become efficient workers.

HEALTH AND SANITATION

DISEASES

MALARIA

Malaria occurs widely over this area and few localities are entirely free from it. Though very infrequent in the central part of the city of Para, it appears in virulent form in the outskirts, inhabited by the poorer classes. The total mortality from malarial fever in the municipal district of Belem (Para) during the years 1910 to 1921 was as follows:

	Deaths		Deaths
1910	885	1916	719
1911	713	1917	542
1912	809	1918	382
1913	708	1919	289
1914	715	1920	345
1915	785	1921	405

Malaria is even more prevalent in the country bordering the Braganca Railway and in the jungle of the islands. Places such as Breves in the furo region are veritable centers of infection, whereas a short distance up the same channel at the lumbering village of Antonio Lemos we observed no signs of fever. The town of Macapa, on the mainland to the north of the main channel of the Amazon, though built on high ground, suffers from the presence of low, swampy ground in its vicinity. The population of that place had a particularly unhealthy appearance. However, the vast campos country that stretches away northward to the Guianas is notably healthful. The Soure district on the east side of Marajo Island and the coast belt about Salinas are not only free from malaria but are the most generally healthful sections of all this region.

HOOKWORM

Hookworm plays a most serious rôle. According to the report of the Federal Health Service in the State for 1922, "hookworm is

a plague which advances day by day in the country districts, leaving nearly all the population wasted and enfeebled, the almost universal practice of going barefoot, among other causes, contributing to its spread." The same report gives the percentage of those suffering from hookworm in different districts as follows:

	Per cent
Braganca	59.6
Igarape-assu and Quatipuru	96.6
Salinas	58.4
Chaves	92.2
Oyapock	98.5

In the outskirts of the capital over 80 per cent were found to have hookworm. Classified according to ages, the percentage was:

	Per cent
Under 5 years	62.7
6 to 18 years	84.7
19 to 40 years	80.7

Tests according to race showed the following results:

	Per cent
Whites	79.23
Mixed	77.57
Negroes	86.52

It is estimated that at least 80 per cent of the inhabitants of the State as a whole have hookworm.

OTHER DISEASES

Gastric and enteric fevers are responsible for heavy infant mortality; deaths from this cause in Para during the year ended June 30, 1923, numbered 814.

The State of Para has been free from yellow fever since 1911. However, the reappearance of the stegomyia mosquito in Para later furnished a possible medium for transmission, in case the disease should be introduced from the outside, and in 1923 the Rockefeller Foundation undertook its extermination. This work has since been progressing rapidly and the city is now being freed from this possible danger to its health.

Considerable tuberculosis exists in this region, and in the city of Para deaths from this cause during the period 1910–1921 ranged from 441 (1910) to 811 (1918), with an average of 567 a year. Diphtheria appears frequently in Para, but not in so grave a form as in cooler climates. There is little smallpox here, though cases are now and then brought in by steamers from other parts of Brazil.

Leprosy is widely prevalent; 2,025 lepers were reported in the State of Para during 1923 by the Public Health Service, and undoubtedly many more escaped the vigilance of its agents. The government has taken steps to gather the lepers from all over the State and isolate them in the special colony known as the Lazaropolis, or Instituto do Prata.

MEDICAL FACILITIES

The National Department of Public Health maintains a branch of its service in the State of Para under the title "Serviço de Saneamento e Prophylaxia Rural no Estado do Para." The chief is a

highly competent specialist and is aided by a corps of trained physicians. Posts for the treatment of malaria, hookworm, and other diseases are maintained in the municipality of Belem and at several other points in the region under survey. One of the most important phases of its work is the extermination of mosquitoes, especially in the capital. The Prophylaxia also maintains in Para laboratories equipped for biological analysis.

The city of Para is well supplied with hospitals; among them are the Santa Casa de Misericórdia, maintained by a charitable organization, and the hospital of the Sociedade Portugueza Beneficente. There is also a Pasteur Institute, a special hospital for smallpox cases, and another for the isolation of highly contagious diseases, the first two being under the administration of the Department of Public Health. Finally the Tertiary Order of St. Francis maintains a hospital with 100 beds.

In 1922 98 physicians were registered in the State capital, but outside the city physicians are extremely rare, except where the Prophylaxia Rural has its posts.

VEGETATION

The predominant vegetation of this region is that of the varzea, or lowlands. The charactertistic trees of the terra firme (upland) jungle of the upper rivers are wholly absent or appear on the higher ground well up the streams that flow into the Rio Para from the south. Most of the typical trees of the interior uplands are missing. However, there is a great variety of forms, many of them peculiar to the delta.

The principal trees of this area are included in the following list:

Ciriuba (*Avicennia nitida*). Black mangrove.
Faveira amarella (*Vatairea guianensis.*) Grows in flooded forest. Wood of yellowish color. Used in building.
Jaboty (*Erisma calcaratum*). Common in delta lowlands. Coarse wood of reddish-white color.
Churu (*Goeldinia riparia*). Wood of a slight rose color. Used for box shooks, etc.
Anauera (*Licania macrophylla*). Hard, dark wood. Used in civil and naval construction.
Parinari (*Parinarium* sp.). Hard, dark-red wood.
Mututy branco (*Pterocarpus draco* and *P. amazonicus*). White, soft wood. Suitable as material for wood pulp.
Iperana (*Crudya pubescens*). Reddish wood of medium hardness.
Aturia (*Drepanocarpus lunatus*). Heavy yellowish wood.
Pracachy (*Pentaclethra filamentosa*). Reddish wood. Tree produces large quantities of oil-bearing seeds.
Ucuuba (*Virola surinamensis*). White wood, easily worked. Produces seeds rich in oil used for soap making.
Mauba (*Acrodiclidium mauhuba*). Dark-yellow or brownish wood, easily worked. Used for planking and for making canoes.
Tamacoare (*Caraipa* sp.). Grayish to reddish wood.
Caju-assu (*Anacardium giganteum*). White wood suitable for manufacture of paper. Tree attains good dimensions.
Sumaumeira (*Ceiba pentandra*). This is the familiar sumauma, or kapok tree, of the Amazon varzeas. Tree grows to gigantic size. Soft, white wood.
Cedro (*Cedrela* spp.). The common cedar found widely over the Amazon Valley. Commercially most important wood of region.
Tapereba (*Spondias lutea*). Soft, white wood. Could be used for paper manufacture.

Envira branca (*Xylopia* sp.). White, light-density wood. Suitable as material for wood pulp.

Cupuassurana (*Matisia parensis*). Soft, whitish wood, also suitable for paper making. Bark produces a very strong fiber.

Quaruba (*Vochysia* sp.). Wood of a faint rose color. Used for box making, etc.

Inajarana (*Quarariba guianensis*). Light, white wood, suitable for paper making.

Jacareuba (*Calophyllum brasiliense*). Tree grows to large size. Wood dark reddish brown, somewhat resembling cedar, but heavier. Wood employed for many purposes.

Jatuauba (*Guarea trichilioides*). Reddish wood, similar to cedar but lighter in color. Used for planking and box material. Also called cedro rana.

Louro branco (*Ocotea guyanensis*). Also called louro tamancão, because of use in manufacture of sandals. White wood.

Macacauba da varzea (*Platymiscium paracnse*). Tree grows to considerable size and is abundant. Wood reddish brown, with wide streaks. Easily worked. Strong and resistant. Much used in furniture making and interior finishing.

Marupa (*Simaruba amara*). Large tree found on terra firme. Light, white wood, easy to work. Much valued because immune to attacks of termites, due to bitterness of wood.

Maparajuba da varzea (*Mimusops parajuba*). Heavy, dark-reddish wood, used in civil construction.

Pitaica (*Swartzia acuminata*). Also called paracutaca. Medium-weight, white wood.

Paracahuba das Ilhas (*Dimorphandra paraensis*). Also called paracahuba vermelha. Large, lowland tree; light brownish wood. Very resistant. Used for sleepers and other purposes.

Sapupira de varzea (*Diplotropis* sp.). Very resistant wood. Used for sleepers.

Tacacazeiro (*Sterculia specciosa*). White, light wood, suitable for paper manufacture.

Andiroba (*Carapa guianensis*). A well-known and widely distributed wood, brownish in color, resembling cedar, but heavier and of many applications. Tree produces valuable oilseed.

Acapu (*Vouacapoua americana*). Terra firme tree of medium size. Wood turns black on exposure to air and is hard and durable. Much sought after as material for flooring and other purposes.

Pao amarello (*Euxylophora paraensis*). Yellowish-white wood of regular grain, easily worked. Widely used for flooring in which boards are alternated with acapu and for interior finishing.

Frei-jo (*Cordia Goeldiana*). Also called frei jorge. Grayish-brown wood, somewhat resembling walnut, of excellent qualities and easily worked. Used widely in naval construction, furniture making, etc.

Mangue vermelho (*Rhizophora mangle*). This is the mangrove tree, found on the shores of the delta region wherever the movement of the tide is marked. The bark is used locally for tanning leather.

Mata-mata (*Eschwellera matamata*). Heavy, brown wood, much sought for sleepers and piling. Not attacked by ants or teredos.

There is a great wealth of palms in this region, including the mirity or burity, the inaja, the assahy, and the murumuru. The coconut palm is cultivated in many places and gives good results, especially on the east side of Marajo and the coast of the mainland.

WILD RUBBER

From the standpoint of the object of this survey, Region 1 is the least important of any area examined, notwithstanding the fact that it has better transport facilities direct to the United States and Europe and is near the largest city of the Amazon Valley. Of the whole State of Para the production of the island section was 20 per cent in 1922, and that of the north bank of the Amazon 9 per cent, Region 1 therefore furnishing 29 per cent of the State's total production for that year.

In general the appearance of the trees is the poorest of any encountered in the investigation; they are small in both girth and height, the crowns are poorly developed, and the leaves yellow and sickly looking. An exception to this was noted at Macapa, on the north bank of the Amazon; the land here is mainly open grassland, but good jungle grows along the creeks and small rivers coming down from the north. On one such place there was seen a clump of splendid *Hevea brasiliensis* growing under very favorable conditions as regards soil and moisture. One of these trees measured 14 feet 7 inches in girth and was about 100 feet tall, with two others of large size near by. The trees in the region of Macapa are much scattered, growing only in such places as described and also along the bank of the Amazon itself, where, of course, more trees exist.

Many trees were inspected at Antonio Lemos and Breves, and while some of them were of fairly good size they did not have a vigorous appearance.

At Abaete, near the mouth of the Tocantins, there are a few planted trees of very good appearance. The oldest of these, over 25 years old, had a girth measurement of 6 feet. The wild trees along the banks of the various waterways were inferior in appearance. It was stated that there existed a "plantation" a few miles inland with trees 10 years old, and the size indicated was 18 to 20 inches in girth.

Wild rubber exists along the banks of the Moju River in both its lower and its upper reaches, also on the uplands, where, according to local information, the trees are of large size and are evidently an extension of the rubber-bearing area of the Tocantins. Some of the planted trees on a property in this vicinity are of fair size and good appearance. The trees inspected by the field party were planted on a low, tight soil unsuitable for rubber, though there is suitable soil in abundance a short distance up the river.

MARKET GRADES

Methods of gathering and preparation of rubber are, in principle, the same as described at page 22. It does not have the same care and attention, however, as is given to its preparation on the upper rivers.

On the market of Para the rubber from this district is considered a "fine" rubber and is classified as "islands fine." The balls do not have the firm feel and symmetrical form of the interior upriver rubber, but are softer and tend to flatten out; the term "biscuit" better describes their appearance. Due to this characteristic "islands" is not considered so desirable as the hard-cured upriver product and commands a lower price.

The main reason for its condition is that it is marketed soon after preparation, usually within two or three weeks, and has not had the time to thoroughly dry out as is the case with the upriver rubber. Also, in a minor degree, it may be due to a poorer physical condition of the trees, standing as they do a large part of the time with their roots in water. In other words, many of the trees suffer from a superabundance of moisture, which possibly would tend to make the rubber somewhat soft. In other cases trees are growing in a poor and unsuitable soil.

The delta region is the receptacle for seed floated down the river from the whole Amazon Valley, and it is reasonable to believe that

the trees are a mixture of many varieties. Whether or not this fact would have anything to do with the quality of the rubber produced can not be said, but it would appear probable.

PRODUCTION

In this area most of the rubber is gathered by small individual landowners or "squatters" who tap and prepare the rubber, not as a main line of endeavor, but as a side issue to help augment their income for the purchase of a few necessities of life. Their main occupation is hunting, fishing, and cultivation of small farms or gardens. The few large proprietors who own estradas rent them out, as explained on page 26.

The data on production which follow are divided into (*a*) mainland north of the delta and (*b*) the islands of the delta. The population in 1920 of the municipalities composing the first of these divisions was:

	Population
Macapa	18,387
Mazagao	12,058
Montenegro	6,032
Total	36,477

The production of rubber in this region is shown in the following table:

TABLE 19.—RUBBER PRODUCTION, MAINLAND NORTH OF DELTA, 1903–1922

[Quantities in metric tons of 2,204.6 pounds]

Years	District				State of Para	District's percentage
	Macapa	Mazagao	Montenegro	Total		
1903	517	572	24	1,113	10,282	10.8
1904	577	681	26	1,184	10,973	10.8
1905	705	573	18	1,296	10,691	12.1
1906	569	539	32	1,140	11,012	10.3
1907	467	481	38	986	9,671	10.0
Total	2,835	2,746	138	5,719	52,629	
Per cent of State production	5.4	5.2	0.2	10.8	100.0	10.8
1908	474	499	38	1,011	9,963	10.1
1909	425	530	37	992	10,153	9.7
1910	398	441	35	874	9,512	9.2
1911	369	431	35	835	9,186	9.1
1912	350	445	17	812	9,230	8.8
Total	2,016	2,346	162	4,524	48,044	
Per cent of State production	4.2	4.9	0.3	9.4	100.0	9.4
1913	536	369	26	931	8,752	10.6
1914	368	331	28	727	7,748	9.4
1915	424	353	21	798	7,746	10.3
1916	438	355	20	822	8,315	9.9
1917	347	313	20	680	8,047	8.4
Total	2,113	1,721	124	3,958	40,608	
Per cent of State production	5.2	4.2	0.3	9.7	100.0	9.7
1918	280	259	13	551	6,578	8.5
1919	267	211	18	496	6,716	7.4
1920	170	108	13	291	5,475	5.3
1921	186	125	5	316	4,265	7.5
1922	280	80	5	365	4,017	9.1
Total	1,192	783	54	2,029	26,991	
Per cent of State production	4.4	3.0	0.2	7.6	100.0	7.6

The second division comprises (census of 1920):

	Population
Affua	9,850
Anajas	11,859
Breves	22,678
Chaves	18,461
Curralinho	7,692
Muana	12,579
Ponta de Pedras	6,683
Sao Sebastiao de Boa Vista	4,249
Total	94,051

The production of rubber in this area is shown in the following table:

TABLE 20.—RUBBER PRODUCTION, ISLANDS, 1903–1922

[Quantities in metric tons of 2,204.6 pounds]

Years	District									State of Para	District's percentage
	Affua	Anajas	Breves	Chaves	Curralinho	Muana	Ponta de Pedras	S. Sebastiao	Total		
1903	476	971	1,352	234	468	180	35	149	3,865	10,282	37.6
1904	523	1,026	1,349	269	506	277	45	130	4,125	10,973	37.6
1905	519	934	1,205	235	405	313	32	122	3,765	10,691	35.2
1906	552	972	1,203	247	455	338	29	119	3,915	11,012	35.4
1907	492	821	1,003	241	353	226	40	72	3,248	9,671	33.6
Total	2,562	4,724	6,112	1,226	2,187	1,334	181	592	18,918	52,629	-------
Per cent of State production	4.9	8.9	11.6	2.3	4.1	2.5	0.5	1.1	35.9	100.0	35.9
1908	478	836	994	210	378	237	38	102	3,273	9,963	32.8
1909	490	826	1,028	239	306	270	47	122	3,418	10,153	33.6
1910	461	770	959	188	319	184	36	116	3,033	9,512	31.8
1911	449	759	873	194	294	165	82	101	2,887	9,186	31.4
1912	420	685	866	150	205	343	43	77	2,849	9,230	30.8
Total	2,298	3,876	4,720	951	1,652	1,199	246	518	15,460	48,044	-------
Per cent of State production	4.7	8.1	9.8	2.0	3.4	2.4	0.5	1.1	32.0	100.0	32.0
1913	374	633	687	196	217	253	36	82	2,478	8,752	28.3
1914	357	559	664	176	187	155	14	63	2,175	7,748	28.1
1915	335	487	604	256	192	219	43	33	2,169	7,746	28.0
1916	358	534	633	308	250	224	47	98	2,452	8,315	29.5
1917	337	511	608	244	234	215	54	66	2,269	8,047	28.2
Total	1,761	2,724	3,196	1,180	1,080	1,066	194	342	11,543	40,608	-------
Per cent of State production	4.3	6.7	7.9	2.9	2.6	2.6	0.5	0.9	28.4	100.0	28.4
1918	282	482	442	204	162	147	32	27	1,778	6,578	27.1
1919	221	453	342	214	156	154	43	61	1,644	6,716	24.5
1920	154	246	221	138	117	99	18	38	1,031	5,475	18.8
1921	131	170	155	115	70	107	23	39	810	4,205	19.2
1922	139	163	150	107	35	154	21	64	833	4,017	20.7
Total	927	1,514	1,310	778	540	661	137	229	6,096	26,991	-------
Per cent of State production	3.5	5.4	5.0	2.9	2.0	2.4	0.5	0.9	22.6	110.0	22.6

Combining the figures of these two tables gives the following total production of rubber in Region 1 for the years named (quantities in metric tons of 2,204.6 pounds):

TABLE 21.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 1, 1910–1922

Years	Mainland north of delta	Islands	Total, Region 1
	Tons	*Tons*	*Tons*
1910	874	3,033	3,907
1911	835	2,887	3,722
1912	812	2,849	3,661
1913	931	2,478	3,409
1914	727	2,175	2,902
1915	798	2,169	2,967
1916	822	2,452	3,274
1917	680	2,269	2,949
1918	561	1,778	2,339
1919	496	1,644	2,140
1920	291	1,031	1,322
1921	316	810	1,126
1922	365	833	1,198

OTHER INDUSTRIES AND RESOURCES

AGRICULTURE

The principal agricultural crops of this region are sugar cane, mandioca, rice, corn, tobacco, cotton, and cacao.

There are numerous small sugar mills, whose aggregate production of low-grade sugar is considerable, though inadequate for the needs of the State, which still imports sugar from Pernambuco. A mill organized on modern lines should do a very good business. Large areas of land suitable for the growing of cane are to be had, and home and foreign markets should easily absorb the output of such a mill.

Rice is grown in increasing quantities on the alluvial lands of the district, and considerable quantities are shipped out of the State, which until very recently was an importer of rice.

Strong tobacco is an important crop in the zone of the Braganca Railway and in the valleys of the Guama and Acara Rivers. The product is largely utilized in the manufacture of cigarettes by several factories in Para or is shipped over the Amazon Valley in compact rolls. Para cigarettes have a wide sale as far as Bolivia.

Though the industry has not assumed such proportions as in eastern Peru or in the northeastern coast States of Brazil, increasing attention is being paid to the growing of cotton on the mainland immediately tributary to Para.

LIVESTOCK

The campos of Marajo furnish grazing grounds for about half a million head of cattle, which supply the local Para market with meat. The basis of the herds was formed by the old creole stock of colonial days, since much degenerated, but now being bred up by the introduction of zebus. The industry is one of the most prosperous in the State of Para. It is estimated that between 30,000 and 40,000 head of cattle are grazing on the mainland campos between the Macapa coast and the Araquary River.

The State maintains a modern abattoir at Maguary, a few miles from Para, on a spur of the Braganca Railway. Near the same place an American firm operates a modern tannery, which produces an ex-

cellent quality of leather. Mangrove is used as tanning material. There are several tanneries of lesser importance in the region.

OILSEEDS AND NUTS

An effort has lately been made to utilize the vast quantities of oilseeds that exist in the lower Amazon region. Due partly to the high import duties levied on vegetable oils in many consuming countries, the tendency is to ship the seeds rather than the finished product. This is the case of two important concerns now engaged in the business—Turchi & Co., with a large plant on the low Ilha das Oncas across the river from the city of Para, and Merling & Co., whose establishment is just outside Pinheiro and a short distance down river from Belem.

Berringer, Ohliger & Co. are erecting a mill at Breves in the furo region for the manufacture of oils from whatever raw materials are available. A very substantial large brick building is being put up, and oil-extracting machinery of German manufacture is being installed. Engines and boilers are of American make. The Abaete firm of Garibaldi & Co. produces oil from andiroba and ucuuba seeds, using the oil for the manufacture of soap. Large quantities of laundry soap are also made by a Para company, whose product is widely sold all over the Amazon Valley. Small quantities of various vegetable oils are prepared at Jararaca in the furo region.

TIMBER

Most of this region is heavily wooded. The exceptions are those districts where the land has been cleared for agriculture and the campos of Marajo and Macapa. The islands are covered with jungle to the water's edge, the denseness of this jungle depending much on the age of the land and the extent to which it is flooded. In certain parts it is remarkably light, with few large trees, as in the neighborhood of Breves. In other parts, especially to the north and well off the regular steamer channels between Para and Manaos, the jungle is high and dense, forming great walls of dark forest that overhang the deep furos of that region. In the mainland country to the south the vegetation is generally much lighter than on the islands of the delta. Along the streams of the Abaete and Igarape-Miry districts, as on the Tocantins estuary, palms, especially the burity, exist in vast numbers, in many places giving a special cast to the whole forest.

A considerable lumbering industry is being developed on the basis of the forest resources of this area, particularly in the region of the furos and along the main river channels to the west of Marajo. However, no effort is made to utilize more than the trees found near the edges of the watercourses. Part of this business is devoted to the shipping of logs, which are exported to Europe (generally to England, Germany, or Italy), to southern Brazil, or to the River Plate. We also saw one lot of logs destined to be used as cigar-box material in the United States. Ocean steamers taking on cargoes of logs are now a familiar sight in the delta.

A local lumbering business is also being built up and has already become one of the two principal economic supports of the delta area, the other being the collection of oilseeds. Moreover, the industry is

capable of great expansion, provided the timber back from the edge of the streams can be worked. In addition to the sawmills in the city of Para and at several other points, there is a mill at Abaete that appears to be doing an excellent business in working the light and medium woods of the locality, especially for the manufacture of box shooks. We saw one consignment of shooks ready for shipment to Mexico to be used for oil cases. The Para mills are largely devoted to the production of cabinet materials for the local furniture industry and to turning out a wide variety of general construction materials.

TRANSPORTATION AND COMMUNICATION

Para is 3,517 miles distant from New York, 1,484 miles from Barbados, 3,761 miles from Lisbon, 1,403 miles from Pernambuco, and 2,662 miles from Rio de Janeiro—to name only a few of the important places with which this port has ocean-steamer connection.

By river Santarem is 475 miles from Para, Manaos 865 miles, and Iquitos (Peru) 2,040 miles.

OCEAN

The following companies operate steamer services between Para and foreign countries:

1. *Booth Steamship Co. (Ltd.)*.—Maintains the following lines, Para being a port of call in each case:

"*A*" *Line.*—Passenger steamers leaving Liverpool once a month for Havre, Leixoes, Lisbon, Madeira, Para, and Manaos, connecting with river service for Iquitos, returning homewards by the same route and receiving cargo for the ports mentioned.

"*B*" *Line.*—Cargo steamers with accommodations for passengers, from Liverpool for Havre, Leixoes, Lisbon, Ceara, Tutoya Bay, Maranhao, and Para, connecting in Para with other steamers of the same company which bring cargo from Manaos; loading homewards for Portuguese Atlantic islands, Portugal, Havre, Belgium, Holland, Hamburg, and London.

Long "*D*" *Line.*—From New York to Para, Maranhao, Ceara, Natal, Cabedello, Pernambuco, and Maceio. Loading homewards at above-named ports, going up to Manaos and returning to New York.

Short "*D*" *Line.*—New York to Para, Ceara, Maranhao, Para, and Manaos, loading for New York at all ports.

Long "*D*" *and* "*FE.*"—From New York for Pernambuco, Maceio, Bahia, Victoria, Rio de Janeiro, Santos, Paranagua, Sao Francisco do Sul, Florianopolis, and Rio Grande do Sul, loading at all these ports and generally coming as far as Para, where they receive cargo for New York.

2. *Lamport & Holt.*—Operate a line of freighters between New York and the River Plate, touching at Para and going up the Amazon to Manaos.

3. *Pacific-Argentine-Brazil Line.*—Operates freight services between Seattle, San Francisco, and other Pacific ports of the United States and east-coast ports of South America, including Para, via the Panama Canal.

4. *Hamburg-South American Line (Hamburg Sudamerikanische Dampfschiffahrts Gesellschaft).*—Operates freight service between Manaos and Para and Hamburg, calling at Lisbon, Leixoes, Rotterdam, and Antwerp. The ships also have accommodations for a few passengers.

5. *Transatlantica Italiana.*—Operates freight and passenger service between Genoa and Valparaiso via the Panama Canal, touching

at Marseille, Barcelona, Alicante, Malaga, Cadiz, Teneriffe, and Para.

6. *Baltic-South American Line.*—Operates a line of freighters between Copenhagen and Hamburg and South American ports, calling at Para.

7. *Lloyd-Brasileiro.*—Operates two lines of mixed cargo and passenger boats between Rio de Janeiro and European ports, both of which include Para among their ports of call. Liverpool and Hamburg are the respective destinations of these two lines. The Lloyd-Brasileiro operates another line between Rio de Janeiro and New York, via Para.

COASTWISE

The following companies are engaged in coastwise navigation between Para and the coast of southern Brazil:

1. *Lloyd-Brasileiro.*—Operates weekly freight and passenger service between Manaos and Para and Rio de Janeiro, calling at Sao Luiz, Ceara, Natal, Cabedello, Pernambuco, Maceio, Bahia, and Victoria. In addition to this service, in which packets are engaged, there is a frequent freight service by larger ships. The Lloyd also operates a line between Para and Montevideo.

2. *Companhia Nacional de Navegação Costeira.*—Operates weekly freight and passenger service between Para and Porto Alegre, with stops at Sao Luiz de Maranhao, Ceara, Natal, Parahyba, Pernambuco, Bahia, Rio de Janeiro, Santos, and Pelotas. Sailings are on Saturdays. The voyage from Para to Rio de Janeiro consumes 12 days and to Porto Alegre 21 days. The steamers are small, but the service and accommodations are good, and the boats are noted for the punctuality with which their schedules are observed.

Lage Irmãos, of Rio de Janeiro, who control this company, recently acquired the ships of the Lloyd-Nacional, which now operates a monthly freight service between Para and coast ports as far as Porto Alegre and Montevideo. The two companies are shortly to be amalgamated under the name of the Companhia Brasileira de Navegação.

3. *Companhia Commercio e Navegação (Pereira Carneiro & Cia).*—Operates a frequent freight service between Para and Rio de Janeiro.

RIVER

The Amazon River Steam Navigation Co. (1911) (Ltd.) is a joint-stock company, formed in London, and domiciled in Brazil by decree No. 9019, of October 18, 1911. The head office is fixed in the city of Para. The company is owned by the "Port of Para." The capital stock is £300,000. There have been two emissions of debentures, one of £264,640 and another of £1,315,000. Dr. Guilherme Paiva is its general manager, and occupies the same position in the administration of the "Port of Para." There are special agents of the company at Manaos, Porto Velho, and Iquitos, a superintendent in charge of the Purus station, and a traveling inspector.

The company inaugurated its navigation services on November 1, 1911, and in August, 1912, signed a contract with the Federal Government of Brazil to maintain for a period of 10 years the subsidized navigation of the Amazon and its tributaries. This contract

expired in August, 1922, but no definite contract has yet been made for the continuance of the navigation lines. However, at the request of the Government, the company agreed to continue the service without interruption under a provisional agreement, which expired on December 31, 1923.

RIVER SERVICES UNDER GOVERNMENT AGREEMENT

The navigation lines maintained under the provisional agreement with the Federal Government comprise:

Starting from Para

Madeira Line.—Two voyages per month; sailing dates, 7th and 21st; terminal point, Porto Velho; duration of voyage, 35 days; ports of call, Gurupa, Almeirim, Prainha, Monte Alegre, Santarem, Alemquer, Obidos, Parintins, Manes, Urucara, Silves, Itacoatiara, Manaos, Borba, Vista Alegre, Boa Vista, Santa Rosa, Manicore, Bom Futuro, Bocca do Carapanatuba, Bocca das Tres Casas, Cintra, Humayta, Missao de S. Francisco, Boa Hora, Bocca do Jamary, and Porto Velho.

Purus-Acre Line.—One voyage per month; sailing date, 14th; terminal points, Cachoeira (April–October) and Bocca do Acre (November–March); duration of voyage, 32 and 38 days, respectively; ports of call, Santarem, Obidos, Parintins, Juruty, Faro, Itacoatiara, Manaos, Manacapuru, Bocca do Purus, Berury, Guajaratuba, Piranhas, Itaituba, Arima, Tauaria, Jaburu, Bocca do Tapaua, Caratia, Canutama, Bella Vista, Urucury, Assahytuba, Labrea, Providencia, Sepatiny, Hyutanaham, Cachoeira, Bocca do Acre (by stern-wheel steamers to Senna Madureira, Empreza, Xapury, Cobija, etc.).

Solimoes-Javary and Iquitos Line.—One voyage per month; sailing date, 28th; terminal point, Iquitos; duration of voyage, 42 to 45 days; ports of call, Santarem, Obidos, Parintins, Itacoatiara, Manaos, Manacapuru, Codajaz, Coary, Teffe, Caicara, Fonte Boa, Tonantins, Sao Paulo do Olivenca, Remate de Males, Tabatinga, and Iquitos.

Oyapock Line.—One voyage per month; sailing date, 3d day after new or full moon; terminal point, Oyapock; duration of voyage, 12 days; ports of call, Chaves, Bailique, Amapa, Calsoene, Counany, and Oyapock.

Tapajoz Line.—One voyage every other month; sailing date, 15th; terminal point, Itaituba; duration of voyage, 12 days; ports of call, Breves, Antonio Lemos, Gurupa, Porto de Moz, Almeirim, Prainha, Monte Alegre, Santarem, Alemquer, Boim, Aveiro, Brasilia Legal, Urucurituba, and Itaituba.

Pirabas Line.—One voyage every other month; sailing date, day of new or full moon; terminal point, Pirabas; duration of voyage, 8 days; ports of call, Collares, Porto Salvo, Vigia, S. Caetano, Curuca, Marapanim, Maracana, Salinas, and Pirabas.

Starting from Manaos

Rio Negro Line.—One voyage per month; sailing date, 1st; terminal point, Santa Isabel; duration of voyage, 12 days; ports of call, Tauapessassu, Ayrao, Moura, Carvoeiro, Barcellos, Moreira, Thomar, and Santa Isabel.

Jurua Line.—One voyage per month; sailing date, 17th; terminal point, Cruzeiro do Sul and Villa Seabra; duration of voyage, 20 days; ports of call, Teffe, Bocca do Jurua, Marary, S. Felippe, and Villa Seabra on the Tarauaca.

Stern-wheel Steamer Service

Purus-Acre Line.—November-April—four voyages per month; ports of call, Bocca do Acre, Senna Madureira, Empreza, Xapury, Cobija, etc. May–October—two voyages per month; ports of call, Bocca do Acre, Empreza.

Alto Jurua and Tarauaca Line.—Two voyages per month; ports of call, Cubio, Marary, Sao Felippe, Cruzeiro do Sul, and Villa Seabra.

FLEET OF AMAZON RIVER STEAM NAVIGATION CO.

There are three general types of steamers in service; first, the large 2-funnel Dutch-built boats, used on the Iquitos, Madeira, and Purus lines; second, the intermediate steamers of the gaiola type,

used in nearly all the Amazonian rivers; and, third, the stern-wheelers, or chatas, which somewhat resemble our Mississippi River steamboats and are employed in the upper and shallower reaches of such rivers as the Acre and Tarauaca. In general these steamers are well adapted to the needs of the service. Accommodations and food are good, and the service, both freight and passenger, is very satisfactory.

The fleet of the company is represented by the following list of steamers of different types:

TABLE 22.—FLEET OF AMAZON RIVER STEAM NAVIGATION CO.

Name of vessel	Type	Net tonnage	Freight capacity
STEAMERS			*Packages*[1]
Ajudante	Twin-screw	187	3,000
Andira	do	212	5,000
Aymore	do	294	7,800
Belem	do	625	16,000
Bello Horizonte	do	625	16,000
Campinas	Sternwheeler	98	1,500
Cassipore	Twin-screw	280	5,835
Curityba	Sternwheeler	98	1,500
Cuyaba	Twin-screw	625	16,000
Diamantina	Sternwheeler	98	1,500
Districto Federal	Twin-screw	625	16,000
Fortaleza	do	625	16,000
Inca	Sternwheeler	275	3,750
Indio do Brazil	Twin-screw	290	7,620
Itacontiara	Sternwheeler	98	1,500
Nictheroy	do	98	1,500
Olinda	do	98	1,500
Oyapock	Twin-screw	203	5,940
Paes de Carvalho	do	438	6,885
Parnahyba	Sternwheeler	98	1,500
Petropolis	do	98	1,500
Rio Mar	Twin-screw	444	10,000
Sao Salvador	do	625	16,000
Sapucaia	do	301	8,115
Sorocaba	Sternwheeler	98	1,500
Teffe	Twin-screw	212	4,965
Therezina	Sternwheeler	98	1,500
Tucunare	Twin-screw	167	2,500
Tupy	do	294	7,800
Uruguayana	Sternwheeler	98	1,500
Victoria	Twin-screw	625	16,000
TUGS, ETC.			
Ernestina	Steam tug	210	----------
Geoff	do	20	----------
Officinas	do	2	----------
Para	Motor launch	2	----------
Alba	do	3	----------
OIL LIGHTERS			*Tons*
Cumina	Lighter	560	[2] 1,000
Rio Negro	do	563	[2] 1,000
Trombetas	do	560	[2] 1,000
HULKS, LIGHTERS, ETC.			*Packages*[1]
Javary	Hulk	429	450
Joao Alfredo	do	503	533
Bahia	Lighter	----------	100
Cangusso	do	----------	750
Despacho	do	----------	450
Entrega	do	----------	450
Marreca	do	----------	210
Alagoas	do	----------	180
Papagaio	do	----------	100
Periquito	do	----------	100
Preguica	do	----------	80
Tigre	do	----------	120
Mutum	do	----------	210

[1] The "packages" referred to represent an average weight of 50 to 60 kilos, or 110 to 130 pounds.
[2] Tons of oil.

RIVER SERVICE OF PRIVATE LINES

A number of private operators, generally commercial houses, operate boats out of Para and up the different Amazonian rivers. Among operators of this class are Ferreira Costa & Co., Nicolau da Costa & Co. (Jurua), Bitar Irmãos (Tocantins, Xingu, Purus), Jose Antunes & Co. (Empreza de Navegação a Vapor do Tapajoz), A. Borges & Co. (Tocantins), Antonio Moraes (Tocantins), Jose Porphirio de Miranda, jr. (Xingu), and E. Pinto Alves & Co. (lower Amazon).

Also a great number of launches and other small craft ply out of Para among the islands of the delta and up the small rivers of this region.

RAILWAY

The only railway in this region is the one from Para to Braganca, a distance of 145 miles. The main line is of meter (3.28-foot) gauge. Including branches and sidings, the total of meter track is 169 miles, and of 60-centimeter (23.6-inch) track 25 miles. In addition to this there are 5.5 miles of 1.45-meter gauge line from the Benevides station to Bemfica, on which mule-drawn cars are used. There are 18 stations in all on the main line.

For service on the main line and meter-gauge branches the road possesses 26 locomotives, all of American make. The cars used in this section are as follows: Inspection, 4; passenger, first-class, 14; second-class, 9; mixed, 2; baggage, 3; hospital, 1; freight, closed, 30; gondola, 11; flat, 16; inflammables, 2; stock, 2; miscellaneous, 5. On the 60-centimeter branches there are 5 Decauville engines, 3 passenger cars, and 6 freight cars of different types.

The whole line, including rolling stock, roadbed, and track material, is in need of overhauling. To put the road in good working condition will require among other things the replacement of a large number of rails and ties. Provision is made for these improvements in the plan for reorganization described below.

REORGANIZATION OF BRAGANCA RAILWAY

Under decree No. 15563, of July 18, 1922, the Federal Government acquired the Braganca Railway from the State of Para for a consideration of 17,000,000 milreis; 5,000,000 milreis of this to be spent on improvements, the remaining 12,000,000 milre used in liquidating several other pressing obligations of the By the same arrangement the Federal Government agrees to le road back to the State. The Federal Government is to receive cent of the net income. The following improvements and purc of materials are prescribed:

1. Rails and accessories for 54 miles of track.
2. Rolling stock as follows: Locomotives, 2; closed freight cars (20 tons capacity), 8; stock cars (20 tons capacity), 2; flat cars (20 tons capacity), 10; first-class passenger cars, 1; second-class passenger cars, 1; mixed passenger cars, 1; trucks for cars, 38; wheels with axles, 84 pairs; springs and other accessories.
3. Relaying, leveling, and ballasting 54 miles of track.
4. Replacement of 115,000 ties.

5. Placing of 100,000 rail plates, with necessary bolts and spikes.
6. Complete repairs on eight locomotives.
7. General overhauling of other fixed and rolling stock.

Bids were recently accepted by the State government for carrying out the provisions of this program.

TELEGRAPH AND CABLE

The Western Telegraph Co. (English) provides Para with cable connections with the outside world. Connections with the United States are via Pernambuco and Barbados, whence messages are relayed over the Western Union's cable through Miami. Messages to European points go by way of Pernambuco and Madeira. The service is rapid and efficient. Rates per word between Para and representative points during May, 1924, were: New York, 4$510; London, 5$530; Rio de Janeiro, 0$600. Deferred rates to foreign points are half the regular rate. "Week-end letters" may be sent to New York at the rate of 22$530 for 20 words.

The French cable, of the Cie. Francaise des Cables Telegraphiques, from Salinas to Havre, via Cayenne, has suspended its service.

The Amazon Telegraph Co. (Ltd.) operates a subfluvial cable up the Amazon as far as Manaos, with stations at Soure (Marajo), Mosqueiro, and Pinheiro (mainland below Para), Cameta (Tocantins), Curralinho, Antonio Lemos, Macapa, Chaves (Marajo), Mazagao, Gurupa, Prainha, Santarem, Obidos, Alemquer, Parintins, and Itacoatiara. The service is very satisfactory.

The National Telegraphs have a wireless station at Para which communicates with the stations at Santarem and Manaos, and thence with the radio stations at Porto Velho (Madeira), Labrea (Purus), and the Acre stations. The Government land lines from Rio de Janeiro reach Para by way of Braganca.

PORT OF PARA

The concession for the construction of a system of harbor works for the city of Para was granted to Percival Farquhar by the Federal Government in 1906. The text of the concession is contained in executive decree No. 5978 of April 18 of that year. For the purpose of carrying out the terms of the concession Mr. Farquhar organized under the laws of Maine a corporation named "The Port of Para." The capital of the original company was $17,500,000. The plans for the harbor were approved by the Ministry of Transportation and Public Works on February 17, 1907; work was started on November 16 of that year, and the port was opened to traffic in October, 1909. The docks in their present state were completed in October, 1912.

The plans provided for the construction of the quays on the part of the water front between the confluence of the Oriboca and Guama Rivers and the headland of Mosqueiro. The works were to be in two sections, to the right and left of the point known as Castello, or corresponding to downstream and upstream.

The completion of the entire project was gradually found to be beyond the resources available for its prosecution and, moreover,

to be unnecessary as a result of the decline in the movement of the port after the great rubber crisis. Consequently, by executive decree No. 12184 of August 30, 1916, the contract of the port company was revised to permit the suspension of certain provisions until a more favorable moment. Certain features provided for in the original plans were definitely eliminated. At the same time it was specifically declared that the construction of the second section of quays, to be built from the upriver side of the Castello, should be undertaken only in case increased needs of traffic made its completion imperative, an eventuality scarcely probable for a long time to come.

PRESENT PORT FACILITIES

The present port works of Para consist of the following quays, with accessory equipment and services as described:

1. Nearly 6,000 feet of quays, of which 2,000 feet are for accommodating ships of shallow draft and 4,000 feet for vessels of deep draft, the depth of water alongside each stretch of dock being respectively 26 and 30 feet. There is a third stretch of quay, with a length of 1,475 feet and 21 feet of water alongside, for the use of river steamers. The quay walls are built of large concrete blocks.

2. Thirteen warehouses 328 by 65.6 feet and two 2-story warehouses 393.7 by 65.6 feet, a total storage space of about 383,000 square feet. Only a small part of this space is utilized by the present volume of traffic. The warehouses are constructed with a framework of steel girders and roof and sidings of sheet iron. The outer row of warehouses is set back 50 feet from the edge of the quay wall.

3. Due to the steady silting up of the river in front of the city, considerable dredging was necessary to open a channel that would assure access by any ocean-going vessel, and continual work is required to maintain the prescribed depth in the approaches to the quays. The entrance channel, which is marked with buoys, is maintained at a minimum depth of 28 feet below mean low tide for a total distance of 3.75 miles. The docking channel in front of the quays has a minimum width of 394 feet, with 820 feet at the entrances. The company has two dredges for cleaning the channel.

4. For handling goods there are nine movable electrical cranes of 3 tons capacity each and four of 5 tons capacity. There is an additional crane of 30 tons capacity for moving boilers and heavy machinery and timbers. Tracks run the length of the docks both in front of and to the rear of the outer warehouses, with intercommunicating tracks. The company has 54 trucks for hauling goods.

5. For repairing steamers the company has a complete equipment at its plant at Val-de-Caes, a short distance above the city. This includes well-equipped machine shops, three Horton shipways for large river steamers in need of repairs or cleaning, and two floating dry docks of 1,700 tons capacity each. At Val-de-Caes the company possesses nearly 2,500 acres of land and at Miramar an additional 350 acres.

6. There are also located at Val-de-Caes three tanks for fuel oil, with storage capacity of 9,000 tons each, and warehouses for inflammables and explosives. The company has two coal stores at Val-

de-Caes, but has never initiated a bunkering service; it has confined itself to ceding space near by to the Lloyd-Brasileiro for supplying its own ships.

7. The company possesses 4 tugs of 36 to 76 horsepower and 11 lighters of 30 to 270 tons, the lighterage charges (rate of hire per day) being 60$000, 100$000, or 200$000, according to size of lighter.

PORT CHARGES

The schedule of charges fixed by the port company is as follows:

	Milreis
A. Docking charges:	
1. Dockage for vessels tying up alongside quays—	
Per day and per lineal meter (3.28 feet) of quay occupied by steamer or motor craft	0$850
Per day and per lineal meter of quay occupied by any other class of vessel, for example, sailing ships	$650
2. Loading or discharging, any class of merchandise, per kilo	$003
3. Stowage, or service of stevedores for stowing goods in hold of vessel—	
Salt or coal, per ton	1$000
Any other merchandise, as per agreement.	
B. Direct charges paid by merchandise:	
1. Handling charge—	
Per volume not exceeding 50 kilos in weight	$200
For each 10 kilos in excess	$100
Charges for use of the cranes for special purposes, such as the loading or unloading of logs, are fixed by previous arrangement, but average about 10$000 per hour.	
2. Warehousing charges—	Per cent
Up to 30 days	per month 1
Up to 60 days	do 1½
Up to 90 days	do 2
Over 90 days	do 3
8 days, exclusive of holidays and Sundays, are permitted for withdrawal of merchandise after payment of duties, during which no storage is levied.	
C. Voluntary charges for special services:	Milreis
1. Water, per cubic meter	1$000
2. Transfer of goods between docks and railway cars or trams and transportation between docks and railway station—	
Coal, per ton	2$000
Salt, per ton	2$500
Any merchandise in bulk or pieces weighing up to 1,500 kilos, which can not be broken up, per ton	3$000
Volumes weighing over 1,500 kilos and up to 5,000 kilos	4$000
Volumes weighing over 5,000 kilos, charges to be arranged.	

For charges on the transfer of merchandise from one vessel to another in the port, the revised contract of 1916 makes the following provision:

The transfer of goods from one vessel to another, either directly or by small craft, may be permitted by the inspector of customs, at the expense of the interested parties, and subject to fiscalization by the company and the customs. However, the company may collect, with a reduction of 50 per cent on national products destined for export and 20 per cent for any other goods, the charges to which it is entitled by virtue of Clause XVI of the contract (i. e., the charges specified above) in case such merchandise is embarked or reembarked on the docks or other port works covered by the concession.

PORT MOVEMENT

Vessels entered at the port of Para during the years 1912–1923 numbered:

TABLE 23.—PORT MOVEMENT (ENTRANCES), PARA, 1912–1923

Lines	Where from	Entrances											
		1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923
Booth & Co. (British).	Europe and North America.	----	----	----	50	59	37	13	51	46	32	50	48
	Manaos	----	----	----	45	36	18	3	22	23	15	32	27
Lamport & Holt (British).	America	----	----	----	----	----	----	----	----	11	13	20	20
Lloyd - Brasileiro (Brazilian).	Europe and America.	----	----	----	----	----	----	11	6	5	4	17	17
	Manaos	----	----	----	44	59	58	46	45	35	25	26	33
	Southern Brazil	----	----	----	68	84	89	77	77	76	60	82	105
Miscellaneous [1]	Europe and America.	189	158	84	25	40	65	3	21	27	24	38	26
	Southern Brazil	142	135	143	87	91	62	32	54	118	84	93	159
Miscellaneous sailings, various nationalities.	Europe and America.	----	----	----	----	----	----	45	21	24	7	8	12
	Southern Brazil	----	----	----	153	168	177	137	158	160	146	123	119
Amazon River Steam Navigation Co. (1911) (Brazilian).	Amazonas and Acre.	----	----	----	70	75	67	63	63	62	58	53	48
	Para State	----	----	----	16	17	17	19	11	13	10	18	23
Miscellaneous river steamers (Brazilian).	Amazonas and Acre.	565	575	507	147	156	192	129	139	132	130	147	144
	Para State	----	----	----	238	260	331	204	192	159	124	149	230
River launches	do	----	----	----	324	358	284	221	203	104	109	120	149
Sailboats, canoes, etc.	do	1,393	1,547	1,221	1,155	1,088	2,830	9,259	6,212	4,953	4,114	3,307	2,964
Total		2,289	2,415	1,955	2,431	3,421	4,227	10262	7,275	6,008	4,961	4,283	4,124

[1] British, United States, Portuguese, Norwegian, Italian, German, Peruvian, and Mexican.

2. LOWER AMAZON, SOUTH

LOCATION AND AREA

Region 2 embraces the land to the south of the lower Amazon from the Tocantins River as far west as the watershed between the Madeira and the Maues and Tapajoz. Within this territory—near Boim, on the Tapajoz River—Sir Henry Wickham collected the seeds from which the vast plantation-rubber industry of the East developed.

The country between the Madeira and the Tapajoz is well supplied with navigable waterways, such as the Maues, Parauary, Sucundury, and Abacaxis, and possesses very considerable natural resources.

The eastern limit of this general area, the Tocantins River, is sometimes held to be outside the basin of the Amazon, since it flows into the Para mouth of the main river. The region above its confluence with the Araguaya, on the borders of the State of Goyaz, is, because of difficulties of transportation and other unfavorable natural conditions, unsuited to the planting of rubber; hence, chief consideration will be given in the discussion of Region 2 to the basins of the Tapajoz and the Xingu.

SECTIONS VISITED BY FIELD PARTY

Most of Region 2 lies within the State of Para, though the Maues and Parintins districts form part of the State of Amazonas. Also, the region extends far south for an indeterminate distance into the State of Matto Grosso. Vast reserves of wild rubber trees exist in the forested highland country about the headwaters of the Xingu and Tapajoz, but with present transportation facilities their utilization is impracticable. The sections actually visited by the field party were as follows:

1. *Maues.*—Entered from Amazon by Parana de Ramos, examining old rubber planted along this canal. Went up Rio Maues and

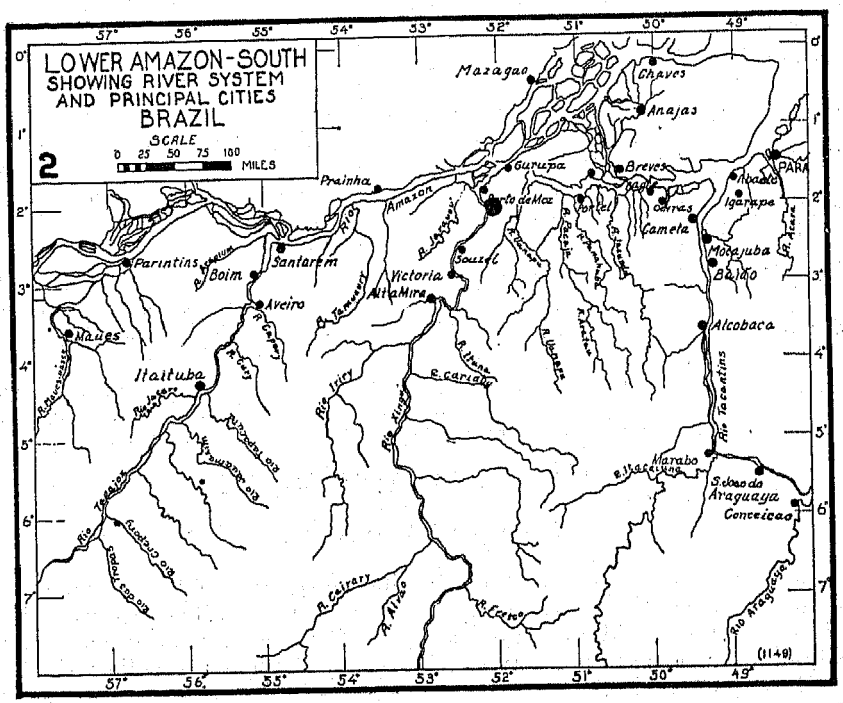


FIG. 25

its confluent, the Rio Parauary, one day. Reentered Amazon by Parana de Ramos.

2. *Tapajoz.*—Went up Rio Arapium, and its continuation, the Aruan, about 85 miles to the first waterfalls. Ascended the main river to Sao Luiz at limit of steamer navigation, thence passed first cachoeiras (rapids) in launch. Entered Rio Tapacura to first cachoeira. Ascended Rio Cupary to Repartimento at forks of river. Examined planted areas of Hevea in region of Boim and Aramanahy and penetrated inland therefrom for considerable distance. Examined planted rubber along lower part of Rio Tauary.

3. *Xingu.*—Ascended main river to head of navigation at Victoria. From Victoria went overland 29 miles across the neck of the Volta Grande (Great Bend) to Alta Mira, commercial center of the upper

river. Examined country along Rio Tucuruhy above Victoria, along small tributary near Souzel, and high lands opposite the latter point.

4. *Tocantins.*—Ascended river to head of steam navigation at Arumatheua, above terminus of railway, examining country about Cameta, Baiao, Nazareth dos Patos, Alcobaca, and Arumatheua.

PHYSICAL FEATURES

The area bounded by the Amazon River on the north, the Tocantins on the east, the cachoeira belt on all the rivers on the south, and the Maues River (and its confluents) on the west, lying as it does in the lower Amazon Basin, is supposed by many people not conversant with the facts to be physically a low country, swampy, and subject to inundation. The very opposite is true. Except a narrow tract adjacent to the great river itself, the country in general is hilly in character. In proportion to superficial area there is less land subject to overflow than in the central and western parts of the basin.

In order to obtain a clear idea of the character of the country it will be treated here under the different rivers, since this is the only means of travel whereby an intelligent notion of the topography can be obtained. The rivers are likewise the centers of settlement and social activity and the natural divisions of districts.

MAUES RIVER

From near the town of Borba, on the lower Madeira, a natural canal (parana) leads to the Amazon near Parintins, on the border between the States of Para and Amazonas. About half way from Parintins to Borba the Maues River empties into this parana, and the town of Maues is located on the right bank of the river at its mouth.

The flat triangle formed by the Parana Uraria-Ramos, the Madeira, and the Amazon is further intersected by numerous small canals, the whole forming an intricate network of waterways. This area is low and swampy and subject to inundation during periods of high water—the highest points being covered only about one month, however.

The Maues River is formed by the confluence of two streams a few miles south of its mouth. The smaller of these, the Paricatuba, comes in from the east and has its source in the watershed between the Tapajoz and the Parauary. The main confluent, called the Parauary, has its source in the highlands of Matto Grosso, flows almost due north, and is roughly parallel to the Abacaxis, Canuma, the Aripuana, and the Roosevelt. At the town of Maues the Maues River is very wide (2 or 3 miles); the water is clear and in the mass has a dark greenish color.

The river begins to narrow a few miles above the town of Maues, and from Maues high land exists on both sides. Near Maues itself the valley is about 4 miles wide, but in three hours' travel by steamer it narrows down to 1½ or 2 miles. The river banks gradually become higher. The land on each side of the Maues River and of Parauary and Paricatuba, near their confluence, is practically

level. Farther south, as the cachoeiras (rapids or waterfalls) are approached, the land becomes rougher and more hilly, in common with all this region. Sixteen hours' travel from Maues the river banks are said to be 200 feet above high water.

From all information secured locally it would appear that a fairly level plain runs back from these rivers, in the lower parts, extending toward the Madeira on the west and the Tapajoz on the east, except on certain small streams flowing roughly parallel to them, and that within this area there exists a large, easily cleared acreage suitable for rubber-plantation purposes. The land is above any possibility of inundation, and naturally well drained. There is a relatively small proportion of varzea land along the rivers to be periodically overflowed. (It is, of course, to be understood this excludes the triangular area of lowland between the Amazon and the Parana Uraria-Ramos, previously referred to.)

TAPAJOZ RIVER

The Tapajoz River is formed by the union of the Arinos and the Juruena, which come together at 10° 24′ south latitude and 60° 35′ west longitude. Both of these streams have their source in the mountains of central Matto Grosso. The Tapajoz, therefore, except in the relatively short distance between its mouth and the first belt of cachoeiras, is a mountain stream, and at no place does it flow through a wide alluvial flood plain, as do the Madeira, the Purus, the Jurua, and the other rivers of the western part of the Amazon Basin. The water of the Tapajoz is clear. Its main tributaries above the cachoeiras are the Jauamaxim and the Sao Manoel, both on the right (east) side. The rubber from both these rivers comes down the Tapajoz.

Only that part of the river between Santarem and the Cachoeiras de Maranhaosinho (the limit of steam navigation for vessels of 400 tons burden) and the tributaries that empty into it within this stretch are of interest here. The Cachoeiras de Maranhaosinho are 175 miles from its confluence with the Amazon at Santarem. They are the beginning of a series of falls and rapids which make transportation difficult, dangerous, and costly.

The Tapajoz is one of the few rivers whose whole valley at almost any point can be seen in a glance. At the village of Alter do Chao, 20 miles from Santarem, the river is 5 miles wide; at Santa Maria, 7.2 miles wide; at Boim, 50 miles from Santarem, 3.7 miles wide; at Pinhel, a few miles beyond Boim, 6 miles wide; and at Aveiro, 70 miles from Santarem, about 1.5 miles wide. At Itaituba, 150 miles from Santarem, the width has narrowed down to approximately 1,000 yards, and normally this is about the average width until the village of Sao Luiz is reached, at the foot of the cachoeiras. The mouth of the Tapajoz is narrow, being less than three-quarters of a mile wide.

The river is confined between rather high banks, and in the rainy season it does not overflow the surrounding country. The only exception to this is a stretch of about 20 miles south of Itaituba, which is subject to inundation, but this extends inland only a short distance, and is of relatively small area.

CHARACTER OF LAND ALONG TAPAJOZ

From Santarem there extends, both down the Amazon and up the Tapajoz for several miles, a low, sandy plain, which is covered with sparse shrubby trees and curua palms and in spots open grassland. Back of this narrow plain, on both sides of the Tapajoz, is a stretch of rolling hills, some of which, however, are isolated, with rather steep sides. These hills are likewise sandy, but with a heavier forest growth and of a better soil than near the river. These two belts together will average about 7 miles in width. On some of this higher land about 10 miles from Santarem there is a considerable area in cultivation. This is of interest as being the site of a settlement of American colonists from the Southern States who located here shortly after the Civil War.

The main point of interest, however, is a distinct plateau back of the plain and rolling hills. This plateau, called at Santarem Piquiatuba, averages about 300 feet above the water level of the rivers. It can be seen for many miles along the Amazon—in fact, is in evidence from the mouth of the Xingu to the Tapajoz and is seen again at Parintins on the Amazon. At Santarem it is level on top, and is the site of a fairly large plantation of sugar cane, rice, cotton, corn, etc. The plateau is covered with a fairly heavy jungle.

The exact area covered by this plateau is not known. It was stated that it was 18 miles back to the first place where water is encountered in a creek. This plateau can be observed all the way on the Tapajoz to the cachoeiras, but in some places it appears to be more eroded than in others. There are few roads or trails leading into it, and to explore it thoroughly would have required more time than was available. It would appear that there is a very large area, amounting to possibly a million acres or more, suitable for rubber-plantation purposes. On account of its excellent location with respect to transportation and proximity to Para, it occupies a very advantageous position.

BOIM AND VICINITY

Boim, 50 miles from Santarem, is located on a flat, sandy plain well above the river, and none of the land adjacent is subject to inundation. From Boim directly west there is a mule trail which leads to the Serra do Humayta, the plateau, and beyond until it reaches the Rio Mentai, a distance of approximately 50 miles from Boim. A branch trail leads around the source of the Mentai and reaches the Rio Preto, a tributary of the Rio Maro, both of these being tributaries of the Rio Arapium.

For the first 2 miles from Boim the land is a sandy plain gradually sloping toward the river. This plain is covered with a light jungle, but dense with curua palms and underbrush. A small, gently sloping hill is then encountered, at the top of which is a level plateau extending about 2½ miles. This plateau is covered with a rather heavy jungle growth, there being many large trees with curua palms and brush underneath. It is very good land and will grow rubber, but is not so suitable as the higher plateau farther in. Following this plateau comes a series of low hills for about a

mile and one-half, on which there are fewer big trees, but which supports a dense growth of smaller trees and curua and other palms, and then begins a long incline (roughly 6 miles from the river) which leads to the top of the plateau.

This hill or incline is known locally as the Serra de Humayta. It is level on top for an undetermined distance both north and south, and west at least to near the Arapium River. It has no watercourses until the headwaters of the Mentai are reached, some 30 miles from the Tapajoz River. The soil is a heavy silt loam. The jungle is rather heavy, though open; that is, it has a lighter growth of vines and underbrush than most jungle encountered and has very few palms. The plateau in all its characteristics resembles that of the Serra do Parintins and the plateau at Santarem and evidently is a continuation of them.

This land is ideal, from a topographic standpoint, for rubber-plantation purposes. It is rather remarkable that the identical spot from which came the seeds for the plantations of the East should itself be one of the most favorable spots in the Amazon Valley for the growing of plantation rubber. The elevation of the plateau does not exceed 300 feet above the level of the Tapajoz, and the construction of roads to it is an easy matter. It is estimated that, at a minimum, this plateau covers 1,600 square miles, or over a million acres, and in conjunction with the cachoeiras of the Aruan River for the generation of electrical power would form a most desirable area for rubber planting.

TRIBUTARIES OF THE LOWER TAPAJOZ

The lower Tapajoz has but few tributaries of economic importance, mainly due to the nearness of the cachoeiras, which are a hindrance to transportation. These rivers are important, however, in the sense that they all have wild rubber and caucho on their upper courses, and everywhere abound in Brazil-nut trees and oil-bearing palms.

The most important of these lower tributaries is the River Arapium and its tributaries. This river enters the Tapajoz at one of its widest points, on the left side, about 25 miles from Santarem. It flows in a northeast direction, roughly parallel to the Tapajoz. At the shipping point of Bella Vista, 74 miles from Santarem, the smaller Rio Mentai enters from the southeast, and a few miles farther on the Rio Maro from the same direction. From its junction with the Mentai the river takes the name Aruan.

About 10 miles from Bella Vista, that is, 84 miles from Santarem, the cachoeiras (rapids) of the Aruan are reached and effectively bar steamer or launch transportation. Below the cachoeiras the Aruan is a fairly large river, being perhaps one-fourth of a mile wide, with occasional enlargements partaking of the nature of small lakes. Below Bella Vista the river is three-fourths of a mile wide at high water. The water is clear and of a dark-green color. In the dry season launches drawing 4 feet can reach the cachoeiras. At Bella Vista the valley is 3 miles wide. High land exists on both sides; near the bank the vegetation in places appears inferior. Open grassland of small extent is seen on the Arapium, similar to that near Santarem and Monte Alegre.

The land around the cachoeiras is level to slightly rolling, and local information was to the effect that like topography characterizes a large area. Undoubtedly the land becomes more hilly as the river is ascended. The soil at the cachoeiras is sandy, and though it supports a good forest growth the inhabitants stated it was unsuitable for certain agricultural crops; but within a walk of one and one-half hours the nature of the soil changes to a black clay on which they grow sugar cane, corn, cotton, rice, and bananas. This would correspond to the plateau already described at Santarem.

The headwaters and upper portion of the Aruan are unexplored. It is only known that the Aruan is a very long river. The Mentai has its source about 35 miles from the Tapajoz. It is also stated that the headwaters of the Rio Maro are unexplored. Seringueiros (rubber workers) have been up the river 30 days' travel in canoes without reaching the source.

The Rio Cupary enters the Tapajoz on the right (east) side 10 miles south of the town of Aveiro. It flows in a northwest direction. Fifty miles from its mouth it is joined by another river coming from the east. The land on each side of this river would be classed as hilly, though many of the hills are level on top and of considerable extent. Within four hours' walk from the junction of the two branches, seringueiros stated, are rocky hills, on the sides and tops of which the best rubber in the area is growing. The river has a rather wide flood plain and much of it is overflowed in the rainy season. High, red banks are frequently encountered, however.

From the uniformity in height of the land along both sides of the Tapajoz from Santarem until near the first cachoeiras it is evident that the hills have been formed by erosion. Large areas of the original plateau exist, and being level or only slightly rolling are eminently suited for rubber planting and agriculture. Very little of the land along the Tapajoz in its lower stretch would prove too hilly for rubber-estate purposes, but due to soil conditions the level tops of the plateau and the sides are much better adapted for plantations.

XINGU RIVER

The Xingu has its source in the high plateau of Matto Grosso. In the greater part of its 1,200-mile course it flows through mountainous country. Its basin, even at this time, has been little explored, due to difficulties of transport caused by the large number of formidable falls and rapids. The Xingu resembles the Tapajoz, though neither so picturesque nor so wide. At its mouth it is 3.5 mile across, but above widens out to nearly double that. At the first cachoeira it is about 1,000 yards from bank to bank. It flows between high walls and has practically no varzea lands except the islands. Its water is clear, like the Tapajoz.

A series of small islands begins a few miles beyond the town of Souzel, 108 miles from its mouth; these extend for about 35 miles up the river until the first large cachoeiras are met, which bar all steam navigation. At Victoria, about 120 miles from its mouth, the river makes a bend (the Volta Grande) to the east for a distance of 120 miles. The distance across the neck of land between the beginning and end of the bend is about 30 miles.

The principal affluents of the Xingu are:

Rio Tucuruhy.—This is a small river coming from the southeast which empties into the Xingu at Victoria below the cachoeiras.

Rio Pacaja.—This river comes from the south and flows into the Xingu in the cachoeira belt in the great bend.

Rio Iriry.—The most important tributary. This river flows north and northeast and joins the Xingu a few miles above the town of Alta Mira at the upper end of the bend. This river also has a very important tributary, the Curua. On the latter there is a waterfall, called by the Indians Cachoeira de Yokoama, which is said to be 400 feet high.

CHARACTER OF LAND ALONG XINGU

The lands around the mouth of the Xingu are low and subject to inundation. Within a few miles, however, high lands begin on both sides and continue the length of the river. The banks, especially on the left (west), are steep, and practically no varzea lands are seen except along the smaller tributaries and the islands.

Along the left bank to the mouth of the Tucuruhy at Victoria there is a plateau about 150 feet above the water level. This is broken in only a few places by the valleys of small streams which empty into the main river. This bluff is covered with forest trees to the water's edge, though in places the soil is exposed, making great red splotches against the green wall of vegetation. This plateau where examined opposite the town of Souzel is level, with a good soil and forest growth. It resembles the plateau at Boim on the Tapajoz and the whole area is probably a continuation of that plateau. On the right bank (east) the land is lower; along the river it consists of small rolling hills, but level plateaus are said to exist in the interior.

There are but two or three rivers of any size between the Xingu and the Tapajoz and flowing parallel with them. There must exist, therefore, between these two rivers and below the cachoeiras belt a very large area of high, well-drained land, level to undulating, that would be excellent for rubber plantations. The land above the cachoeiras is rougher than below, and undoubtedly large areas of excellent land of a hilly character could be found there. The difficulties of transportation, however, make them less desirable for plantation purposes.

TOCANTINS RIVER

The Tocantins unites with the Rio Para (by which name the southern outlet of the Amazon River to the ocean is known) about 60 miles west of the city of Para (Belem). Of the great southern tributaries rising in the high plateau of Matto Grosso and, in this case, Goyaz, which flow north and northeast into the Amazon, it is the one nearest to the city of Para and the ocean. The Tocantins differs in some important respects from the Xingu and the Tapajoz—among them the greater extent of its varzea land and its shallower channel. Near its mouth the river is 7 or 8 miles wide. This width gradually diminishes as the river is ascended, until a few miles above Baiao it narrows to about 1,000 yards and this width continues for a long distance.

The area around its mouth is low and swampy and resembles the near-by island regions. A short distance from the mouth a series of low islands begins, and these continue, forming a characteristic feature, until near Cameta, 30 miles from its mouth. These islands and the margins of the river are covered with a low, inferior-looking jungle, the main characteristic of which is the enormous number of palms, the most common of which is the mirity (or burity). All of this lower area is only a few feet above tidewater, and in times of high floods most of it is completely submerged.

CHARACTER OF LAND FROM CAMETA TO BAIAO

From Cameta up the river the banks gradually rise, until at Mocajuba (22 miles above Cameta) the terra firme (upland) of the river valley is encountered, and a few miles farther on, at the town of Baiao (75 miles from the mouth), the bluffs are 40 or 50 feet above the level of high water. At this place the valley is 5 or 6 miles wide. The terra firme on both sides of the river is level. The valley lands are low and subject to inundation.

Above Baiao the characteristic feature is the high, precipitous bluff, reddish in color where exposed, on the right side of the river. This bluff gradually increases in height until opposite Arumatheua (about 115 miles from the mouth) it becomes 75 or 80 feet, the highest point seen. On the left side there is more or less varzea land, which gradually rises also, and at Alcobaca, 100 miles from the mouth, the river valley has narrowed down to about 2 miles. On both sides of the river from a few miles above Baiao low, rolling hills gradually rise to a level and undulating plateau that appears to be 200 or 250 feet in elevation above the river. These hills are constantly in evidence as the river is ascended, and in the distance look much higher than they are really found to be on approach.

CAMPOS OF THE TOCANTINS

Beginning as far north as Cameta, on both sides of the river, there exists a campos, or natural prairie, region back of the jungle belt along the river, which extends in varying width to Arumatheua at least. At Baiao these campos are 7 or 8 miles from the river, and they are some 4 or 5 miles wide. Beyond that forest is again encountered. On the left bank they are about 15 miles away, and are approximately 3 or 4 miles wide. In this case the heavy forest also continues beyond them. They have no particular interest in connection with rubber growing, except as pasturage for cattle and as protective or quarantine strips between areas of planted rubber.

These campos areas are apparently not continuous, though having a general north and south axis, or else have local names taken from the nearest settlements. The French explorer, Henri Condreau, in his account of the explorations of the Tocantins (Voyage au Tocantins-Araguaya, Paris, 1897), gives the names of the campos on the lower Tocantins as follows: Arumatheua, Breu Branco (the smallest, near Alcobaca), Sao Miguel (the largest), Defuntinho, Remansinho.

He states that the Arumatheua prairie is only 2 or 3 miles in the interior, and is of little importance. He apparently had very meager information about them himself, and even to-day they are little better known.

The first formidable rapids begin at Arumatheua (115 miles from the mouth), though smaller ones exist below, and these continue for about 200 miles to the junction of the Tocantins and the Araguaya.

LANDS SUITABLE FOR RUBBER PLANTING

The Tocantins has its origin near the proposed Federal District in the State of Goyaz, and bears the name Rio Maranhao to near Porto Nacional. From there to its mouth it is called the Tocantins. Its main tributary is the Rio Araguaya, coming from the south, which empties into it at the point where the three States of Para, Goyaz, and Maranhao come together.

From all standpoints the lands commencing at Baiao, up the river and in the interior (excepting the natural campos), are excellently adapted to rubber planting, and around Alcobaca and Arumatheua are probably the best seen by the field party in the State of Para.

WATER POWER

Maues section.—Waterfalls exist on both the Parauary and Paricatuba. These, however, are several days' travel from Maues by steam launch. We did not reach them and can offer no opinion as to their suitability for the generation of electrical power.

Rio Aruan (Arapium) section.—This particular region is of interest from the fact that, in addition to the topographic suitability of the land for rubber-plantation purposes, the cachoeiras could be utilized for the generation of power. Within a distance of 200 yards a fall of about 40 feet might be obtained, and by going farther up an even higher fall. The valley or gorge is narrow and could be easily dammed and made to furnish enough power for a rather large enterprise and for transmission to Santarem.

ELEVATION

The elevation of the whole area is comparatively low above sea level. The lands gradually rise in elevation from the Amazon River south to the cachoeira belt, beyond which they rise more abruptly, until low mountains are encountered. The elevation of a high point in the town of Santarem is only 70 feet above sea level. An isolated peak, called Serra de Piroca, 25 miles from Santarem, is approximately 430 feet above sea level. In general it may be stated that the tablelands and hills in the Tapajoz area below the cachoeiras have an elevation of 300 to 500 feet above sea level. Around the cachoeiras they may be possibly 600 feet, and beyond that more.

On the lower Xingu there does not seem to be any lands near the river over 325 feet above sea level, though in the interior there are hills higher than this. At Victoria, approximately 100 miles from its mouth, the elevation is only 40 feet above sea level. On the trail

to Alta Mira an elevation of 344 feet is reached at 18 miles from Victoria, and a few miles beyond 426 feet. At Forte Ambe, the end of the trail, 29 miles from Victoria, and on the Xingu River the elevation is 269 feet. The difference in level of the river in the great bend (Volta Grande) at this place (which is the worst cachoeira belt of the river) is, therefore, approximately 230 feet.[1] Near the divide in Matto Grosso an elevation of 2,000 feet is attained in places.

CLIMATE

TEMPERATURE

The mean temperature and absolute maxima and minima for the station at Taperinha (lat. 2° 30′ S., long. 54° 20′ W., alt. 65.6 feet) near Santarem, are given below. This is for the years 1914–1919. It can be taken as representative of the region along the Amazon and its lower tributaries in this district.

TABLE 24.—MONTHLY MEAN TEMPERATURE, TAPERINHA (SANTAREM), 1914–1919 [a]

Months	Mean	Mean maximum	Mean minimum	Absolute maximum	Absolute minimum
	° F.	° F.	° F.	° F.	° F.
January	77.5	83.1	72.3	91.0	67.6
February	76.6	82.6	71.9	88.5	68.4
March	77.2	83.1	72.5	88.1	69.1
April	77.2	83.3	72.5	86.4	69.4
May	77.0	83.5	72.3	88.9	68.7
June	76.5	84.9	71.4	89.2	67.1
July	77.0	86.2	70.3	91.0	65.3
August	78.3	88.9	71.1	95.0	66.2
September	79.7	89.8	72.1	93.6	68.4
October	79.7	90.3	72.7	96.3	68.7
November	80.4	90.4	72.8	94.3	68.5
December	78.8	87.1	72.5	92.8	68.7
Year	78.1	86.0	72.1	96.3	65.3

[a] Directoria de Meteorologia, Ministerio da Agricultura, Industria, e Commercio, Rio de Janeiro.

The temperature of the region will not vary much from that of Manaos, the Madeira area, and Obidos (see pp. 218, 238, and 200). In the remote highland country of the upper rivers it is not rare for the thermometer to fall about to the freezing point during the winter months. There the nights are very cool for much of the year.

RAINFALL

The rainfall along the Amazon River at Parintins and Taperinha (Santarem) are given in the table below. Parintins is in the State of Amazonas, on the right bank of the Amazon; Taperinha, in the State of Para, near Santarem, at the mouth of the Tapajoz River.

[1] Report of 1922 of Dr. Avelino Ignacio de Oliveira, Ministerio da Agricultura, Industria, e Commercio.

TABLE 25.—AVERAGE MONTHLY RAINFALL AND WET DAYS, PARINTINS AND TAPERINHA (SANTAREM)[1]

Months	Parintins, Amazonas, 1910–1919		Taperinha, Para, 1914–1923	
	Inches	Days	Inches	Days
January	6.91	14	6.67	22
February	8.48	14	11.64	24
March	13.73	17	11.88	27
April	10.14	17	12.04	25
May	8.74	16	10.79	26
June	5.51	12	6.74	23
July	4.16	11	4.41	14
August	3.29	8	1.91	10
September	1.78	4	1.46	7
October	2.68	4	1.42	5
November	3.54	7	2.30	8
December	4.42	10	4.77	14
Total	73.38	134	76.12	205

[1] Directoria de Meteorologia, Ministerio da Agricultura, Industria e Commercio, Rio de Janeiro.

The area under consideration has the reputation of being the driest part of the Amazon Basin. Thus Huber,[2] quoting LeCointe, states that this zone is relatively drier in the summer than the delta district east of it and the upper Amazon region to the west.

LeCointe, in his L'Amazonie Bresilienne, makes the following observations in this connection:

> On going up the Amazon, on the left bank especially, the two seasons are very distinct as far as the mouth of the Purus, but the length of the rainy season diminishes markedly while the dry season is interrupted by heavy showers from time to time. At Almeirim, Prainha, Monte Alegre, Obidos, and even as far as the mouth of the Rio Negro at Manaos each season lasts about six months: from the 15th of December to the 15th of June abundant rains, which sometimes last a whole week, alternate with shorter periods of fine weather. From about the 15th of June the dry season commences more or less markedly according to the year. In this region, which constitutes the lower Amazon, the total annual rainfall diminishes from Gurupa to Prainha; the minimum falls between Prainha and Santarem. At Itacoatiara it rains more than at Obidos.

It is to be observed this refers more specifically to the north bank of the Amazon and would not be strictly true for the larger inland high region lying between the Tocantins and the Maues south of the Amazon.

Akers in his exhaustive report on the Amazon Valley estimates the annual rainfall on the Xingu and Tapajoz at 70 inches, and further states that in his opinion there is little difference between the amount of rainfall on the lower Tocantins, Xingu, and Tapajoz. Judging by the forest growth on the highlands we can observe no difference here from other regions with a reputed heavier rainfall. We are of the opinion that the rainfall becomes heavier as the higher hilly country around the cachoeiras is approached. We have no recorded data to substantiate this opinion, but we doubt if the total annual rainfall is markedly lower in the inland areas in this section away from the Amazon River than in the other parts of the valley (except the far western edge in Bolivia, the Acre, and Peru).

[2] Mattas e Madeiras Amazonicas, Boletim do Museu Goeldi, Para, Vol. VI, p. 100.

SEASONS

The seasons are roughly divided as follows: The first rains generally come in November. December has more rain than November. The rainy season proper embraces the months of January to May. In June the rains are lighter. The remaining four months, July to October, are dry, though ordinarily rains occur twice a month. There have been times of 90 days without rain, but this is unusual.

The effect of the overflows in the rainy season in the Tapajoz area is less marked than in other regions examined. This follows from the high banks of the river, with practically no varzea lands, and the general high character of the country. The lower tributaries have some overflowed areas, but these rivers are relatively unimportant and the areas submerged are comparatively small.

During the time of our examination the rainy season was on, the field party suffered little inconvenience from it. The Tapajoz was on an extraordinarily high rise, yet only in two places were houses noted invaded by the water. These were built on low ground, too close to the river. Rains were observed several times early in the morning, it apparently raining quite as often in the morning as in the afternoon.

POPULATION

The Federal census of 1920 returned the population of this region as 249,270, distributed by municipal districts as follows:

State of Amazonas:	Population
Maues	11,541
Parintins	16,068
Urucurituba	4,478
Total	32,087
State of Para:	
Abaete	24,556
Alta Mira	9,343
Avelro	4,973
Bagre	3,474
Baiao	7,400
Cameta	41,365
Conceicao	11,001
Gurupa	10,901
Igarape-Miry	15,286
Itaituba	8,221
Maraba	4,652
Melgaco	6,650
Mocajuba	7,261
Oeiras	4,204
Portel	8,708
Porto de Moz	3,070
Santarem	41,546
Sao Joao	2,170
Souzel	2,402
Total	217,183

Even an approximate estimate of the population of that part of Matto Grosso comprehended within the scope of this report is impossible, but the number of inhabitants can scarcely exceed 10,000, most of whom are uncivilized Indians. The great majority of the existing population is concentrated within a strip about 2 miles wide on each side of the rivers.

PRINCIPAL TOWNS

The principal town of the region is Santarem, at the mouth of the Tapajoz, which has an excellent situation from every standpoint. Its population is probably between 4,000 and 5,000, which makes it the third city in the Brazilian part of the Amazon Valley. The town has several paved streets, electric light, and a small motion-picture theater; an ice plant is in process of installation. Santarem lies on

high, well-drained ground and is swept almost constantly by cool breezes from the Tapajoz or the Amazon, which form a wide expanse of water in three directions. Behind it sandy heath country stretches away to the base of the high tableland of Piquiatuba. There are cable connections with the outside world and three or four boats weekly to Para, which can be reached in two or three days.

Parintins and Maues, in the State of Amazonas, are towns of probably 1,000 inhabitants each. They are well situated on terra firme (high land). Of other places on the Tapajoz only Itaituba, near the cachoeiras, has any vitality.

Of the Xingu towns, all the life and movement of the river is concentrated in Alta Mira above the Volta Grande (Great Bend). It is an interesting fact that the most activity in the Tapajoz is in the lower river, whereas on the Xingu it is above the first series of cachoeiras. Gurupa, well situated where a promontory of the terra firme between the Xingu and the Tocantins touches the Amazon opposite the entrance to the zone of the "islands," is only a shell.

The largest town on the Tocantins is Cameta, near its mouth. This place has a population of between 3,000 and 3,500, and was formerly a very active and prosperous rubber shipping point. Baiao and Mocajuba are small towns not well situated. Maraba is an important place of several hundred on the upper Tocantins, due to its position as the center of a region rich in Brazil nuts. However, it is built on low ground, inundated by the annual floods, and is consequently very unhealthful.

RACIAL COMPOSITION OF POPULATION

The population of this region consists of the usual elements found everywhere in the Brazilian portion of the Amazon Valley, with the so-called caboclo type (with varying proportions of white, black, and Indian blood) in the majority. Most of the inhabitants were born in the States of Para and Amazonas, but there is also a goodly proportion of natives of the northern States of Piauhy and Maranhao. Cearenses and natives of Rio Grande do Norte and Parahyba are less numerous than in the region of the upper rivers, though some are employed on the castanhaes of the upper Tocantins. In that region between 6,000 and 7,000 natives of Maranhao and Goyaz work each year at gathering castanha (Brazil nuts).

There are many Indians in this area. Some of these tribes, such as the Maues, of the region of that name, and the Araras of the Xingu, are civilized. Others, like the Mundurucus and their enemies, the Apiacas of the Tapajoz country or the Gavioes of the Tocantins, are either yielding to the influence of civilization or disappearing. However, still other tribes, such as the Nhambiquaras of the forests of the upper rivers and the Assurinis of the Volta Grande of the Xingu, have persisted in their savage state and generally resist the entrance of whites into their tribal lands.

The only foreign colony in this region is the American colony founded near Santarem shortly after the Civil War. Few of these settlers, who were responsible for the establishment of several industries in that locality, survive

LABOR

What is said as to the quality of labor in other parts of Brazilian Amazonia would apply with equal force in this area, since, barring the Cearense, so prominent on the upper rivers, the elements are largely the same. The natives of Maranhao and Piauhy are considered very good workers, with generally more initiative than the native of the region. The latter, however, would compare very favorably as to efficiency with the best classes of tropical labor found elsewhere. He is inured to privation and hardship and rarely complains of his lack of the most elementary comforts. He is mild mannered and seldom given to violence, except under the influence of liquor or from motives of jealousy. We have been more and more impressed by the natural kindliness and hospitality of these people as we have also become more convinced of their potential value as a labor element. Once employed it is probable that the most serious problem offered by them would be the curbing of their nomadic instincts.

POSSIBLE SOURCES OF ADDITIONAL LABOR

With the prospect of the better living conditions and more permanent employment assured on a plantation it should be possible, with comparatively little effort, to obtain 20,000 very satisfactory laborers within the State of Para. The castanha forests are at present the largest bidders for labor. It should always be possible to recruit several thousand additional laborers in the north-coast States, even if improved economic conditions there should discourage emigration to the Amazon Valley on the scale of former times.

The Indians are a labor element whose possibilities have been too greatly ignored. Much of the Indian's hostility is only revenge for aggressions committed against him, and when approached in a spirit of conciliation he has generally proven amenable to friendly intercourse with the whites. By the very conditions of his life he is an extraordinary riverman and woodsman. Moreover, as an agriculturist he is often superior to the caboclo himself. Finally, he is generally endowed with a good physique. There is considerable difference between the moral qualities of the various tribes, certain peoples, such as the Maues, having a better reputation for dependability and industry than others. Other groups lack the physical or moral qualities for adaptation to the orderly processes of society.

LIVING CONDITIONS

Living conditions vary greatly between different localities of this area, the worst being found where malaria has reduced the vitality of the inhabitants, or where the population of a place has survived the industry that formerly gave it importance. Of the latter is Porto de Moz, near the mouth of the Xingu, formerly a town of considerable activity but now fallen into a state of lamentable decay. On the other hand, at Alta Mira, above the Volta Grande of the Xingu, there was noticeable a startling contrast in the comparative well-being of the people, who are dependent on the active rubber industry of the Iriry and other localities of the upper river.

The population was living under very satisfactory conditions in such districts of the Tapajoz as Aramanahy and in the higher parts of the Maues country.

Except in the narrow sandy strip that often borders the rivers, it is easy to raise corn, beans, mandioca, rice, and other crops as well as a wide variety of fruits. Hogs, chickens, and ducks round out a food supply that is possible for the poorest inhabitant. Fish, on the other hand, are not so plentiful in these clear-water streams as in the Amazon and its alluvial tributaries. As a rule the food supply of the workers in the rubber districts is produced locally. This is true, for example, of the Cupary and Jauamaxim, affluents of the Tapajoz, though it is not the case in the Iriry, of the Xingu zone, where the seringueiros (rubber workers) buy most of their food from the store of the proprietor, who imports it from Para. Due to the greater predominance of terra firme and the consequent absence of wide flood plains, except along the Amazon, good sites for workers' houses are available.

HEALTH AND SANITATION

All in all, Region 2 is one of the most healthful of the Amazon Valley, undoubtedly due largely to the fact that there is comparatively little low or swampy land along the main river courses, where population naturally concentrates. Houses are nearly always built on terra firme, with a consequent minimizing of the danger from malaria and other complaints. The country along the lower Tapajoz, as also in similar sections of the Xingu and Tocantins, where the river runs between high bluffs or steep hills, with a fringe of sandy beach, the high country in the Maues district, the high shores of the Juruty, the site of Santarem, and the sertão, or interior plateau, country between the main rivers, all these offer much the same conditions of healthfulness.

However, certain rivers and localities have a reputation for being malarial. Some of the tributaries are centers of paludal infection, though conditions may vary considerably from year to year, as was found on the Cupary. On that stream few signs of malaria were seen, though the river had formerly been dreaded for its fevers. Santarem itself is notably healthful, but malaria exists a short distance downstream in a poorly drained belt of land. On the road across the Volta Grande of the Xingu neither anopheles mosquitoes nor malaria sufferers were seen by the field party until the river was reached at the southern terminus of the trail, where the mosquitoes appeared in considerable numbers, and cases of fever were reported in Alta Mira. There is malaria in the lowlands of the huge varzea island of Tupinambarana that occupies the triangle between the Amazon and Madeira and the Parana of Uraria-Ramos. At Gurupa, on the southern branch of the Amazon below the mouth of the Xingu, malaria was rampant at the time of our visit in April, 1924. Five cases were reported in one house.

Hookworm is widely prevalent, as everywhere in the Amazon Valley, yet little effort is made to eradicate it. Lepers may be found in any part of this region, but the State government of Para is planning the isolation of these unfortunates in a colony near the capital.

The Prophylaxia Rural, or Rural Sanitary Service, supported by the National Department of Public Health, has one post in this region, at Santarem. Except for this place physicians are rare, and those who are ill rely either on prepared medicines bought at the nearest drug store or on home-made remedies brewed from some local plant. While some of these domestic remedies are of doubtful virtue, others, such as the bark of the arauary shrub, which is used for treating wounds, have real curative powers, as was observed on several occasions. Another plant, known as balsamo da terra, which is widely distributed in the lower Amazon, is said to be an efficacious remedy in the cure of malarial fevers.

VEGETATION

It should be borne in mind that because of the great measure of uniformity existing over the Amazon Valley many statements made in the following discussion of the vegetation of Region 2 would be true of other areas also. In only a few cases are different species of trees or palms confined to specific areas, and speaking broadly it may be said that the development of the forests has been uniform, modified in particular locations by atmospheric or other agencies.

The standard works on the Amazon forests are Huber's Mattas e Madeiras Amazonicas, included in the Boletim do Museu Goeldi, Vol. VI, 1909, and LeCointe's L'Amazonie Bresilienne. These have been the source of the brief descriptions given in this report, supplemented by personal observations made by the field party.

VARZEA

On the Amazon itself, in the stretch commonly spoken of as the lower Amazon—that is, between the Xingu and the Trombetas—there is a change in the aspect of the vegetation along the sides of the river as compared with the stretch from the mouth of the Xingu to the sea. The restingas, or natural levees, are generally of narrow width, and the vegetation is reduced to a smaller number of predominant elements. In this stretch extensive sand bars appear on which grow the characteristic *Salix martiana*, *Alchornea castaneifolia*, *Cecropia paraensis*, and *Cecropia robusta*. In the established forest the following trees were observed:

	Scientific name
Munguba	Bombax munguba.
Apuhy	Ficus sp.
Tachy	Triplaris surinamensis.
Parapara	Cordia sp.
Tapereba	Spondias lutea.
Ucuuba	Virola surinamensis.
Andiroba	Carapa guianensis.
Murupita	Saplum lanceolatum.
Genipapo	Genipa americana.
Macacauba da varzea	Platymiscium paraense.
Castanha de macaco	Couroupita sp.
Mutamba	Guazuma ulmifolia.
Pao mulatto	Calycophyllum spruceanum.
Louro da varzea	Nectandra amazonum.
Tachy de flor amarella	Pterocarpus ancylocalyx.
Cuaxinguba	Ficus sp.

The largest of these is the apuhy, which is somewhat smaller than the sumaumeira (*Ceiba pentandra*—the silk-cotton, or kapok, tree), the largest tree on so many of the upper tributaries. In this stretch a sumaumeira is rarely seen.

The luxuriant growth of palms so noticeable in the estuary portion of the river is greatly diminished here. While in the estuary more than 20 species are in evidence, here probably not over half a dozen are to be seen, the most important of these being:

	Scientific name
Jauary	Astrocaryum jauary.
Jurumuru	Astrocaryum murumuru.
Urucuri	Attalea excelsa.

On the lower Amazon, and principally in the stretch between the Xingu and the Tapajoz, the forest occupies a subordinate position on the flood plain (varzea), having to strive against conditions little favorable to its existence. The forest on the varzea becomes more luxuriant between the mouth of the Tapajoz and the Trombetas, and the varzea grasslands are farther removed from the river. In the latter regions trees of greater height and denser foliage, such as muiratinga, pao mulatto, and cuaxinguba, indicate a condition more favorable for tree growth.

Above Parintins the influence of the overflow of the Madeira begins to be felt, and the varzea grasslands almost completely disappear, with the forest taking possession of the alluvial plain. Small campinas of limited extent and covered with rank grass occupy places on river banks formed by an accumulation of rubbish. Here begins to be seen for the first time a characteristic feature of the upper Amazon and its tributaries, namely, the presence of canna de frecha, used by the Indians for arrows.

TERRA FIRME

If the forest on the alluvial lands along the main river in this area is not so rich and luxuriant as in other districts, the same can not be said of that along the Tocantins, Xingu, Tapajoz, and Maues a short distance above their mouths and of the hills and plateau between them. The forests between the Tocantins and the Xingu are considered the richest in the State of Para. On the average we found the forest here as heavy as in any part of the Amazon Valley. In the hills on the Tapajoz and on the Tocantins near the cachoeiras are areas of very heavy jungle.

The most characteristic large trees in this region are:

	Scientific name
Angelim	Hymenolobium sp.
Castanheira	Bertholletia excelsa.
Cedro vermelho	Cedrela spp.
Muirapiranga	Brosimum paraense.
Massaranduba	Mimusops spp.
Piquia	Caryocar villosum.
Sapupira	Bowdichia nitida.
Sapucaya	Lecythis paraensis.

The castanheira, piquia, and angelim are the largest trees of the forest here, growing to enormous sizes. We encountered on the Tapajoz angelims that measured 9½ to 10 feet in diameter, but were told that cedros also as large existed in the forests.

CAMPOS

The forests of the State of Para are interrupted by natural campos, or open grasslands, these, however, being principally north of the Amazon. Campos of more recent formation, known as campinas, extend the length of the lower Amazon within the flood plain. To the south of the Amazon the forests are predominant, but in the southern part of the State, which is yet incompletely explored, it appears that grasslands occupy a large area. These occur far beyond the cachoeira belt of the rivers, in regions difficult of access, and of little importance for purposes of our investigation. Open lands of small extent are encountered along the lower Tocantins, Xingu, and Tapajoz, but they are insignificant in comparison with the uninterrupted forests which extend over the vast terra firme between these rivers. The soils of the upland open grasslands in every case observed by us are unsuited to rubber planting.

COMMERCIAL WOODS

Below is given a partial list of the more common commercial woods and the uses for which they are peculiarly adapted:

Andiroba (*Carapa guianensis*). Known as crabwood in the Guianas. Sometimes sold under names of Demarara or Brazilian mahogany. This is one of the chief construction timbers of the Amazon Valley. It is a wood of medium hardness and is easily worked. Exported in small quantities.

Cedro, or Spanish cedar (*Cedrela* spp.). The most widely used wood in the Amazon Valley; furnishes most of the exports from the region. It is the well-known cigar-box cedar of commerce.

Muirapiranga (*Brosimum* sp.). Usually known in Brazil as muirapiranga, but has the name of palo de sangre in the Amazon region of Peru. It is preeminently a cabinet wood. Small quantities have been exported.

Muirapinima, or snakewood (*Piratinera*). Red in color, with dark markings like those of a snake, hence the name. Its main use is for canes. The chief source of this wood is the Guianas, but small shipments have been made from the Amazon.

Ucuuba (*Virola*). A reddish-brown, moderately hard, and easily worked wood that is fairly abundant in certain parts of the Amazon. It is used locally for many purposes.

Itauba (*Silvia itauba*). A yellowish-green wood that is highly prized for shipbuilding. It is found principally on the terra firme (uplands) of the lower Amazon.

Jutahy (*Hymenaea* spp.). The equivalent of the wood known as West Indian locust in outside markets. This is a hard and heavy dark-brown wood; considered durable, and has many local uses. Also yields a resin known as copal in the markets.

Pao roxo (*Peltogyne*). The purpleheart of commerce. As the name implies, it is decidedly purplish in color. The wood is very hard and heavy but is fairly easy to work. It is chiefly a cabinet wood, though in parts of Brazil it is used for wagon spokes.

Angelica do Para (*Dicorynia paraensis*). Known in French Guiana as angelique. It is a fairly hard and heavy wood that is used for many construction purposes. It is said to be valuable for salt-water pilings.

Massaranduba (*Mimusops* spp.). The equivalent of the well-known bullet wood of British Guiana, although the latter comes from a different species of Mimusops, which also produces the balata of commerce. The wood is hard and heavy, dark red in color, and is considered excellent for railway ties and other outside construction work where great durability is required. Small quantities have been exported.

Frei jorge (*Cordia Goeldiana*). A yellowish-brown wood of medium hardness, fairly light in weight and easily worked. It is being shipped to Europe for cooperage and small quantities enter the United States, where it has been used for furniture and certain parts of automobile construction.

Pao d'arco (*Tecoma*). One of a group of similar woods widely distributed throughout tropical America that is used for construction purposes, especially in contact with the ground, such as railway ties and house posts; also in wagon making, cabinetwork, turnery, etc. The wood is hard and heavy, straight grained, yellowish-green in color when freshly cut, turning to a dark gray on exposure.

Pao mulatto (*Calycophyllum spruceanum*). One of the most common trees in the flood plains of the Amazon and because of its proximity to the rivers is burned as fuel by the river steamers. In places in the Peruvian Amazon it occurs in pure stands. The wood is used locally for many purposes. It is fairly hard and heavy and brownish in color but is not easily worked. Very small quantities of it have been exported.

Pao santo (*Zollernia paraensis*). A very hard and heavy wood, brownish to greenish-black in color. It is not abundant. Sometimes used as substitute for lignum-vitæ in propeller bearings. Small amounts are exported for articles of turnery. It is not abundant in the forests.

Macacauba (*Platymiscium*). A hard, heavy wood, red to reddish-brown in color, fairly easy to work. A similar wood from Panama is sometimes exported and used for making tool handles. Locally it has many uses.

Cumaru (*Dipteryx*). A yellowish-brown wood, extremely hard and heavy, but not much used. The tree produces the tonka bean of commerce, which is used as sachet powder and to flavor tobacco.

Pao amarello (*Euxylophora paraensis*). A fairly hard, yellow wood. Used locally in connection with acapu in alternate strips for flooring in the better class of houses in the lower Amazon. The tree is said to be abundant in some localities. Small quantities have been exported.

Marupa (*Simaruba amara*). One of the most important woods of the Amazon. It is yellowish white in color and easily worked. Used locally for matches, boxes, house sheathing, and general carpentry work. Considerable quantities have been shipped to New York for organ pipes, piano keys, interior trim, etc.

Piquia (*Caryocar villosum*). A hard, heavy, grayish-brown wood with cross fibers. Said to be abundant in the forests of terra firme and is a very large tree. It has many uses, especially shipbuilding, wagon making, ties, cooperage, etc.

Matamata (*Eschweilera matamata*). A dark reddish-brown wood said to be fairly abundant on the terra firme of the lower Amazon. Locally it is considered very desirable for salt-water construction work, as it resists the attacks of the teredo.

Acapu (*Vouacapoua americana*). A large tree found on the terra firme of the lower Amazon. The wood is hard, heavy, chocolate brown in color, streaked with lighter brown, and is not very easy to work. It is locally used for general construction, especially for house flooring of the best grade. Small quantities have been exported to the United States, where it has been employed for interior finish.

Jacareuba (*Calophyllum brasiliense*). The equivalent of the wood known generally as Santa Maria, found in Mexico and Central America, where it is better known and sometimes exported. The wood is moderately hard and heavy, dull red in color, and works fairly easy. It is used for flooring and general house construction.

WILD RUBBER

MAUES RIVER

There seems to be no rubber at all on the Maues, except a few planted trees. In the forests along the lower parts of its confluents, the Paricatuba and Parauary, the trees are not *Hevea brasiliensis*, being guayanensis, collina, or other species, the rubber from which is classified as "weak fine." On both these rivers *Hevea brasiliensis* begins above the cachoeiras and extends for an indefinite distance south. Planted patches of *Hevea brasiliensis* are frequently met on the lower parts of the rivers.

TAPAJOZ RIVER

A great part of the Tapajoz and its tributaries, except near its mouth, is rich in wild rubber, only a small proportion of which has been exploited or is exploitable under present conditions, due to the rough nature of the country and the consequent difficulty of transport. There is no wild or native rubber near Santarem, though there are many planted trees of different ages and sizes. In general they have an extraordinarily healthy appearance; however, the younger trees are small for their age as compared with Eastern plantation trees.

The first native *Hevea brasiliensis* is encountered in the hills and plateau at Boim, 50 miles above Santarem. It was from this place, according to all accounts and traditions, that Sir Henry Wickham secured the seeds taken to Kew Gardens and later transplanted in the Middle East. On both sides of the river below Boim there are several places having planted *Hevea brasiliensis*. On the left side of the river above Boim, wild *Hevea brasiliensis* extends along the river and into the interior for great distances. On the right bank wild brasiliensis is encountered on only a few small tributaries until the cachoeiras are reached, beyond which it spreads out over the interior for undetermined distances.

On the Arapium and Aruan Rivers no rubber exists until after the cachoeiras at Porto Franco are passed. The rubber in this area is a "weak" rubber, called locally seringa torrada, and according to Huber's classification is *Hevea collina*.

SOURCE OF SEEDS COLLECTED BY WICKHAM

In other words both species exist together in the interior between the Tapajoz River and the Para-Amazonas boundary below the cachoeira belt. The mixing of the latex of these two species probably explains the poorer quality of rubber coming from this area. This matter is of particular interest, as there has been a great deal of discussion and confusion as to the parent seeds of the Eastern plantations. Many people have assumed that since the rubber from the lower Tapajoz has a lower classification and brings a lower price, the Eastern plantation seeds were derived from an inferior tree and not from the best, or seringa verdadeira, of the Amazon Valley.

Boim is the first place on the Tapajoz at which wild Hevea is found, and it is not probable that Wickham went farther up the river. Estradas were being worked here at the time. There is now living at Boim a man (Moyses Serigue) who stated that his father, who also lived in the same house at Boim, had helped Wickham in procuring the seed. Wickham in his writings and statements has always insisted that the source of the seed was the high plateau between the Tapajoz and the Madeira and not the low or inundated lands where, he states, the tree never has normal development. The land here is the level plateau which extends for at least 50 miles and is about 250 to 300 feet above the Tapajoz River. Wickham also mentions the scarcity of water in the summer time. On the plateau at Boim there are no watercourses and water can be obtained only from vines and roots, as he stated. Had he gone very

far west he would have come into a region where "weak" species exist alongside the brasiliensis, and farther west, or into the basin of the Arapium River, where only "weak" is found.

The evidence is strong, therefore, that the origin of the seeds was the plateau lying west of Boim and Pinhel. In this case the seeds were derived from *Hevea brasiliensis* of good quality, and not from any mixture or inferior species, as is so often claimed. This fact is further proven by the statements of Doctor Huber after his return from a voyage to the Orient in 1911–12, in the report of which to

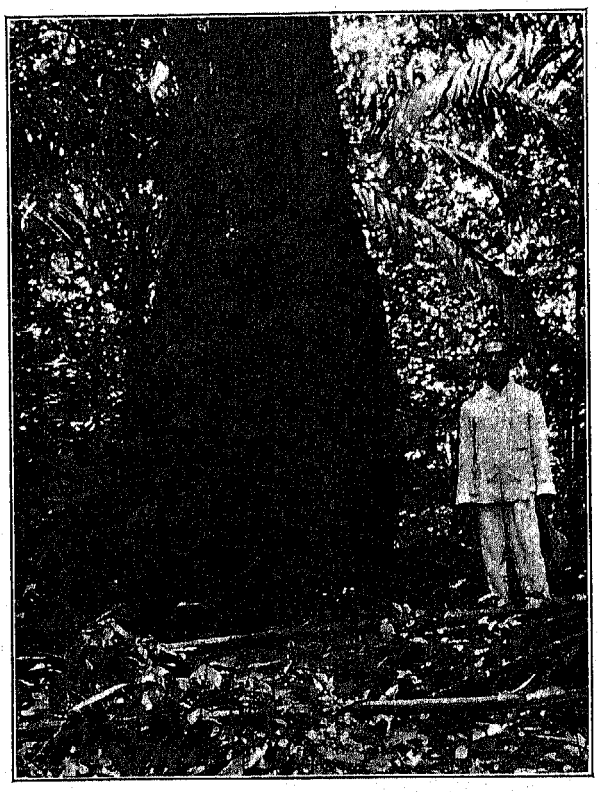


FIG. 26.—An old *Hevea brasiliensis* on the plateau near Boim, on the lower Tapajoz

the Para Government he stated that of all the millions of trees which passed before his eyes he saw not one that did not exhibit the characteristics of the true *Hevea brasiliensis*.

In its inspection of this plateau the field party encountered nothing but *Hevea brasiliensis*. These were the varieties known to the seringueiros as pretas and brancas (see p. 84), and others which did not have the distinguishing characteristics of either and possibly a hybrid of the two. Some trees were good yielders and others poor.

RUBBER AT OTHER PLACES

The Cupary is the most important tributary of the Tapajoz below the cachoeiras. It enters on the right side a few miles above the

small town of Aveiro. Very little rubber is seen along its banks for a distance of 50 miles. Beyond that rubber exists over the uplands to the Xingu. The tree appears to be *Hevea brasiliensis*, but the samples of rubber inspected by us were rather weak.

At Aveiro and at the few places on the Tapajoz on the right side below the cachoeiras where any native trees exist at all they are brasiliensis, but are poor and inferior trees and the rubber is of a poor quality.

Between the mouths of the Tapajoz and Xingu there is no native wild rubber along the Amazon itself. There is some *Hevea brasiliensis* on the margins of the smaller rivers between these, which has evidently come from seeds washed down from the higher lands above the cachoeira belt.

XINGU RIVER

There is practicaly no native rubber along the banks of the Xingu until the small islands are reached beyond the town of Souzel, on the right side of the river. There are a few estradas on the banks of the creeks emptying into the Xingu on the right side, but they are unimportant. There are likewise many planted trees, particularly around Souzel. These trees along the lower Xingu are all *Hevea brasiliensis*, but there seems to be some difference from trees observed in other regions. This difference is particularly noticeable in the seeds, which are abnormal. Some trees produce seeds that are large and flat, double the size of ordinary brasiliensis seed. In the forests below the first cachoeira there is very little rubber, but beyond that *Hevea brasiliensis* exists on the river and its tributaries and the surrounding country far into the State of Matto Grosso, to the south.

The principal tributary of the Xingu is the Iriry, with its tributary, the Curua. The basins of these rivers are rich in Heveas.

TOCANTINS RIVER

In the area between the mouths of the Xingu and the Tocantins *Hevea brasiliensis* is found on the lowlands and islands of the Amazon River and of the tributaries parallel to these two rivers. These trees have probably grown from seeds washed ashore from the upper parts of the tributaries. Wild rubber exists on the lowlands around the mouth of the Tocantins and on the islands and in places along the banks of the river.

Hevea brasiliensis undoubtedly exists in greater or less quantity along a considerable length of the river, as in the case of the Xingu, and in the area lying between the Tocantins and the Xingu, beginning at the first rapids. East of Baiao there is some wild Hevea rubber in the forests along the creeks, and on the left side of the river opposite Baiao, but several miles away from the stream, wild rubber is found in the uplands. At Alcobaca, approximately 25 miles above Baiao, some wild rubber exists in the forest on the left side of the river, but not a great deal within a convenient distance.

A few miles north of Arumatheua, at the first large cachoeira, approximately 115 miles from the mouth of the river, on the terra firme close to the river, the most magnificent Heveas encountered

in the Amazon Valley were found. In an area of less than three-quarters of an acre were counted 20 *Hevea brasiliensis*, some of which had girth measurements ranging from 8 feet 3 inches to 16 feet 3½ inches at 3 feet from the ground. On the opposite, or right, bank of the river wild trees also are to be found in the forest. West of Arumatheua, a few miles in the interior, hills with heavy stands of Hevea were found a few years ago by explorers in railroad reconnaissance work. These trees have never been tapped. Akers states there are districts near the confluence of the Tocantins with the Araguaya River which are rich in rubber.

There seems no reason to doubt that a considerable number of Hevea trees exist in the forests, beginning at the cachoeira belt, between the Xingu and the Tocantins, and extending far to the south on the main river itself and up its tributaries. It appears strange that so little should be known about the matter, since the district is so close to Para, but most of the country away from the immediate vicinity of the river is little known as yet. The areas along the banks from Alcobaca are heavily forested; and Brazil-nut trees of great size exist in enormous numbers. This industry seems to be worked to the exclusion of everything else, and no attention is paid to rubber or to agriculture.

SIZE OF WILD TREES

In size the native Heveas are about the average found in other districts. There do not seem to be quite so many large trees as in the western part of the basin, but individual trees as large or larger are frequently encountered.

A few trees on the plateau west of Boim on the Tapajoz in the region where Wickham secured his seeds were measured. The first trees met in an estrada on the slope of the hills averaged 6 feet 9 inches in circumference at 3 feet from the ground. On the top of the plateau the average of the best trees in the estrada was 7 feet 4 inches. The largest tree encountered was 17 feet 10 inches in girth. Farther in there were said to be even larger ones.

Trees which have long been tapped by the machadinho are badly mutilated and disfigured. Many are suffering from attacks of borers and white ants. Most are tapped to 15 or 18 feet above the ground. Some have weakened under the strain and are slowly dying.

PRESENT CONDITION OF THE INDUSTRY

The production of Hevea rubber has almost ceased on the upper parts of the rivers, and caucho (*Castilla ulei*) has taken its place. This is particularly true of the Xingu, which is rich in Castilla.

Practically the only rubber trees existing along the lower part of the rivers, with the exception of the Tocantins, in this area, are planted trees belonging to small individual proprietors who produce their rubber not as a regular business but spasmodically and as a side issue. On the low Tapajoz there are only a few individuals controlling a large number of estradas, while in the upper parts of the rivers, above the cachoeiras, the whole area is in the hands of a very few individuals. There is little or no organization. Serin-

gueiros tap the trees for their own account and sell the rubber to the owners at a fixed price. The owners are also merchants and supply goods to the men and receive the rubber against their indebtedness.

On the lower Tocantins most of the rubber comes from small individual holdings. There are a few large holders who rent out the estradas for a certain proportion of the rubber produced. There is no effective oversight, and under such conditions no incentive to safeguard the trees, with the result that they are worked to the limit.

COLLECTION AND PREPARATION

Practically the same methods of extraction of latex and the preparation of the rubber are used as described on page 22. One exception to this is the system employed on the lower Tapajoz, called the arracho.

The same care is not observed here in the smoking and preparation of the rubber as in the Acre and the upper Amazon regions, and this probably explains the difference in its market value, since the trees are equal. It is not at all uncommon to see balls of rubber flattened out, the result of never having been turned over after they were first coagulated and laid aside in their wet state.

The rubber from the lower Tocantins is known on the market as Cameta scrap. It is simply coagulated sernamby or scrap. The method employed is to collect the latex in the shells of a mollusk. A part of the shell is broken out, and when the latex has coagulated naturally the insertion of the fingers pushes the scrap out of the shell. It is then pressed together and shipped in this form. The tapping season in this area is from May to November.

MARKET GRADES

In the market of Para the rubber from this district is considered as inferior to that coming from the Acre and upriver areas of the western part of the Amazon Basin. A distinction is made between rubber coming from the upper Tapajoz and Xingu and the lower parts of these rivers; the latter is considered inferior and brings the same price as islands. A special classification is made of the rubber coming from the Rio Uanapu (between the Xingu and the Tocantins); this brings a better price than islands, but lower than upriver Xingu or Tocantins.

As an example showing the grades and price, the following market quotations are given for April 15, 1924:

	Per kilo
Upriver:	
Fine	2$000
Coarse (sernamby)	2$000
Caucho	2$300
Xingu (upper)	2$600
Tapajoz	2$700
Uanapu	2$200
Cameta (coarse)	1$000
Islands:	
Fine	2$100
Coarse (sernamby)	$600
Clean coarse (en rama)	1$700

YIELDS OF WILD TREES

On the upper Xingu or Tapajoz (or, for that matter, in any of the upriver districts) a new estrada or one recently opened, of an aver-

age number of 150 trees, can easily produce 1,000 kilos (2,204.6 pounds) of dry rubber in the average season of 120 working days. The average production is much less, around 400 to 500 kilos (880 to 1,100 pounds) per season, but this is due more to the lack of industry on the part of the seringueiro than to the inability of the tree to produce. In the regions around the mouths of the rivers and in the islands, where some of the trees have been tapped for 40 and 50 years, the average production is only 200 to 300 kilos (440 to 660 pounds) per year, exclusive of scrap.

Labroy, after an extended investigation in this region, reached the conclusion that the total average production per tree per tapping was 27½ grams of dry rubber, which is a conservative estimate, and is a high yield when compared with the average yield of trees of all ages on the Eastern plantations. An acre of such trees (80), tapped only 200 days in the year, would yield 432 kilos, equivalent to 952 pounds, of rubber. It should be borne in mind that the average tree giving this yield is not the magnificent, century-old tree of gigantic dimensions so often pictured. It is a very ordinary tree, a composite of trees from 18 inches in circumference up to possibly 10 feet, and in size is less than the average well-grown 13-year-old tree of the Malayan plantations.

The same thing is true of wild Heveas as of planted trees on the Eastern plantations. Some trees are high yielders and others poor. A few trees in each estrada give the largest proportion of the latex, but in general the proportion of such good yielders is probably a little higher here than there. Some trees season after season consistently give high yields, and with the system in use the actual tapping surface is much less than with the knife system, or, in other words, fewer latex tubes are cut. With the knife system of tapping the yields, on a very conservative basis, would be even larger.

YIELDS OF PLANTED TREES

An effort was made on the Tapajoz to learn the average production of planted trees whose ages were known. Naturally, this is not an easy matter, since no records are kept. The data obtained are not reliable from an accurate, scientific viewpoint, and no general conclusions could be drawn from such evidence; but at least it is interesting and it is believed worth giving. There is no reason to doubt the informants, but it is not possible to verify the statements. The methods used are so wasteful that a great loss occurs in the sernamby, or scrap, which would probably overbalance the shrinkage due to moisture if the rubber were weighed before being perfectly dry.

Santarem.—Two hundred trees on the farm of Mr. Riker. Trees 14 years old, and growing under very unfavorable conditions. Tapped in the dry season only. From the 200 trees each 15 days 75 to 80 kilos (165 to 176 pounds) are said to be obtained.

Alter do Chao.—(*a*) Thirteen trees, 30 years old. Tapped in dry season only. Yield of the 13 trees said to be an average of 1 kilo (2.2046 pounds) per tapping.

(*b*) Six hundred trees tapped through the year as follows: 200 trees each day for two months, then 200 others for two months;

the remaining 200 for two months, thus tapping each lot of 200 trees twice in the year. Yield: 200 kilos (440 pounds) from each lot in the two months.

Aramanahy.—(*a*) Two hundred and thirty trees, 43 years of age, tapped in dry season only; give 5 kilos (11 pounds) of dry rubber per tapping.

(*b*) Two hundred trees, 12 years old, tapped during four months (but not each day) during the dry season. Yield, 2.5 kilos (5.5 pounds) per tapping.

(*c*) Seventy-three trees, 17 years old; give 2 kilos (4.4 pounds) per tapping.

Boim.—(*a*) Twenty trees, 18 years old, tapped from time to time in the dry season; give 1 kilo (2.2046 pounds) per tapping.

(*b*) Fifty-five trees, 28 years old, tapped as above; yield, 3 kilos (6.6 pounds) per tapping.

(*c*) Twenty-five trees, about 40 years old; yield, 1 kilo (2.2046 pounds) of dry rubber per tapping.

(*d*) Twenty-six trees, supposed to be 25 years old; yield approximately the same as above.

(*e*) Sixteen trees, 24 years old; yield, 1.5 kilos (3.3 pounds) per tapping.

When it is considered that these trees have had no particular care, that they are tapped in a very indifferent and slovenly manner, and that they are tapped on an average of only 100 to 120 days in the year, and in the dry season when the yields are at the lowest point, the production is extraordinarily high. There is no reason why trees should not be tapped the whole year. In the East the highest productions are reached in the months of heaviest rainfall. Trees tapped here by Eastern methods on alternate days and on one-quarter the circumference, for the whole year, ought to double or treble the present production with less damage to the tree.

The reason trees are tapped only in the dry season is that by the machadinho method, the latex being collected in small tin cups, there is no channel for the latex to follow, and when the tree is wet from rains the latex naturally spreads out over the bark and a great proportion is lost. With a channel, as in the knife or excision method, the latex is collected, even if a rain comes. The only damage is a dilution of the latex, or at most a premature coagulation from the acid of the bark and wood; the rubber can be worked up into a marketable product.

With the meager data it is futile to try to calculate the yields of these trees to a "per acre" basis. Spaced as they are, all of the examples are producing at a rate of over 1,000 pounds per acre per year, and the older trees at a much higher rate than this.

CAUCHO

While only the areas near the rivers have been explored, undoubtedly the whole State of Para south of the Amazon, except the area within approximately 100 miles of the river, is rich in Castilla (caucho). Every evidence points to that fact. Only roads and cheaper transportation are needed to make this natural wealth available.

The working season for caucho is four to five months. The trees are close together, and one man can work many trees in a day. The result is that he can produce from 2 to 3 tons in the season, and as there are no expenses for materials as used in Hevea rubber extraction the profits are much greater in working caucho.

PRODUCTION

The population in 1920 of that part of the State of Para embraced in Region 2 was 217,183, distributed by municipalities as follows:

	Population
Tapajoz:	
Aveiro	4,973
Itaituba	8,221
Santarem	41,546
Total	54,740
Xingu:	
Alta Mira	9,343
Porto de Moz	3,070
Souzel	2,402
Total	14,815
Xingu-Tocantins:	
Bagre	3,474
Gurupa	10,901
Melgaco	6,650
Oeiras	4,204
Portel	8,708
Total	33,937
Tocantins:	
Abaete	24,556
Baiao	7,400
Cameta	41,365
Conceicao	11,001
Igarape	15,286
Maraba	4,652
Mocajuba	7,261
San Joao	2,170
Total	113,691

Production of rubber and caucho in this section, divided according to rivers and subdivided according to municipalities was as follows for the period 1903–1922:

TABLE 26.—RUBBER PRODUCTION, TAPAJOZ RIVER, 1903–1922

[Quantities in metric tons of 2,204.6 pounds]

Years	District					State of Para	District's percentage
	Upper Tapajoz		Lower Tapajoz		Total		
	Itaituba	Sao Manoel	Aveiro	Santarem			
1903	666	----------	103	116	885	10,282	8.6
1904	692	----------	112	122	926	10,973	8.4
1905	672	----------	119	87	878	10,691	8.2
1906	669	----------	109	121	899	11,012	8.1
1907	666	----------	121	112	899	9,671	9.3
Total	3,365	----------	564	558	4,487	52,629	----------
Per cent of State production	6.4	----------	1.0	1.0	8.4	100.0	8.4
1908	734	----------	125	98	957	9,963	9.6
1909	754	----------	138	99	991	10,153	9.7
1910	662	----------	138	91	891	9,512	9.4
1911	746	----------	135	88	969	9,186	10.5
1912	750	----------	133	110	993	9,230	10.7
Total	3,646	----------	669	486	4,801	48,044	----------
Per cent of State production	7.6	----------	1.4	1.0	10.0	100.0	10.0
1913	576	128	112	86	902	8,752	10.2
1914	644	166	109	87	1,006	7,748	12.8
1915	666	158	129	99	1,052	7,746	13.3
1916	525	107	117	96	845	8,315	10.0
1917	589	129	117	109	944	8,047	11.5
Total	3,000	688	584	477	4,749	40,608	----------
Per cent of State production	7.4	1.7	1.4	1.1	11.6	100.0	11.6
1918	537	125	123	69	854	6,578	12.7
1919	554	128	122	81	885	6,716	10.0
1920	496	101	89	55	741	5,475	13.3
1921	356	76	61	31	524	4,205	12.2
1922	370	102	55	39	566	4,017	13.7
Total	2,313	532	450	275	3,570	26,991	----------
Per cent of State production	8.6	1.8	1.7	1.0	13.1	100.0	13.1

TABLE 27.—RUBBER PRODUCTION, XINGU RIVER, 1903–1922

[Quantities in metric tons of 2,204.6 pounds]

Years	District				State of Para	District's percentage
	Alta Mira	Porto de Moz	Souzel	Total		
1903	----------	25	446	471	10,282	4.6
1904	----------	16	422	438	10,973	4.0
1905	----------	24	484	508	10,691	4.7
1906	----------	32	466	498	11,012	4.5
1907	----------	17	524	541	9,671	5.6
Total	----------	114	2,342	2,456	52,629	----------
Per cent of State production	----------	0.2	4.5	4.7	100.0	4.7
1908	----------	24	568	592	9,963	6.0
1909	----------	19	584	603	10,153	6.0
1910	----------	15	804	819	9,512	8.6
1911	----------	19	942	961	9,186	10.4
1912	729	15	277	1,021	9,230	11.0
Total	729	92	3,175	3,996	48,044	----------
Per cent of State production	1.5	0.2	6.6	8.3	100.0	8.3

TABLE 27.—RUBBER PRODUCTION, XINGU RIVER, 1903–1922—Continued

[Quantities in metric tons of 2,204.6 pounds]

Years	District				State of Para	District's percentage
	Alta Mira	Porto de Moz	Souzel	Total		
1913	900	21	111	1,032	8,752	11.8
1914	892	9	141	1,042	7,748	13.4
1915	851	7	144	1,002	7,746	13.3
1916	1,113	7	150	1,270	8,315	15.3
1917	1,251	4	148	1,403	8,047	17.4
Total	5,007	48	694	5,749	40,608	
Per cent of State production	12.3	0.1	1.7	14.1	100.0	14.1
1918	1,607	3	180	1,790	6,578	27.2
1919	1,672	2	126	1,800	6,716	26.8
1920	1,941	2	160	2,103	5,475	38.4
1921	1,428	7	153	1,588	4,205	37.8
1922	1,335	68		1,403	4,017	34.9
Total	7,983	82	619	8,684	26,991	
Per cent of State production	29.6	0.3	2.3	32.2	100.0	32.2

TABLE 28.—RUBBER PRODUCTION, XINGU–TOCANTINS,[1] 1903–1922

[Quantities in metric tons of 2,204.6 pounds]

Years	District						State of Para	District's percentage
	Bagre	Gurupa	Melgaco	Oeiras	Portel	Total		
1903	286	481	502	122	330	1,721	10,282	16.7
1904	264	528	515	147	337	1,791	10,973	16.3
1905	246	563	455	160	336	1,760	10,691	16.5
1906	244	538	408	175	345	1,710	11,012	15.5
1907	198	470	329	146	318	1,461	9,671	15.1
Total	1,238	2,580	2,209	750	1,666	8,443	52,629	
Per cent of State production	2.3	4.9	4.2	1.4	3.1	15.9	100.0	15.9
1908	206	435	342	194	330	1,507	9,963	15.1
1909	188	447	326	206	342	1,509	10,153	15.0
1910	167	408	336	126	322	1,359	9,512	14.3
1911	166	398	344	78	308	1,294	9,186	14.0
1912	156	391	301	68	387	1,303	9,230	14.1
Total	883	2,079	1,649	672	1,689	6,972	48,044	
Per cent of State production	1.8	4.3	3.5	1.4	3.5	14.5	100.0	14.5
1913	108	327	306	70	272	1,083	8,752	12.4
1914	105	258	263	97	185	908	7,748	11.7
1915	116	237	260	162	230	1,005	7,746	13.0
1916	111	226	287	178	197	999	8,315	12.0
1917	103	220	280	161	168	932	8,047	11.5
Total	543	1,268	1,396	668	1,052	4,927	40,608	
Per cent of State production	1.3	3.1	3.4	1.6	2.5	11.9	100.0	11.9
1918	75	135	189	87	101	587	6,578	9.0
1919	64	134	179	81	116	574	6,716	8.5
1920	41	87	113	41	69	351	5,475	6.3
1921	15	68	85	34	32	234	4,205	5.5
1922	11	80	63	20	26	200	4,017	5.0
Total	206	504	629	272	344	1,955	26,991	
Per cent of State production	0.8	1.9	2.3	1.0	1.3	7.3	100.0	7.3

[1] District between lower Xingu and the Tocantins.

TABLE 29.—RUBBER PRODUCTION, TOCANTINS RIVER, 1903–1922

[Quantities in metric tons of 2,204.6 pounds]

Years	District										
	Lower Tocantins		Central Tocantins			Upper Tocantins					
	Abaete	Igarape	Baiao	Cameta	Mocajuba	Conceicao	Maraba	S. Joao de Araguaya	Total	State of Para	District's percentage
1903	87	253	418	596	149	.....	.....	.....	1,503	10,282	14.6
1904	76	244	715	628	137	.....	.....	.....	1,800	10,973	16.4
1905	108	198	815	623	146	.....	.....	.....	1,890	10,691	17.7
1906	133	268	819	667	172	.....	.....	.....	2,049	11,012	18.6
1907	132	219	840	539	150	.....	.....	.....	1,880	9,671	19.4
Total	536	1,172	3,607	3,053	754	.....	.....	.....	9,122	52,629	.....
Per cent of State production	1.0	2.2	6.8	5.8	1.4	.....	.....	.....	17.3	100.0	17.3
1908	151	258	879	608	153	.....	.....	.....	2,049	9,963	20.5
1909	150	209	606	612	154	.....	.....	276	2,007	10,153	20.0
1910	101	153	406	610	158	228	.....	308	1,964	9,512	20.6
1911	92	122	220	491	135	372	.....	312	1,744	9,186	19.0
1912	104	117	156	392	90	355	.....	461	1,675	9,230	18.1
Total	598	859	2,267	2,713	690	955	.....	1,357	9,439	48,044	.....
Per cent of State production	1.2	1.8	4.7	5.6	1.4	2.0	.....	2.8	19.6	100.0	19.6
1913	111	108	153	409	159	435	328	70	1,773	8,752	20.2
1914	109	105	142	343	66	277	462	23	1,527	7,748	20.0
1915	125	105	142	353	79	136	419	15	1,374	7,746	18.0
1916	127	109	159	482	87	252	284	12	1,512	8,315	18.2
1917	101	97	161	493	90	225	297	18	1,482	8,047	18.4
Total	573	524	757	2,080	481	1,325	1,790	138	7,668	40,608	.....
Per cent of State production	1.4	1.3	1.9	5.1	1.2	3.2	4.4	0.3	18.8	100.0	18.8
1918	59	43	71	238	54	198	207	2	872	6,578	13.2
1919	68	93	92	354	48	154	368	4	1,181	6,716	17.6
1920	50	29	69	287	71	139	232	1	878	5,475	16.0
1921	39	20	51	226	41	72	117	.....	566	4,205	13.5
1922	75	83	34	336	57	72	62	6	725	4,017	18.0
Total	291	268	317	1,441	271	635	980	13	4,222	26,991	.....
Per cent of State production	1.1	1.0	1.2	5.3	1.0	2.3	4.4	0.0	16.3	100.0	15.6

Combining the figures of these four tables gives the following total production of rubber in Region 2 for the years named (quantities in metric tons of 2,204.6 pounds):

TABLE 30.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 2, 1910–1922

Years	Tapajoz	Xingu	Xingu-Tocantins	Tocantins	Total, Region 2
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
1910	891	819	1,359	1,964	5,033
1911	969	961	1,294	1,744	4,968
1912	993	1,021	1,303	1,675	4,992
1913	902	1,032	1,083	1,773	4,790
1914	1,000	1,042	908	1,527	4,483
1915	1,052	1,002	1,005	1,374	4,433
1916	845	1,270	999	1,512	4,626
1917	944	1,403	932	1,482	4,761
1918	854	1,790	587	872	4,103
1919	885	1,800	574	1,181	4,440
1920	741	2,103	351	878	4,073
1921	524	1,588	234	566	2,912
1922	566	1,403	209	725	2,903

COST ESTIMATES

The difficulty of transport, when the cachoeiras are reached, makes the cost of taking in necessary articles and bringing the rubber out very high. Only high-yielding trees and those along the watercourses can be worked while the price of rubber is low, and even then the price paid is so low that there is little or no incentive for the seringueiros to continue work. Furthermore, the men themselves produce practically no food except what they may get by hunting and fishing. The region is, as far as Hevea rubber is concerned, in a state of abandonment.

With caucho, however, conditions are better. Due to the high yields that can be obtained, thus lessening the cost of production, caucho has become the main industry of the region.

On the upper Xingu the price paid to the gatherer is 1$000 per kilo for both Hevea rubber and caucho. As is the general custom, this is paid in merchandise, and consequently the seringueiro or caucheiro gets much less in actual value than this price. At the average rate of exchange for 1923 this amounts to $0.046 a pound. The price paid on the Tapajoz, where transport difficulties are not so onerous, was 2$000 in merchandise per kilo for "fine" in April, 1924.

The expenses of getting the rubber to Para from a high point on the Xingu or the Iriry are, per kilo of 2.2046 pounds: River freight, 400 reis; freight overland (mule trail), 150 reis; steamer freight, Victoria-Para, 72 reis; municipal tax, 150 reis; total, 772 reis. Expenses at Para, exclusive of duty and port charges, average about 150 reis per kilo, made up of: Brokerage, 20 reis; receiving and inspecting, 20 reis; packing and shipping, 15 reis; case, 40 reis; and sundry handling expenses, 55 reis.

OTHER INDUSTRIES AND RESOURCES

AGRICULTURE

The State of Para, on account of having a larger population and better transportation facilities, has in general more agricultural development than other localities described. In the aggregate a considerable quantity of agricultural produce is raised, but there are few large farms as the term is understood in the United States. The nearest approach to this is the cultivation of cacao along the lowlands of the Amazon itself, a few sugar-cane plantations, and cotton farms at Santarem, Monte Alegre, and other places. There are no reliable statistics as to acreage in cultivation nor can an approximate estimate be made.

The principal crops produced in this region are:

Cacao.—Indigenous to the country, wild varieties being frequently encountered in the forest. It was first cultivated in Para in 1678. For centuries it was the principal cultivated product along the Amazon, but since the beginning of the demand for rubber its cultivation has declined. It is planted generally on the lowlands along the Amazon and tributaries.

Manioc or mandioca.—Grown generally all over Brazilian Amazonia. From the tubers is made farinha, the main starchy item

of diet of the inhabitants. Tapioca is made from the tuber also. The plant prefers a sandy soil.

Tobacco.—Produced on both varzea and upland soils.

Sugar cane.—An indigenous variety was known to the Indians before the arrival of the Europeans. The cultivated variety was first introduced in Para in 1667. It is widely planted; used mainly for the production of crude sugar and alcohol.

Rice.—Introduced in Para in 1772 from the Carolinas. Grown in small amounts. The lowlands along the river should be able to produce enormous quantities.

Maize (Indian corn).—A considerable quantity of this is raised for horse, hog, and cattle feed. Very little seems to be used for food, notwithstanding its great value and ease of preparation as compared with farinha.

Bananas.

Cotton.—In only a few places is cotton grown to any extent. Santarem is the principal producer in Region 2. Its cultivation is increasing, however. The Amazon Valley has much land adapted to cotton growing and could produce large quantities.

Coffee.—Grown only in isolated patches and not commercially. It seems to do well in many places.

OILSEEDS AND NUTS

The Amazon Valley is peculiarly rich is trees and palms which bear seeds or nuts containing oils of commercial value. The exploitation of these natural forest products has become, next to rubber, the greatest industry of the States of Para and Amazonas in both volume and value. Except where difficulty and expense of transportation prohibit their gathering and marketing are well developed. In many districts the production of rubber has completely ceased, and the oil-nut industry has taken its place.

Some of the oil nuts, particularly the castanha do Para (Brazil nut) and the sapucaia (paradise or cream nut), are edible, having a high food value and making delicious confections. Their use in the United States and Europe is constantly increasing. Most of them, both trees and palms, grow rapidly and produce early, thus making them adaptable to plantation purposes. On account of the great lowering of the cost of production by cultivation, the formation of plantations for several of the most valuable ones should be a remunerative enterprise, but nothing along the line has yet been attempted.

Below is given a list of the more important ones. For the notes on them we are indebted to Col. Raimundo Monteiro da Costa. It should be borne in mind that not all of them are restricted to the area under discussion (Region 2), but they have reached a higher degree of exploitation in this and the delta region. Under favorable economic conditions they are exploited in other districts as well.

EDIBLE NUTS

Castanha do Para (*Bertholletia excelsa*). This nut, known in commerce as the Brazil nut, is the seed of the tree locally called the castanha. It is the largest and most widely distributed tree on the

terra firme in Para and Amazonas, in some places existing in rather close stands. It forms, next to rubber, the most valuable export from these States.

Castanha sapucaia (*Lecythis paraensis*). This is the nut known in the United States as the paradise nut. As an edible product it is superior to the Brazil nut, having a better flavor and being more digestible. The tree occasionally grows to be as large as the castanha do Para, but is not so widely distributed. It grows on both varzea land and terra firme. When ripe the bottom of the pod containing the nuts drops out, allowing the seed to scatter on the ground, where they are eagerly picked up by birds and animals. For this reason they are scarce and consequently more expensive than the Brazil nut. The tree responds to planting and cultivation, and on good soil will begin to bear in four or five years. Its artificial cultivation might become one of the most remunerative undertakings in the Amazon Valley.

OIL-BEARING TREE SEEDS

Andiroba (*Carapa guianensis*). The andiroba tree is widely distributed over the Amazon Valley, but is particularly abundant in the islands of the estuary of the Amazon and on the lower Tocantins River. Besides furnishing an excellent medium-hard lumber widely used, its seeds contain a valuable oil. The fruit of the andiroba is a dry irregular pod 1 to 3 inches in diameter divided into four sections containing several seeds or angular (polygonal) kernels weighing from 5 to 18 grams (from 0.18 to 0.63 ounce) each. The seed is covered with a thin tough skin which represents from 15 to 30 per cent of the total weight of the seed. The seeds, not being covered with a shell, are difficult to keep for any length of time. The kernels on pressure give a large quantity of yellow oil, rather disagreeable in odor, with a bitter taste, used by the natives as a preventative against insect bites. In commerce the oil is used for the manufacture of soap and stearine and as a lubricant, and by the natives also as an illuminant.

Bacury-assu (*Platonia insignis*). Abounds principally in the Amazon delta region. The seeds are surrounded in the fruit by an edible pulp of a very agreeable taste. From the pulp are made sweets and preserves. The seed furnishes an oil used in the manufacture of soap.

Tamacoare (*Caraipa* sp.). A tree widely distributed over the Amazon Valley, furnishing an abundant supply of seeds, which are as yet very little exploited. The oil content of the dry seed is around 52 per cent.

Castanha de Arara (*Joanesia heveoides*). A tree abundant on the Madeira and the Tapajoz; furnishes a large seed from which the kernel is easily extracted. The possibilities of this seed have been little studied.

Coco de Coatia (not yet classified). A tree abundant on the terra firme of the Rio Purus and the region of Maues, Parintins, and Barreirinha, in the State of Amazonas. The seed, easily broken, contains one kernel. It is edible. The oil content of the kernel is around 40 per cent.

Mauba (*Acrodiclidium mauba*). An abundant seed, but the kernel contains 50 per cent of water, which makes it difficult to keep. The dry seed contains 50 per cent of fat, rich in stearic acid. It liquefies at 43° C. (109.4° F.).

Mamorana (*Pachira aquatica* and *P. insignis*). A common tree on the low, inundated lands. The kernels, which are edible, contain about 50 per cent of oil.

Munguba (*Bombax munguba*). The oil content is about 15 per cent of the weight of kernel and hull.

Piquia (*Caryocar villosum*). One of the largest and most beautiful trees of the Amazon Valley; widely distributed on the terra firme only. The seeds are surrounded by an edible pulp which contains 45 per cent of oil; the kernels (which are difficult to extract) contain 50 per cent. It is claimed that from the fruit of one tree 5 to 8 gallons of oil can be obtained.

Pracachy (*Pentaclethra filamentosa*). Very abundant in the Amazon Valley, but difficult to collect on account of the fruit falling into the water, where they are devoured by fish. The kernel, which is edible, contains 50 per cent of oil.

Sumaumeira (*Ceiba pentandra*). The seeds of this tree (Amazonian kapok) resemble cottonseed. The oil content is about 15 per cent of the seed.

Ucuuba (*Virola surinamensis*). A common tree of the Amazon Basin, growing on both low inundated land and on uplands. The trees bear numerous seeds extremely oily and easy to keep. From the seed is made a wax, used for candles, soap, etc. One tree is said to produce from 25 to 35 liters of seed per year, or around 22 pounds of tallow or wax. The tree grows rapidly and produces seed quickly, thus being adapted to plantation conditions. It is estimated that one hectare (2.47 acres) of planted trees will yield annually around 8,000 pounds of tallow or wax.

OIL-BEARING PALM SEEDS

Assahy (*Euterpe oleracea*). Very abundant over the whole Amazon Valley. The pulp or cover surrounding the seed yields 8 to 10 per cent of its weight in oil, which, when refined, is edible.

Bacaba (*Oenocarpus bacaba* and *O. distichus*). Abundant over the whole Amazon Valley. The pulp of the first produces a green-colored oil; the second, a clear yellow. The oil is edible after refining.

Caiahue (*Elaeis melanococca*). This palm, which resembles the African oil palm, is well distributed but not abundant. It is found on the uplands of the Madeira, Purus, and the Maues. Below Manaos it is found in the varzea lands also. The pulp produces an excellent oil for cooking, illumination, use with paints, and the manufacture of soaps and stearine. The nuts produce a fat valuable for cooking purposes.

Curua piranga (*Attalea spectabilis*). A widely distributed palm that prefers a sandy soil. The seed contains from 2 to 6 kernels according to the region in which found; north of the Amazon, as near Prainha, Monte Alegre, and on the Maycuru River, the seeds contain the higher number. It is abundant around Santarem and

near the margin of the Tapajoz, where the seeds are both monosperm and polysperm. The kernels contain much moisture and have to be dried before shipment to prevent their becoming rancid. One curua nut will produce as much oil as two or three babassu nuts.

Curua una (*Orbignia monosperma*). This palm is the same as the above, except that the seeds are monosperm, and in many places the two palms are found together. The composition of the kernels is the same. The kernels in both cases compose 20 per cent of the total weight of the nut.

Babassu or ua-uassu (*Orbignia speciosa*). A widely distributed palm on the uplands. Large quantities exist near Maues, and on the Rio Apucuhytaua above Maues. Also on the Canuma, Abacaxis, the lower Madeira and Purus, the Solimoes to Teffe, the Arua-assu (near Santarem), the highlands of the Tapajoz near Aramanahy, and the Tocantins. The seed (containing three kernels) is hard, fibrous, and difficult to crack. The palm is a prolific yielder. The State of Maranhao is the principal exporter, having shipped 26,000 tons in 1922. The kernel forms 6 to 9 per cent of the total weight of the nut. The oil is edible.

Inaja (*Maximiliana regia*). An upland palm, with a smaller variety on the delta lowlands. It produces large bunches of fruits of the size of a small lemon. The pulp surrounding the nut contains 25 per cent of orange-yellow oil. The nut, which contains three small kernels, is hard and difficult to break. The oil and fats from both pulp and kernels are similar to that of the African palm.

Jauary (*Astrocaryum jauary*). A common palm on the low varzea lands. The pulpy part of the fruit furnishes a small quantity of edible oil. The kernels of the seed furnish an oil similar to palm oil, being 37 per cent of the weight of the kernel.

Jupaty (*Raphia tadigera*). The pulp furnishes 10 per cent of its weight in oil. Used as a medicine and also for soap making.

Mirity or burity (*Mauritia flexuosa* and *M. vinosa*). The pulp of the fruit produces 8 per cent of its weight in an edible oil. Exists in enormous quantities over wide areas. Common in the delta region. Prolific bearer.

Mucaja (*Acrocomia sclerocarpa*). The pulp surrounding the seed contains 27 per cent of an edible oil. The kernels (representing 6.5 per cent of the entire weight of the fruit) contain 55 per cent of a colorless oil which can be used as sweet oil for the manufacture of soap, etc.

Murumuru (*Astrocaryum murumuru*). Common on the lowlands and in the delta. The seeds are monosperm and are easy to crack. The kernel is hard. It represents 45 per cent of the weight of the dry seed and contains 35 to 40 per cent of an edible oil and fat.

Pataua (*Oenocarpus pataua*). A large palm growing on low, damp land. The pulp contains 10 per cent of edible oil.

Tucuma (*Astrocaryum tucuma*). A very abundant palm, especially in the lower Amazon region. There are perhaps half a dozen varieties of the tucuma. The seeds are monosperm and easy to break. The pulp of the fruit yields 37 per cent of its weight in an edible oil. The kernels (20 per cent of the entire fruit) furnish an oil running about 38 per cent of a good quality either for food or for soap making.

FIBERS

There exist all over the Amazon Valley palms and trees which produce fibers that are used locally and some exported. Many of those at present not exported will undoubtedly find uses in commerce in the future. These fibers are used for making cloth, hats, ropes, cords, cables, brushes of various sorts, and numerous other articles.

The principal palms supplying valuable fibers are:

	Scientific name
Piassava	Leopoldinia piassava.
Maraja-assu	Bactris maraja.
Maraja-y	Bactris cuspidata.
Paxiuba	Iriartea exorrhiza.
Jacitara	Various species of Desmoncus.
Bussu	Manicaria saccifera.
Ubim	Various species of Geonoma.
Paxiubinha	Iriartella setigera.
Carana	Mauritia martiana.
Carana-y	Mauritia aculeata.
Jara	Leopoldinia pulchra.
Jupaty	Raphia tadigera.

The principal trees and plants producing fibers are listed below. Some of the fibers are the covering of the seeds, as kapok and balsa, but most are products of the inner bark or of the roots.

	Scientific name
Sumaumeira or kapok	Ceiba pentandra.
Munguba	Bombax munguba.
Mamorana	Pachira aquatica.
Cupuassurana	Matisia paraensis.
Pau de balsa	Ochroma sp.
Tauari	Couratari sp.
Envira or embira	Sterculia spp.
Tururi	Sterculia sp.
Uaissima	Hibiscus tiliaceus.
Curana	Bromelia.
Gravata bravo	Bromelia.
Piteira (similar to sisal)	Fourcroya gigantea.

Among other natural forest products—which are too numerous to mention in detail—are tanning and dyeing materials and medicinal and aromatic plants. An excellent list of these is given, together with their uses, in the chapter, "Industries extractives," of LeCointe's L'Amazonie Bresilienne, vol. 1.

TIMBER

Huber [3] estimates that the State of Para possesses a minimum of 1,000 species of trees. Of this only a small part have immediate practical utility. The number in use in the State and utilized for commercial exploitation is about 40.

The extra-fine-grained woods, those of various colors, the so-called "precious" or rare woods, have a minor importance as compared with those which have present or potential uses for construction purposes, cabinet work, railroad sleepers, furniture, etc., since the former are found only in small stands and the total quantity is very limited.

[3] Mattas e Madeiras Amazonicas, Boletim do Museu Goeldi, vol. VI, p. 165.

It would appear that if lumbering were carried on in connection with other enterprises it should prove lucrative. In the case of a large opening for plantation rubber or any other product, a sawmill equipped to handle several different classes of timber, a shingle-making machine, planers, etc., could work up felled trees into lumber for all buildings, bridge timbers, and other improvements, and might furnish a considerable quantity for sale in the markets of Para and Manaos or for export. Before lumbering operations are undertaken, there should be a careful examination of the particular forests to be exploited.

TRANSPORTATION AND COMMUNICATION

RIVER

The river system of Region 2 may be represented by the following outline:

Amazon.
- (Parana de Ramos-Uraria.)
- Canuma.
  - Acary.
  - Sucundury.
- Abacaxis.
- Manes.
  - Parauary.
  - Guaranatuba.

Tapajoz.
- Arapium.
- Cupary.
- Tapacura-assu.
- Jauamaxim.
- Crepory.
- Das Tropas.
- Sao Manoel.

Amazon—Continued.

Tapajoz—Continued.
- Sao Joao do Barra.
- Arinos.
- Juruena.

Curua do Sul.

Uruara.

Xingu.
- Iriry.
- Fresco.

Uanapu.

Pacaja.

Jacunda.

Tocantins.
- Itacaiuna.
- Araguaya.

As everywhere throughout the Amazon Valley, the navigability of the streams varies greatly between the rainy and dry seasons. Sometimes a large canoe would find difficult going in a river in September where in April there is sufficient water for a steamer of 20-foot draft. Distances that require weeks in the dry season by canoe travel can be covered in a few days by launches or steamers when the rivers are full. Cachoeiras that form insuperable obstacles to navigation during the summer can be passed without difficulty by launches during the winter, at which time the limit of navigation is pushed far up the streams, making accessible districts that are cut off from the outside world during the dry months except as they can be laboriously reached by canoe. This circumstance is of great importance in the movement of rubber and other products in the minor streams. Conditions of navigation in the principal rivers of this area are as described below.

AMAZON RIVER

That part of the Amazon which is embraced in Region 2 is navigable at all times for ships of any draft. The weekly vessels of the Lloyd-Brasileiro between Rio de Janeiro and Manaos touch at Santarem. The Amazon River Steam Navigation Co. runs a steamer every few days between Para and Manaos, calling at this port. In

addition several trading houses in Para operate steamers up the Amazon. The ships which ply between Manaos and the United States and Europe sometimes call at Santarem to load logs. There are no docking facilities at Parintins, but there is a wooden wharf at Santarem at which the regular river steamers tie up. However, larger boats are compelled to lie offshore, cargo being lightered.

Parana de Ramos-Uraria.—This natural canal, though bearing two names, forms a continuous waterway between the Madeira and the Amazon and receives the rivers of the Maues district. The town of Maues can be reached all the year from the Amazon by steamers of 9-foot draft through the Ramos section of the parana. However, the Uraria section, leading from the Madeira, is closed to boats of this draft for about three months of the dry season, as is also the Furo de Ramos, the canal which leads from the parana a little below the town of Maues directly to the Amazon. The principal streams which flow into the parana, such as the Canuma-Sucundury and the Maues-Parauary, can be ascended for a considerable distance by steamer and offer admirable facilities for penetrating the fine hinterland of the Maues zone.

TAPAJOZ RIVER

The limit of navigation on the Tapajoz for steamers of 9-foot draft is the barracão, or trading post, of Sao Luis, some 170 miles above Santarem. During about four months of the highest water vessels of 25-foot draft could reach Itaituba, a short distance below Sao Luis. Steamers drawing 12 feet of water could reach Boim all the year, which place would be accessible for ships of 30-foot draft except for the existence of a ledge of rocks off Aramanahy.

The total length of the Tapajoz from the source of the Arinos is estimated at 1,240 miles. For much the greater part of this distance the river is broken by cachoeiras (rapids) which render navigation extremely difficult even for canoes. However, at high water launches may reach the mouth of the Sao Manoel at the border of Matto Grosso in 5 or 6 days. From Sao Luis beyond the Cachoeira das Capoeiras the river is wide, strewn with islands, and with a very rocky bed. There are 18 well-defined cachoeiras in this stretch.

From the Cachoeira das Capoeiras there are 90 miles of free navigation to the Cachoeira de Todos os Santos. For part of this distance the river flows through open country, the campos of Cururu extending to the east and those of Mucajazal to the west. Above this there follows another stretch of about 325 miles that is broken by 27 cachoeiras. Some of these, such as the Salto do S. Simao (with a 25-foot drop) and the Salto Augusto, are impassable for craft of any kind. The Salto Augusto consists of three falls with a total drop of about 33 feet.

TRIBUTARIES OF THE TAPAJOZ

The Sao Manoel, the principal tributary of the Tapajoz, which has an estimated length of 840 miles, is broken by bad cachoeiras, at least three of which form barriers to navigation.

For 300 miles farther up the Arinos, above the point known as Pousa Alegre, there is a stretch of free water, except for some

rapids easily passed by canoes, as far as Porto Velho, the terminus of the road from Cuyaba. (This town should not be confused with one of the same name on the Madeira River, Region 5.) Porto Velho is distant about 35 miles from the town of Diamantina, just over the divide between the Amazon and the Paraguay. To travel from Santarem to Porto Velho by canoe would require from 80 to 90 days, the canoes being dragged around the worst cachoeiras.

The Juruena, whose confluence with the Arinos forms the Tapajoz, is much less navigable, its course being broken by a most difficult series of cachoeiras.

FREIGHT AND PASSENGER SERVICE ON LOWER TAPAJOZ

Steamer navigation in the lower Tapajoz is limited to two regular services. One of these is maintained by the Amazon River Steam Navigation Co., which runs a boat from Para as far as Itaituba in alternate months; the journey takes about six days. The other service is operated by the Para trading house of Antunes & Co., which sends a steamer to Sao Luiz each month.

Above the cachoeiras transportation is carried on by launches of a special type, built at Santarem and owned by Antunes & Co., Col. Raimundo Pereira de Brasil, and other local trading interests.

XINGU RIVER

The actual limit of navigation on the Xingu for steamers of 9-foot draft is the barracão of Victoria, about 130 miles from the mouth of the river. Victoria is located a short distance up the Rio Tucuruhy, a tributary of the Xingu. A little above the mouth of this latter stream begin the cachoeiras of the Volta Grande, or Great Bend, of the Xingu. This section of about 125 miles is practically one continuous cachoeira, where the river plunges over a series of rocky ledges as down the steps of an amphitheater. The total drop is about 225 feet, the highest cachoeira being that of Tapayuna, which is a real cataract in the dry season but only a great chute of water at time of flood. This series of rapids and falls constitutes an absolute barrier to all navigation, particularly between the cachoeiras of Tapayuna and Jurucoa.

Above Alta Mira, where the Xingu resumes its general north and south course, navigation continues very difficult. Rapids are encountered with discouraging frequency. Some of these are dangerous, while others can be passed with little difficulty. During the dry season the rocky bed of the river appears in wide expanses, with huge boulders standing out above the general mass of rock. In spite of all these obstacles a shallow-draft launch with a good engine can reach the border of Matto Grosso throughout the year. Flor de Ouro, at the frontier, can be reached from Alta Mira in eight or nine days by launch during the rainy season, the descent being accomplished in about five days.

Steamer navigation on the lower Xingu is in the hands of two concerns; State Senator Jose Porphirio de Miranda, jr., who is

the largest proprietor in the zone of the Xingu, operates a steamer monthly to Victoria and the Para firm of Bitar Irmãos runs a monthly steamer to the limit of navigation.

TOCANTINS RIVER

Ocean-going steamers drawing 20 feet can enter the Tocantins as far as Cameta, though careful pilot work is necessary to follow the channel at its mouth. The limit of all-the-year navigation for river steamers drawing 8 or 9 feet is the town of Baiao, but boats of 6-foot draft can always go up to Nazareth dos Patos. During the height of the rainy season steamers drawing 9 feet can ascend to Arumatheua, a few hours beyond Alcobaca, the terminus of the uncompleted railway around the cachoeiras. However, this point is the absolute limit of steamer navigation. Flat-bottom stern-wheelers drawing 4 feet can reach this point all the year. Above Arumatheua launches engaged in bringing out Brazil nuts pass the cachoeiras during high water and ascend two days to Maraba, and can go far beyond up both the Tocantins and the Araguaya. During the dry season all transportation above Alcobaca is restricted to slow and arduous travel by canoe.

The Amazon River Steam Navigation Co. does not maintain a service in the Tocantins; navigation is in the hands of a few trading firms of Para. Manuel Charves, of that city, operates a bi-monthly service as far as Nazareth dos Patos all the year, and during the rainy season, together with three others, Borgez & Co., Nicolau da Costa & Co., and Antonio de Moraes, runs steamers up to Arumatheua to load Brazil nuts. These firms maintain motor launches to collect the nuts farther upstream for shipment at Arumatheua.

ROAD

Such roads as exist in this area serve the purpose of avoiding the cachoeiras of the rivers, thus acting as auxiliaries to navigation, or of connecting the upper courses of different rivers, or of forming outlets for rubber or agricultural districts.

A road was built several years ago around the lower cachoeiras of the Tapajoz by Col. Raimundo Pereira de Brasil, then the largest proprietor in that region and intendent of Itaituba. This road is used during the dry season, when launches are unable to pass the rapids.

Nicolau da Costa & Cia., of Para, have a road around the Cachoeira Itaboca of the Tocantins, over which they use about 40 mules in bringing down Brazil nuts and carrying up merchandise.

PRIVATE ROAD ACROSS GREAT BEND

The outstanding example of the first class of roads is that built across the neck of the Volta Grande, or Great Bend, of the Xingu by Jose Porphirio de Miranda, jr. This road, approximately 30 miles in length, has the double utility of reducing the distance between the upper and lower Xingu by nearly 100 miles and of avoiding the impassable cachoeiras of the Volta Grande, thus giving an

outlet to the rich rubber country above. Its lower terminus is at Victoria, on the right bank of the small Rio Tucuruhy a short distance from its mouth. Its other terminus is at Forte Ambe, less than a mile below Alta Mira, the principal town above the cachoeiras of the Volta Grande.

The road is divided into three sections, with houses and sheds in the midst of large clearings at the two intermediate stations known as Ponte Nova and Boa Vista. These mark the points for relaying the goods from one mule train to another and also furnish meals and sleeping accommodations to travelers. The first section of the road is sandy but easily passable. The second section offers a very good highway, hard and well-drained for nearly all its length. The last section has one stretch of about 3 miles where the road drops into low ground which is deep in mud after the heavy rains of the wet season. Travelers can cover the entire distance in six to eight hours, exclusive of stops. Our party made the distance in six and one-half hours in the height of the rainy season.

TRANSPORT FACILITIES AND RATES ON PRIVATE ROAD

Mules, horses, and oxcarts are used for transport. About 120 mules are kept for draft purposes. These are brought from Ceara at a cost of 500$000 to 600$000 delivered at Victoria. Each mule generally carries three balls of rubber or three blocks of caucho, a total load of 150 to 180 kilos (330 to, say, 400 pounds), but the through trip is made with three different relays of animals. Oxcarts make the journey throughout the year. Motor trucks were formerly employed on the road, but were taken off when the fall in the price of rubber and the rise in the price of fuel made their continued operation uneconomical. However, the owner of the road has considered the use of tractors with trailers to replace the present system of mule trains and oxcarts. The road could easily be adapted for tractors or trucks. A Decauville railway is an alternative solution of the transport problem offered here. Few natural obstacles are present; there are no watercourses, except a small creek at Ponte Nova, and no steep grades; both wood and stone are easily obtainable.

As to rates, passengers pay 40$000 each way, which includes the right to meals. Baggage pays at the rate of 10$000 per package. Those who travel across on foot are charged a toll of 15$000. The freight rate on rubber is 150 reis per kilo.

PUBLIC ROADS

Competition with this road is offered by a public road which leads from a point on the Rio Tucuruhy above Victoria, known as Cachoeira, to Alta Mira. Though this road is inferior in every respect to the other, crossing long stretches of boggy ground and without accommodations for travelers, it probably has more traffic than the private highway, due to the lower cost of transit. Several merchants of Alta Mira maintain troops of pack animals for service over this trail. The usual freight charge is 100 reis per kilo from Cachoeira to the river port of Redempcao. Below the mouth of the Tucuruhy

transport is by means of motor launches belonging to Nicolaus Pereira, of Redempcao, who collects 40 reis per kilo.

A good road, now being widened and improved, leads out of Santarem to the tableland of Piquiatuba and a day's ride across this plateau to an agricultural colony.

An existing mule trail which leads from the upper Iriry to the barracão of Repartimento on the Cupary is now used for carrying rubber from the Xingu side of the divide to free navigation on the Tapajoz. The trip overland is made in four or five days. It is also possible to go from an affluent of the Iriry to a point on the Jauamaxim, which enters the Tapajoz above the first cachoeiras. This route was first explored in 1908 by Dr. Emilia Snethlage, curator of the zoological section of the Goeldi Museum at Para.

There is a trail from Conceicao de Araguaya in the Tocantins Basin to a navigable point on the Rio Fresco, a tributary of the Xingu. The trail is about 225 miles long and is little used. Sao Felix, at the mouth of the Rio Fresco, is about 300 miles above Alta Mira and can be reached in four or five days at high water, the trip down taking about three days.

PROJECTED ROADS

A road has been started from a point in the Tocantins known as Nazareth dos Patos, with the town of Maraba on the upper river as its objective. The total length would be about 120 miles, of which less than a mile and half has been opened, and it is not unlikely work will have to be suspended for lack of capital.

There is a project before the State Legislature of Amazonas for the construction of an automobile road from the Tapajoz (at the mouth of the Sao Manoel) to the head of navigation in the Sucundury. The object is to furnish a better outlet for the rubber production of that part of Matto Grosso. The total length of the road would be between 55 and 60 miles.

By law No. 1723 of November 14, 1918, the State Legislature of Para authorized the governor to grant to Archimino Pereira Lima and Victor Mallet Hamelin "the right to construct, use, and enjoy for the period of 50 years a wagon road which may be transformed into a railway of economical construction in the municipality of Itaituba, to start from a point which may seem most suitable between the Rio Tapajoz, in front of the city of Itaituba and the Rio Sao Manoel, at the frontier of the State of Matto Grosso, with three branches, one going to the Rio Iriry, an affluent of the Xingu, between the mouth of the Riozinho and the rapids below that, the second going to the Rio Jauamaxim, affluent of the Tapajoz, above the Salto Grande, the third going to the Rio Curua, an affluent of the Iriry, above the Piriquito Rapids." However, this concession has lapsed, due to failure to begin construction within the two-year period stipulated in the contract.

RAILWAY

The only railway in this region is the Estrada de Ferro Norte do Brasil, or the Northern Railway of Brazil. The line was built by a Brazilian company to furnish an outlet for the region of the Tocan-

tins and the Araguaya above the zone of the cachoeiras. Work was commenced in 1904, but many difficulties, financial, administrative, and sanitary, hindered the progress of the undertaking. By 1918 some 55 miles had been completed out of Alcobaca, the lower terminal of the line, and opened to traffic for that length. The upper end of the road was to be at the point known as Praia da Rainha, near the town of Maraba, a distance of about 114 miles. The original plans were subsequently modified so as to extend the line beyond both of its projected termini—that is, to Cameta below Alcobaca and to Sao Joao or Conceicao do Araguaya above Praia da Rainha, a total distance of about 255 miles.

Traffic was suspended on the line in June, 1922, the company being bankrupt. The railway was expropriated by the Federal Government, and is now under the control of the Ministry of Transportation, pending resolution as to its future disposal. The government of Para is desirous of leasing the road, as it has done in the case of the Braganca line, but lacks the resources to carry out the operation unaided. It is interested in completing the line for the purpose of attracting to Para the trade of the upper Tocantins-Araguaya Basin, which threatens otherwise to be drained off to Sao Luiz by a projected railway from the coast to Maranhao, or eventually across Goyaz to Sao Paulo by extensions of the railway from that direction.

The rolling stock of the line consists of: Locomotives, 5, including 1 American, built in 1910; cars—passenger 2, inspection 1, mail and baggage 1, wrecking 1; freight—closed 14, flat 8, stock 3, coal or gondola type 6, flat dump 8. In addition there are 29 platforms for freight cars and over 4,000 rails of different lengths. All this stock, with the exception of the locomotives and passenger cars, which are kept under sheds, is exposed to the weather and is rapidly rusting or rotting. The cars are of Belgian manufacture. The shops are well equipped with machine tools and a great variety of other materials. The track is already grown up with vegetation so heavy as to prevent the movement of a train.

PROJECTED RAILWAYS

A concession for the construction of a railway from Cuyaba, the capital of Matto Grosso, to Santarem is held by Dr. Jose Agostinho dos Reis, vice director of the Polytechnic School at Rio de Janeiro. The concession was granted by the Federal Government by decree No. 11750 of October 13, 1915, and was renewed by law No. 4555 of August 10, 1922. The usual favors and prerogatives offered by the laws of Para and Matto Grosso were specifically granted to the holder of the concession. The projected route would cross the divide from Cuyaba to a point on the upper Sao Manoel and, crossing this stream, would roughly follow the divide between the Xingu and Tapajoz until approaching Santarem. The total length would be around 1,200 miles and the projected line would extend across 14 degrees of latitude. Although presenting no serious engineering problems, due to the great distance the total cost of construction would be high. It may be added that this project is complementary to another for linking up Cuyaba either with the line of the Noroeste do Brasil or with the terminus of the Araraquara at Sao Jose

do Rio Preto in the State of Sao Paulo. The country through which the line would pass is one of great natural resources and good climate, but the problem of financing a scheme of this magnitude, with no prospect of remunerative traffic for an indefinite period, would be a serious one. At present a small amount of rubber is carried across from the headwaters of the Tapajoz to Cuyaba and shipped out via Corumba.

According to law No. 1237 of the State of Para, dated November 6, 1911, "the governor of the State is authorized to contract with parties offering the greatest advantages for the building and operation of railways of economical construction in the valleys of the Gurupy, Tocantins, Araguaya, Xingu, and Tapajoz Rivers and in the State of Para to the north of the Amazon." Among the advantages offered is the cession of public lands within 12 miles on each side of the line and exemption from State taxes for 30 years.

In October, 1922, the State Legislature of Para authorized the government to contract with Amyntas de Lemos, an engineer, for the construction of a meter-gauge (meter=3.28 feet) railroad between the lower Xingu and Alta Mira.

TELEGRAPH AND CABLE

There are stations of the Amazon Telegraph Co.'s subfluvial cable at Parintins, Santarem, Gurupa, and Cameta. The principal intermediate station between Para and Manaos is at Santarem, where an American is in charge.

There is also a radio station of the Government system at Santarem, which communicates with similar stations at Manaos and Para.

Several years ago the Federal Government began the construction of a land line between Para and Manaos, but the undertaking was abandoned after considerable work had been done.

The Rondon telegraph line between Cuyaba and the Madeira crosses the far southwestern edge of this area.

OWNERSHIP OF LAND AND LAND LAWS

The accounts of the land laws as given in the report on the Madeira (Region 5) and the Lower Amazon, North (Region 3) apply with equal force to the area covered by this report.

Most of this region still consists of public lands, private ownership extending only a short distance back from the rivers. Many of the holdings are only posses, or claims, whose occupants have failed to satisfy the legal requirements as to the development of the land; such lands are liable to reversion to the State. Other occupants, by making certain improvements and by long settlement, have established "squatter's rights," entitling them to definitive title to their holdings.

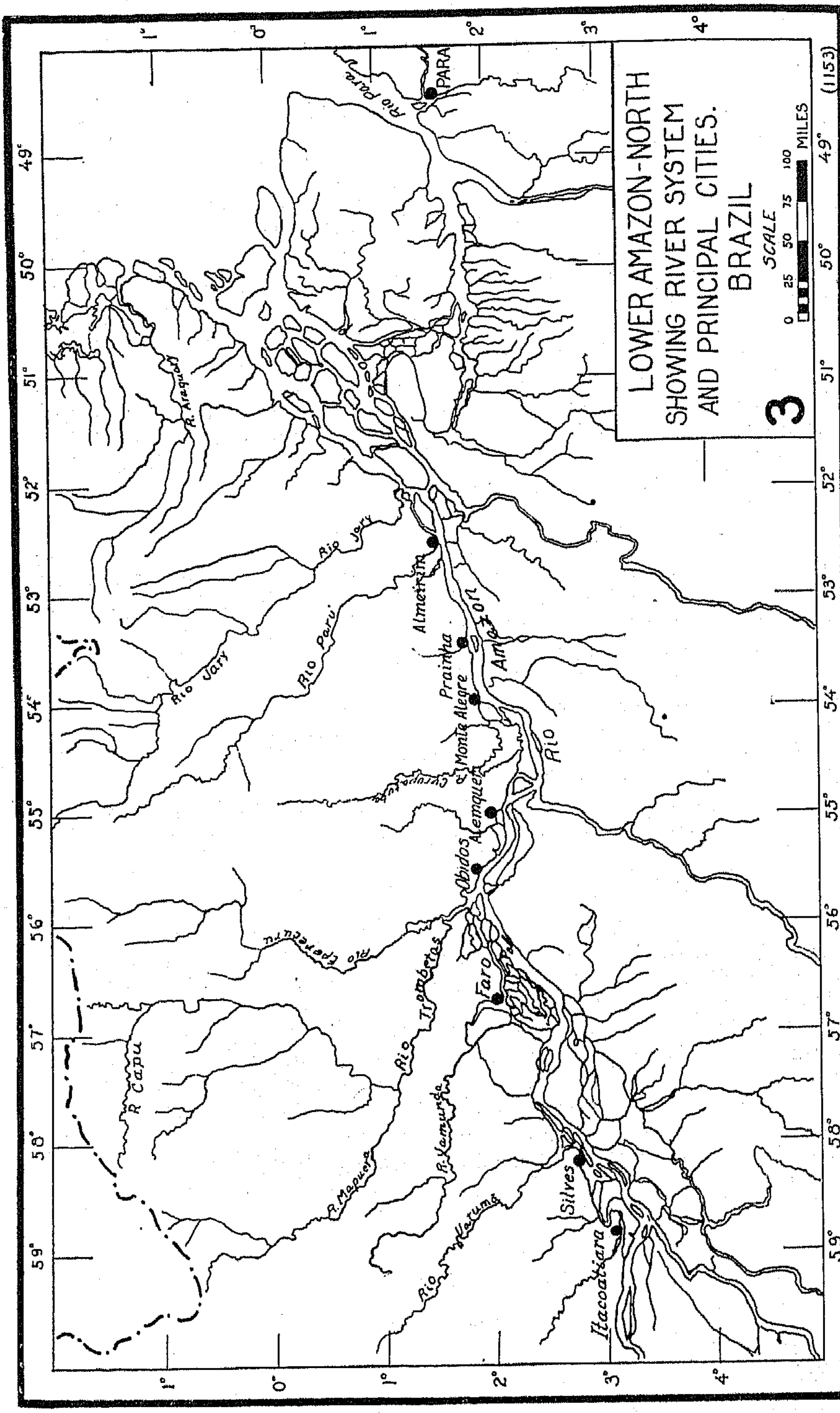

LOWER AMAZON-NORTH
SHOWING RIVER SYSTEM
AND PRINCIPAL CITIES.
BRAZIL
3
SCALE
0 25 50 75 100 MILES
(1153)
PARA
Rio Para
R. Araquary
Rio Jary
Rio Parú
Almeirim
Prainha
Monte Alegre
Rio Amazon
Alemquer
Obidos
Rio Trombetas
Faro
R Capu
R. Mapuera
R. Kamunda
Rio Uatumá
Silves
Itacoatiara

FIG. 27

3. LOWER AMAZON, NORTH

LOCATION AND AREA

Region 3 comprises the country lying to the north of the lower Amazon between the Rio Urubu and the Atlantic Ocean. Most of it lies within the State of Para, but the triangle between the Rio Jamunda and the Amazon, which is included within the scope of this report, forms part of the State of Amazonas. In area it approximates 145,000 square miles.

Due to the difficulty of penetrating the remoter sections because of the numerous cachoeiras (rapids) in the rivers, only a comparatively narrow zone within reach of the Amazon has been developed at all. Much of the country lying above the cachoeiras has not even been explored and could be investigated to best advantage by airplane.

The principal industry along this section of the Amazon is the growing of cacao, and in the terra firme country to the rear it is the gathering of castanhas, or Brazil nuts. The search for new castanha forests has led to the opening of several large districts hitherto wholly undeveloped. Meanwhile whatever interest was formerly shown in the extraction of rubber has long since died out, except in a few localities where some estradas are worked in a desultory fashion.

SECTIONS VISITED BY FIELD PARTY

This territory has never been of more than minor importance as a producer of rubber, since such wild trees as exist there are largely of the guyanensis variety. However, we made an examination of as much of it as the time at our disposal permitted to ascertain its suitability for the planting of *Hevea brasiliensis*. In addition to following the course of the Amazon the length of this area, with stops at different points, we made the following side trips inland:

1. From Obidos up the Rio Trombetas to the Rio Eperecuru, thence into Lago Salgado, with examination of forest lands adjacent to the lake; thence up the Rio Cumina to Repartimento, with an excursion into the forest from that point.
2. From Obidos one day's ride through terra firme (upland) forest over road leading northeast to the Branco River, a tributary of the Amazon.
3. From Alemquer by launch across Curua Lake and up the Curua River to the town of that name at the edge of terra firme.
4. From Monte Alegre one day's ride across open grasslands.

PHYSICAL FEATURES

Contrary to current popular belief, the proportion of high land in this area, as of the lower Amazon Basin in general, is much greater than in the upper reaches of the master stream. After leaving the delta region below Almeirim, ranges of hills or isolated peaks are almost continuously visible until above Obidos, particularly on the north side. Then after a short intermission they appear again on the south side in the Serras do Balaio and continue to Parintins beyond the borders of the State of Para, reaching to the

river's edge in the Serra do Parintins, which rises nearly 500 feet above the level of the Amazon. Following another interval, the river again skirts the terra firme on the north bank, where red bluffs extend for many miles, to be succeeded by another stretch of low shores until the high ground in the vicinity of Itacoatiara is encountered.

AMAZON RIVER

At no point throughout this length is the river more than 20 miles distant from one of these chains of hills. The flood plain of the Amazon is narrowest at a point to the southeast of Alemquer, where the distance from the terra firme of Paracary to that of Santarem is about 15 miles. At Obidos the width is about 20 miles, while between Faro near the mouth of the Jamunda and Parintins it is some 28 miles.

Through this plain the Amazon works its way, sweeping from one side to the other in long, gentle curves, but following a single channel only at Obidos. For the remainder of its length it flows through a number of paranas, or side channels, though the principal channel is generally distinct from these arms. At Obidos the Amazon is but 1,922 yards from shore to shore. However, below the mouth of the Tapajoz at Santarem and the region of paranas that reaches upriver almost to Obidos the main channel is from 3 to 7 miles wide, and at high water it spreads out over a far wider area of country.

The rest of the flood plain is covered with a veritable labyrinth of lakes, paranas, and furos (or connecting canals), between which lies lowland inundated by the annual flood (varzeas). One who climbs the hill back of the town of Monte Alegre may see in the panorama around him nearly every topographical feature of the Amazon Valley. Before him lies the flood plain of the Amazon that stretches away to the horizon, a maze of waterways and low islands, with the channel of the muddy river in the distance. To the rear there is a wide view over campos (open grasslands) and low mountains and terra firme (upland) forest.

DISASTROUS FLOODS ON LOWER AMAZON

The annual rise of the lower Amazon generally begins about the middle of December, and the flood reaches its crest in June, the river falling very gradually from July. However, due to the fact that the season of high water in the northern tributaries of the upper Amazon is the reverse of that of its southern tributaries, the periodical difference in level of the lower Amazon is not so marked as it would otherwise be. This difference is generally from 20 to 25 feet, whereas in the Purus and Jurua it may be as much as 40 or even 50 feet. Moreover, the rise of the lower Amazon is very gradual, since the lakes of its flood plain serve as great storage reservoirs for much of the volume of flood waters. On the other hand, when the Amazon begins to fall these lakes pour out their surplus water, thus helping to maintain the level of the main river at a greater height than would be the case were it dependent solely on the contributions of its falling tributaries.

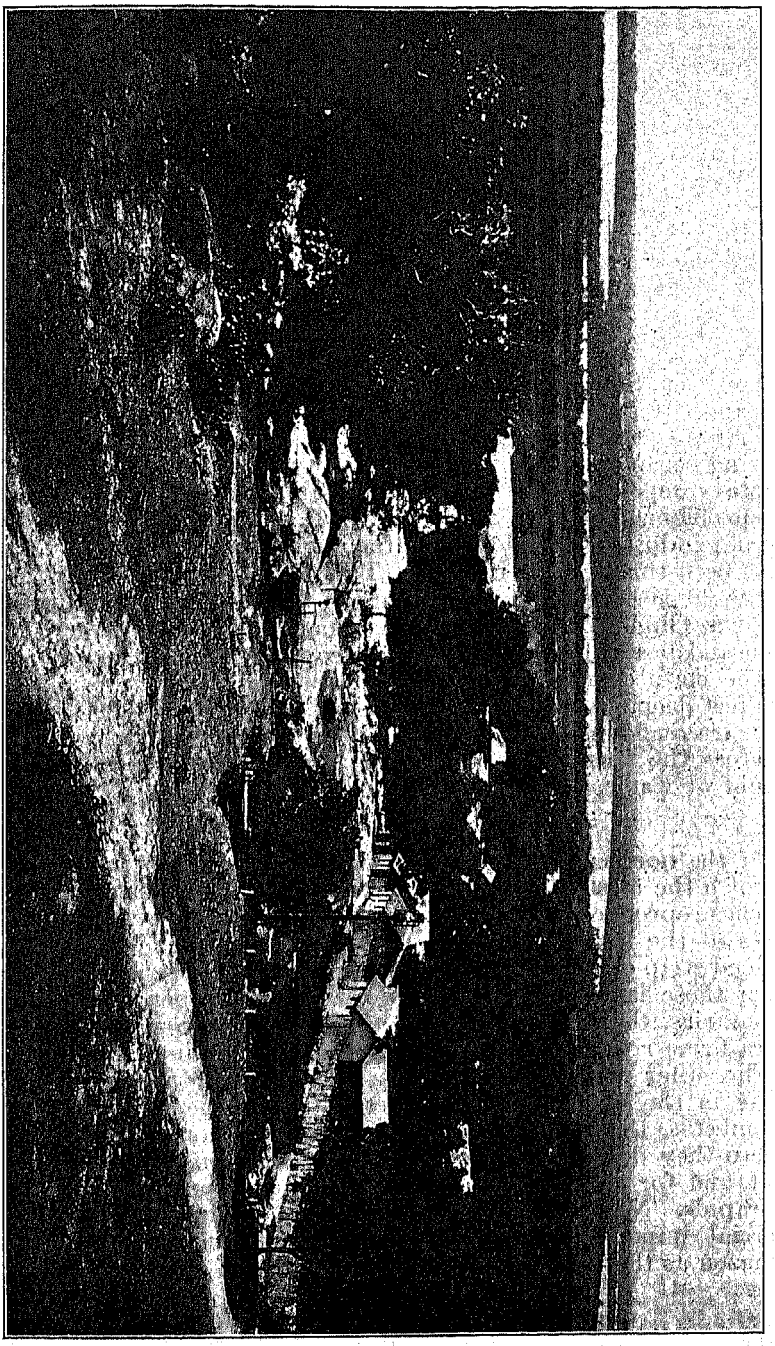


FIG. 28.—Monte Alegre, on the lower Amazon. The streams in the foreground are paranas, or arms of the main river, which can be seen in the distance

Since 1918 there has been a succession of extraordinary and devastating floods in the lower Amazon, though in 1924 the level of the river was considerably below normal. The veritable deluges that have swept over the lower Amazon Valley during the past few years may be accounted for by the unusual coincidence of heavy rains over a considerable and simultaneous period throughout most of its drainage basin and the melting of uncommonly heavy masses of snow in the Andes. The concurrence of those circumstances has also probably been supplemented by a third factor, whose influence is more difficult to estimate; that is, the effect of the gradual accumulation of alluvial deposits in the bed of the river in its lower reaches, serving to slacken the rapidity with which the Amazon is able to evacuate its flood waters into the ocean.

LOSS TO INDUSTRY

However, this would appear to be a temporary and unnatural disturbance of the normal process, whereby the tremendous force of the river's current is ever deepening its channel, while the north-flowing ocean current off its mouth serves to carry much of its sedimentary deposit up the coast of the mainland. Meanwhile, pending the problematical cycle of rise and fall, the agricultural and stock-raising industries developed on the varzea lands of the flood plain have been threatened with ruin. This is well illustrated by the fate of the flourishing cacao plantations on the restinga, or natural-levee, lands at Obidos, which have been damaged beyond recovery. Many thousand head of cattle have been drowned in these floods.

The main channel of the Amazon at low water is usually 75 to 100 feet deep. At Obidos it attains a depth of 270 to 300 feet; here the current flows at a speed of 4 to 5 miles an hour in mid-channel, whereas the normal speed is from 1 to 3 miles, depending on the height of water.

TROMBETAS AND OTHER TRIBUTARIES

Of the northern tributaries of the lower Amazon the Trombetas is much the most important. Moreover, the flood plain of its lower reaches reproduces on a smaller scale most of the physiographic features of the lakes that border it on either side and of the clearly defined strip of restinga (natural-levee) land that separates the river from those lakes for long distances. In its upper course, like its tributaries, the Mapuera, Cachorro, and Eperecuru, it is a typical terra firme river, narrow, swift, and broken by numerous rapids.

The other rivers of the region, the Curua, Maicuru, and Paru, share in the same general characteristics of the tributaries of the Trombetas, that is, they are freely navigable only from the point where they descend to the level of the Amazon flood plain; above that, and for much the greater part of their course, they are broken by rapids. No stream of this region compares in magnitude or commercial importance with such great southern tributaries of the Amazon as the Tapajoz and Xingu.

TERRA FIRME

The terra firme extends north from the edge of the Amazon's flood plain to the Tumuc-Humac Mountains, which form the

boundary between Brazil and the Guianas. According to all reports, this is a comparatively flat or gently undulating tableland, rising like the steps of an amphitheater toward the north and broken by occasional isolated peaks and ranges of hills or low mountains. The altitude of some of these hills, chosen at random, is: Serra de Ariramba (Obidos), 984 feet; Serra do Timotaken, 2,624 feet; Serra do Itaujary (Monte Alegre), 1,000 feet; Serra do Erere (Monte Alegre), 886 feet; Serra do Paranaquara (Paru), 1,180 feet; Serra do Maracanay (Paru), 980 feet; Morro Grande (Maicuru), 2,063 feet; Serra da Boa Vista (Obidos), 416 feet.

CAMPOS

This region is characterized by vast areas of open grasslands. The largest single extent of these is in the northern part of the region, where they evidently constitute an extension of the vast campos geraes of the upper Branco. Explorers have encountered them about the headwaters of all the rivers. However, it is not known whether they constitute a continuous strip extending across the northern part of the State of Para or are separated by belts of forests. Their inaccessibility has hindered the verification of the current belief that they constitute a single unbroken area, the truth of which could easily be ascertained by airplane. They have never been occupied by settlers and no development of any kind has taken place on them.

However, near the Amazon and approaching to within a very few miles of the river along the stretch between Alemquer and Prainha there is a large area of such grasslands. These campos extend, with a slight break, for nearly a hundred miles east and west, and with a depth of 12 to 40 miles. They can be seen to excellent advantage by a horseback ride of about an hour and a half back of Monte Alegre. Isolated tracts of grassland are found farther in the interior—for example, the Ariramba tract, lying about 60 miles north of Obidos and accessible by way of the Trombetas and Eperecuru and a small tributary of the latter, the Cumina, thence by trail overland, or directly by the Rio Ariramba, which is, however, broken by several rapids.

WATER POWER

Due to their swift descent to the Amazon the streams of Region 3 contain many waterfalls and rapids that could be utilized for the development of electrical power. This is in contrast to conditions on most of the southern rivers, where the difference in level, especially at high water, is too small for hydroelectric utilization. The waterfalls in the northern rivers have the added advantage of proximity to the Amazon. Among the falls suitable for power development are the following:

Eperecuru River.—Cachoeira do Inferno, height 65 feet.

Curua River.—Cachoeira de Bemfica, height 16 feet.

Maicuru River.—Cachoeira de Panacu, height 45 feet; Cachoeira de Castanhal, height 19 feet.

Paru River.—Salto de Panama, height 30 feet.

Jary River.—Cachoeira de la Pancada, height 60 feet; Salto de Desesperacao, height 80 feet.

CLIMATE

TEMPERATURE

The following observations, made at Obidos by M. Paul LeCointe from January, 1903, to May, 1906, illustrate the range of temperature at that place (figures represent monthly averages for the period):

TABLE 31.—MONTHLY MEAN TEMPERATURE, OBIDOS, 1903–1906

Months	Average temperature	Months	Average temperature
	° F.		° F.
January	80.76	September	82.49
February	79.79	October	83.19
March	79.57	November	84.27
April	79.11	December	81.85
May	79.25		
June	78.84	Year	80.91
July	79.92	Absolute maximum	101.56
August	81.51	Absolute minimum	66.38

The lowest temperature coincides with the cold wind known as the friagem, which decreases in intensity in proportion to the distance from the Andes but whose influence is perceptible at Obidos. The month of highest temperature, November, is one of the driest months in the year. The hottest time of the day is between 1 and 3 p. m. There is a marked drop in the temperature after midnight, the coolest hour being about 5 or 6 a. m. The nights are always refreshingly cool, however hot the day may be.

With slight differences the temperatures given above would serve for other points similarly situated along the main stream, though Obidos is said to enjoy the best climate of any of the river towns, due to its exposure to the winds that blow up the Amazon. Its only possible rival in this respect is Santarem, which is located on a wide bay at the mouth of the Tapajoz. There can be no doubt that few towns situated anywhere in the Tropics at the same altitude enjoy so agreeable a climate. As one goes north from the Amazon toward the Guianas there is a noticeable decline in the prevailing temperatures; this is especially marked in the open country. Climatic conditions in the vicinity of Itacoatiara are substantially the same as those of the region of Manaos (see p. 218).

RAINFALL

In no other part of the Amazon Valley are the wet and dry seasons so clearly defined as in Region 3. The rainy season comprises roughly the six-month period from the middle of December to the middle of June. The remainder of the year constitutes a pronounced dry season, though there may be considerable variation in the duration of the respective seasons and in the relative volume of rainfall in each. Thus, in 1915 and 1916 the rainy season began in early November, nearly a month and a half before the usual time.

During the dry season, for one or two months or an even longer period, there may be no rain whatever, and one case of 156 consecutive days with less than 0.8 inch of rain is recorded at Obidos (June–November, 1899). It is, however, a well-recognized fact that the rainfall is heavier in the forested regions than in districts where large clearings have been made.

LeCointe gives the following records of his observations of rainfall at Obidos:

TABLE 32.—AVERAGE MONTHLY RAINFALL AND WET DAYS, OBIDOS, 1903–1918

Months	Rainfall	Wet days	Relative humidity	Months	Rainfall	Wet days	Relative humidity
	Inches	*Number*	*Per cent*		*Inches*	*Number*	*Per cent*
January	9.48	21.8	80.76	August	0.56	4.5	69.26
February	6.75	20.2	81.25	September	2.46	5.5	70.80
March	12.36	21.6	84.74	October	2.63	5.0	65.00
April	8.78	23.0	85.34	November	2.91	5.2	62.49
May	6.05	18.6	83.69	December	4.44	12.7	78.77
June	3.66	12.6	79.33				
July	1.92	7.0	73.60	Total	62.00	157.7	[1] 76.26

[1] Average.

The lowest humidity registered was 45 (November 7, 1903). The driest atmosphere generally accompanies the east or northeast winds. At Obidos about 65 per cent of the rainfall occurs during the night.

POPULATION

Region 3 consists of the following municipalities, with their respective populations, as given by the Federal census of 1920:

State of Amazonas:	Population
Itacoatiara	17,842
Silves	3,533
Urucara	3,535
Total	24,910
State of Para:	
Alemquer	15,873
Almeirim	7,643
Faro	6,513
Monte Alegre	11,837
Obidos	26,812
Prainha	3,890
Total	72,568

Or 97,478 for the whole district. The two municipalities of Monte Alegre and Prainha take in both banks of the Amazon, but the great majority of their inhabitants live to the north of the main river. Also, the upper point of the municipality of Mazagao, comprehended within the basin of the Rio Jary, is included in the general area under examination, but the population of that district is insignificant. The entire area covered in this report may be said to have a population of about 100,000 persons, most of whom live within 50 miles of the Amazon.

LABOR

The predominant element in the population consists of natives of the two States. Cearenses and immigrants from other northeastern coast States are much less prominent than in the Acre and along the upper rivers in general, where they have given a special character to the population.

The typical native of the region is the usual type common to the Amazon Valley, with the negro element probably predominating and with a certain admixture of Indian blood in his make-up. He is ordinarily less nomadic than the Cearense, though large numbers have been lured from agricultural pursuits by the fallacious promises of the labor agents of the Brazil-nut dealers. His diet consists largely of pirarucu and other fish, which abound in the rivers and lakes; bananas, beans, farinha or mandioca, and rice. His habitation is the usual palm-thatched hut of the Amazon Valley.

It is our opinion, after examination of the labor situation and making inquiries of large employers in a position to know, that 3,000 laborers could be obtained in this region without great difficulty. The nearest source of supply for additional laborers is the delta section, and beyond this the seaboard States of Maranhao and Ceara, with which there are direct and frequent steamer connections. No Indian tribes that could be drawn on for laborers live below the rapids. The terra firme is suitable for settlement by white immigrants, provided they were willing to face pioneering conditions.

The principal towns of this area are Itacoatiara, Obidos, Alemquer, and Monte Alegre. Their population ranges from about 1,000 to 3,000, Obidos being the largest of the four. Due to its healthfulness, comparative cleanliness, and other circumstances, Obidos offers the most satisfactory living conditions of any town within the region.

HEALTH AND SANITATION

Health conditions vary greatly from one locality to another, but as a rule the country bordering the main river, even its lowest-lying parts, is more healthful than that bordering the tributaries. The town of Obidos has a well-earned reputation in this regard, and other places similarly situated on high ground share in the same excellent sanitary conditions. Some of the tributaries, however, are notorious centers of malaria in its most malignant form. The cachoeira zone is especially unhealthful. This is true of the Trombetas and its affluents, the Mapuera and Eperecuru, as it is of the Curua, Maicuru, Paru, and Jary. Where malaria appears along the main river it is generally of a less malignant character.

A very large majority of the population, nearly all of whom go barefoot, have hookworm. Leprosy is altogether too frequent here, as throughout most of the Amazon Valley. Digestive complaints are common in the interior, due mainly to malnutrition. This is particularly true of the castanha (Brazil-nut) gatherers, whose diet is pitifully inadequate. No cases of yellow fever or beriberi have been reported for several years.

The bad sanitary conditions prevailing in many parts of this area may be laid to the natives' utter disregard of the most rudimentary

rules of hygiene. Many do not possess hammocks, and few sleep under mosquito nets.

The activities of the Prophylaxia Rural maintained by the Federal Department of Public Health have not been extended to this region. The nearest post of this service is at Santarem, on the south side of the Amazon, at the mouth of the Tapajoz. There is a small hospital at Obidos, but physicians are rare throughout this area. There are well-stocked drug stores in all the towns—nine in Obidos alone. For cases requiring treatment beyond the capacity of local physicians, medical or surgical treatment may be secured at Para, which is not over two or three days from river points in this area.

VEGETATION

The three types of vegetation common to the Amazon Valley—that is, varzea, terra firme, and campos—are well represented in this area.

VARZEA

The flora peculiar to the varzea (lowlands subject to periodic inundation) is found in all its phases and cycles of development on the flood plain of the Amazon and of its principal tributary, the Trombetas. The first plant life to appear on the newly formed lands consists of the ceiranas, with their sparse foliage. Behind these are the familiar imbauba (*Cecropia paraensis*), the most prominent feature of varzea vegetation throughout the Amazon Valley. Along the margin of the rivers and paranas there is generally a strip of the high cannarana grass and in the low swampy lands near the varzea lakes vast areas are covered by the aninga (*Montrichardia arborescens*).

As the newly formed land ages, a more permanent vegetation supersedes the first forms, such as the imbauba. Among the trees of the adult vareza lands are the following:

	Scientific name
Munguba	Bombax munguba.
Tachy	Triplaris surinamensis.
Parapara	Cordia sp.
Tapereba	Spondias lutea.
Andiroba	Carapa guianensis.
Macacauba da varzea	Platymiscium paraense.
Pao mulatto	Calycophyllum spruceanum.
Muiratinga	Olmedia sp.
Cuaxinguba	Ficus sp.
Louro da varzea	Nectandra amazonum.

Among palms are the murumuru (*Astrocaryum murumuru*), the urucuri (*Attalea excelsa*), and jauary (*Astrocaryum jauary*).

In spite of the deceptive appearance caused by the netted curtain of climbing plants, the varzea jungle of this section of the Amazon Valley is not heavy when compared with that of the islands near the mouth of the river.

TERRA FIRME

The terra firme (upland) forest in the belt bordering the Amazon is noticeably lighter than in either the Solimoes section farther up the river or the delta section below. This can be explained by the

lighter rainfall as well as by the sandy character of the soil. However, on a horseback ride of several hours back of Obidos we observed a progressive improvement in the jungle, which for the first few miles was very light, but after a certain distance gradually became heavier, though never so heavy as forest that we saw in some of the upper rivers. We were assured by the natives that several miles beyond in the country about the small Branco River the forest was still heavier (matta fechada), but we did not have an opportunity to verify their statements. Inland from the Lago Salgado, near the junction of the Eperecuru with the Trombetas, we encountered better jungle than in the vicinity of Obidos.

The outstanding tree of the terra firme here as elsewhere in the Amazon Basin is the gigantic castanheira, or Brazil-nut tree, which is frequently found in heavy stands. Among other trees on the terra firme are the following, many of which have a considerable commercial value:

	Scientific name
Itauba	Silvia itauba.
Acapu	Vouacapoua americana.
Muirapinima	Piratinera guianensis.
Muirapiranga	Brosimum paraense.
Pao de rosa	Aniba parviflora.
Pao santo	Zollernia paraensis.
Copaiba	Copaifera guyanensis.
Pao roxo	Peltogyne densiflora.
Jutahy	Hymenaea courbaril.
Jacaranda	Dalbergia spruceana.
Macacauba	Platymuscium Duckei.
Assacu	Hura crepitans.
Cedro	Cedrela spp.
Seringueira vermelha	Hevea guyanensis.
Sumauma	Ceiba pentandra.
Piquia	Caryocar villosum.
Massaranduba	Mimusops spp.
Pao d'arco	Tecoma sp.

CAMPOS

The character of the campos (grassland or natural-prairie) vegetation varies from the campo fechado type, where the grass is interspersed with scrub trees, to the true open campos. The natural growth of grass in either zone is sparse and coarse, though of a better quality in the open than in the so-called "closed" campos, where it exists rather in scattered clumps in the sandy soil. The arboreal growth of the "closed" campos consists of low, stunted trees of scant foliage. Cacti are numerous, and the dominant palm is the low, spreading curua, which flourishes in sandy ground. In the lower belts along the watercourses the vegetation is noticeably heavier.

WILD RUBBER

The rubber industry of Region 3 is insignificant. The district has furnished only 2.44 per cent of the total production of the State of Para since 1903, and has never exceeded 3.53 per cent, the proportion for that year. In 1922 it supplied only 1.55 per cent of the total production of the State, or 62 tons in all.

Hevea brasiliensis is not native to this area; it appears on the north bank of the Amazon only near the islands (Region 1), whither the seeds have been carried by the river.

Hevea benthamiana, whose product is classed as "weak fine," is found in the western part of Region 3 in the basins of the Jamunda, Mapuera, and Cachorro. However, the predominant species is the *Hevea guyanensis*, or seringueira vermelha, which exists over most of this section, but whose rubber is classed as "weak" and therefore not a profitable subject for working under present conditions of the industry.

OTHER INDUSTRIES AND RESOURCES

AGRICULTURE

The foreigner in the Amazon Valley is strongly impressed by the small development of agriculture in relation to the manifest fertility of the soil and the opportunities which the industry would appear to offer. Instead of progressing, agriculture has in fact declined, and certain products which once were exported in considerable quantity are now imported from abroad or from southern Brazil. Of such are sugar and coffee, while cotton, at one time an important item of export, is now produced on an insignificant scale. Rice and tobacco are the only agricultural products in the State of Para whose cultivation is showing signs of vitality.

However, the restoration of agriculture to something of its former importance is one of the conditions essential for the economic revival of the Amazon Valley. Not only would it stop the drainage of large sums annually from the State to pay for imported foodstuffs but it should, furthermore, produce a surplus for export.

CAUSES CONTRIBUTING TO THE DECLINE

Several causes have contributed to the decay of agriculture. One of these was the disastrous civil wars of the early part of last century; another, the liberation of the slaves. Later the lure of the high returns to be made in working rubber was a serious blow to agriculture, as is the attraction of Brazil-nut gathering to-day. Epidemics of malaria and other diseases were additional factors in the decimation of the agricultural communities. Finally, the destruction of several successive crops by extraordinary floods disheartened the cultivators in some places.

The caboclo of these regions generally prefers to devote himself to the extractive industries rather than to agriculture, despite the more certain rewards of the latter and the more satisfactory living conditions possible. On the lowlands he lives in dread of the annual floods, and on the uplands he is liable to be daunted by the effort required to make a clearing in the forest and afterwards to keep it clear of the vegetation that always threatens to overrun it. Yet with a fair amount of industry the inhabitants of this region can produce in abundance a great variety of products, many of which are always marketable. These include rice, sugar cane, cacao, coffee, corn, mandioca, beans, and sweet potatoes. Of fruits, there grow with a minimum of care the banana, orange, lemon, mango, pineapple,

melon, abacate or alligator pear, mamao or papaya, guava, maracuja, caju, cupu-assu, and bacury.

CACAO POSSIBILITIES

Of the products listed above cacao is not only found extensively in a wild state throughout the Amazonian forests but its cultivation is the most important branch of commercial agriculture practiced in the lower Amazon Valley. The industry is an ancient one in that region, over a thousand tons having been exported from Para as early as 1775. Though a large amount of cacao is produced by the State of Amazonas, particularly in the municipal districts of Parintins and Itacoatiara, the principal producer is the State of Para. The plantations are concentrated on the restinga (natural-levee) lands along the Amazon and may be observed to good advantage along the parana of Obidos, which is lined for 20 miles or more on its north side with small properties devoted largely to the production of cacao. An interesting plantation is the Cacoal Imperial, which is situated on the south bank of the river a short distance below Obidos. At this place plants over a century old are still bearing heavily. The Cacoal Grande, located between Santarem and Monte Alegre, made elaborate preparations to produce cacao on a large scale but later abandoned the project. This property, which is probably the finest establishment along the Amazon, is owned by a company with headquarters in Strassburg.

In spite of the recognized high quality of the Amazonian product and the assurance of a good market, the industry in this region is in a far from flourishing condition. In the first place, it has never recovered from the general abandonment of agriculture that was caused by the exodus to the seringaes (rubber properties) in the days of the great rubber boom. Also, during the past few years the cacao plantations have been ravaged by the unusual floods of the Amazon, and many fine cacaoes (cacao plantations) have been ruined beyond recovery. Finally, few of the growers make an intelligent effort to maintain the production of their older trees by pruning or other means.

However, the industry is capable of wide development, but on condition that the plantations be located on terra firme (upland), where, given proper soil conditions, the plants will flourish despite the current local belief to the contrary, and on the further essential condition of a radical change in the methods of cultivation and preparation.

LIVESTOCK

Though it has declined as a result of pests and floods, the raising of cattle is still an important industry along the lower Amazon and one capable of considerable development.

There are three types of pasture lands on which cattle are raised.

(*a*) The first consists of the varzea lands of the flood plain, on which cattle may generally be pastured for about nine months of the year. These low-lying meadows are of great extent and are covered with grasses that furnish excellent fattening forage for cattle. Where there are near-by open lands on the terra firme to which cattle may be driven upon the rise of the river, the utilization of the varzea pas-

tures is entirely practicable. This combination exists in several localities, as for example at Monte Alegre.

The cattle breeder who has no high land within reach to which he can transfer his stock is at a great disadvantage. If the annual flood is normal he may preserve his herds by driving them to high points of the restingas (natural levees) or onto platforms constructed for the purpose, where they remain huddled together until the recession of the flood. During this time they feed on whatever floating grass comes within reach or on whatever their owner may bring to them in canoes. This is, under any circumstances, a precarious and inadequate nourishment. Moreover, when the flood exceeds all normal calculations, as has occurred frequently since 1918, the usual precautions are of no avail and cattle are drowned by the thousands.

(*b*) Though the natural grasses of the campos are comparatively sparse at all seasons and parch during the long dry summer, in the rainy season they are adequate for the support of considerable herds, especially as they are supplemented by the better pasturage always to be found along the watercourses. The planting of such grasses as the jaraguá, which is suited to a sandy soil and resists a long rainless season, should greatly increase the capacity of these campos pastures.

(*c*) A third and less important type of pasture is represented by artificial clearings made for the purpose on the terra firme. While this is a relatively costly procedure, these pastures have the advantage over the natural grasslands of superior fertility, artificial grasses growing on them with great luxuriance.

THE SMALLER FOOD ANIMALS

Very few breeders have made any effort to improve the quality of their cattle beyond the introduction of a few head of zebus, which at least increase the hardiness of the stock, though they lower the quality of the beef.

The market available to cattle breeders along the Amazon comprises, in addition to the limited demand for local consumption, the cities of Manaos and Para and the regular river steamers, with which a good business is done. In March, 1924, an average steer in the neighborhood of Monte Alegre and Prainha sold for 100$000 to 150$000.

Though there are no large droves, hogs demand a minimum of effort, as they obtain much of their food by foraging about the forest, and corn for fattening them is easily grown in abundance.

Some woolless sheep are raised on the higher lands, and both sheep and goats could be raised in considerable numbers by utilizing unoccupied grasslands in the interior. For the purpose of supplying a meat diet to the rural population these smaller animals are preferable to cattle, as there is no means of preserving beef except to dry it as xarque, which is only possible during the dry season.

OILSEEDS AND NUTS—TIMBER

In addition to these there are a great variety of other natural resources in this region which, though little utilized at present, are

capable of furnishing considerable raw materials for potential local industries or for export. The most important of this class of products are the vegetable-oil materials. Of these, andiroba and copaiba oils have long been shipped out in limited quantities, as have also the aromatic cumarú or tonka beans. However, the various classes of palm nuts hold much larger possibilities, a subject which is given more consideration in another part of this report. (See p. 183.) The highly important castanha, or Brazil-nut, industry is described in a separate report.[4]

The timber resources of the region have been little developed, notwithstanding the manifest possibilities in this line. Only trees within easy reach of the navigable rivers are cut, as facilities are lacking for taking out logs from the interior forests. However, either the laying of Decauville track or the building of roads suitable for tractor hauling would be comparatively easy in the forests of the terra firme, where the undergrowth is light and the topography presents few difficulties.

Other products that offer advantages are a number of valuable fiber plants, several plants with possibilities for the manufacture of paper, tanning and dyeing materials, and a long list of aromatic and medicinal plants.

TRANSPORTATION AND COMMUNICATION

RIVER

The river system of this region may be illustrated by the following diagram:

- Amazon.
  - Jamunda.
  - Trombetas.
    - Eperecuru.
    - Cachorro.
    - Mapuera.
  - Curua.
  - Maicuru.
  - Paru.
  - Jary.

The Amazon is freely navigable at all times for vessels of any draft.

With the exception of the Paru, the tributaries named above flow across the low plain that borders the Amazon and are there navigable; but as a rule, soon after entering the terra firme one encounters cachoeiras that mark the limit of navigation for any craft larger than canoes. Many of these rapids can not be passed by canoes, which must be dragged around them. Sometimes when the tableland is reached above a series of cachoeiras there is a considerable stretch of smooth water that is navigable for canoes. However, none of these rivers can ever be utilized for penetrating the remote interior, and their usefulness for purposes of transportation is limited to the moving of the local products of the country tributary to their lower reaches. Also navigation is greatly restricted during the dry season, when some of the smaller rivers,

[4] Pierrot, A. Ogden. The Brazil-Nut or Castanha Industry, Trade Information Bulletin No. 259. The Bureau of Foreign and Domestic Commerce, Washington, D. C., 1924.

such as the Curua, can be traveled only by canoes. The seasons of highest and lowest water correspond roughly to those of the southern tributaries of the Amazon and do not follow the rule of the Branco River and most other northern streams to the west of this region. The annual rise generally begins in December and the rivers are at their height in May or June and at their lowest in the months of September to November.

The series of lakes which occupy a large part of the low alluvial lands bordering the Amazon are a prominent feature of the fluvial system of this region. During most of the year these lakes are navigable by the regular river steamers which ply on the Amazon and which enter them to take out Brazil nuts and other products. During the dry season these lakes may be freely navigated by launches.

LIMIT OF NAVIGATION

To consider the different rivers separately:

The Jamunda is navigable by the regular steamers beyond a maze of lakes and furos to the town of Faro. Above that light-draft launches can navigate for a considerable distance to the first cachoeira.

River steamers of 200–300 tons burden can ascend the Trombetas to near the first cachoeira, a distance of about 145 miles, during most of the year. Larger boats can reach the Lago do Jacare, some 113 miles from the mouth, for the same season.

The first cachoeira in the Eperecuru can be reached by launch during high water but is accessible by canoe for most of the year. Above that point it requires about a month of the most difficult traveling to reach the campos country. The total distance covered is short, but the course of the river is broken by 33 rapids and falls, down which it works its way as by a succession of stair steps from the tableland above.

The Curua is little navigable, first, because of the small volume of water during about six months of the year, and, second, because of the 52 cachoeiras that interrupt its course.

The Maicuru is navigable by launches to the rapids known as Cachoeirinha, and at high water boats may ascend to the Cachoeira de Panacu, where the river drops 40 feet in a distance of about 400 yards.

Launches may ascend the Paru about 70 miles to the fall of Panama, where the river plunges over a ledge about 30 feet high.

The Jary is navigable to a short distance below the falls of the Pancada, which are about 60 feet high.

FREIGHT AND PASSENGER SERVICE

Itacoatiara, Obidos, and Prainha, three river ports of this region, are respectively 762, 542, and 387 miles from Para. Of these towns, Obidos and Itacoatiara are on the main channel of the Amazon and Prainha on a parana or arm. All three have good wooden wharves with small warehouses capable of handling all present traffic needs.

There is frequent communication with Para by several lines of steamers; these include the Lloyd-Brasileiro, with direct weekly

connection from Obidos to Rio de Janeiro and intermediate points on the Brazilian coast, and the Amazon River Steam Navigation Co. In addition, several private trading companies of Para operate steamers on this section of the Amazon. Considerable local traffic is handled by launches owned by merchants of the different towns along the main river.

All products of this region destined for export are sent to Para for transshipment. However, such goods may be loaded at Obidos or other point, on condition that a customs inspector is taken on at Para or Manaos, the shipper bearing the charge for this special concession.

ROAD

Though the total mileage of highways is still very small in proportion to the area of the territory, more has been done toward the building of roads in this region than in any other part of Brazilian Amazonia. Nearly all the important towns have roads that connect them with agricultural settlements some distance from the river. One from Obidos leads northeast to the Branco River, where a community of small farmers is located. Similar roads have been built out from Alemquer and Monte Alegre to other agricultural colonies. It is said to be possible to go by connecting trails from Obidos to Prainha. While these roads are used only by pack animals, with a little repairing in certain stretches they could be made suitable for wheeled traffic. Some of the more important private landowners of this country have built roads on their properties, usually for taking out Brazil nuts. Thus, Jose Picanso Diniz has constructed roads in the Lago Salgado district of the lower Eperecuru on which he is using a tractor with good results. He has another road leading around the seven lower cachoeiras of the Eperecuru.

This last-mentioned road illustrates the ease with which communication could be opened up between the line of the Amazon and the vast campos country that borders on the Guianas. The land is generally level or only slightly undulating, though steadily rising to the table-land in the interior. Steep grades could be avoided, and the ground offers a good natural surface for roads. In fact, road building in this zone presents uncommonly few difficulties.

RAILWAY—TELEGRAPH AND CABLE

Several years ago the survey was made for a railway to connect Lago Salgado in the Trombetas country with the campos geraes in the northern part of the State, but construction never was begun.

The subfluvial cable of the Amazon Telegraph Co. between Manaos and Para touches at Itacoatiara, Obidos, Alemquer, Monte Alegre, Almeirim, and Prainha, with stations at all these points. The service is very good, though rates are high, except for deferred messages.

OWNERSHIP OF LAND AND LAND LAWS

Most of the land in Region 3 easily available to river transportation has long since been occupied. Many of these properties are small, as in the cacao-producing districts and the few agricultural

colonies, and a zone about the capital of each municipal district is reserved to the municipality to be disposed of in small lots under conditions fixed by the local government. However, the interest in the collection of Brazil nuts has resulted in the taking up of large tracts of forest land during the past few years. The campos geraes of the northern part of the State are still public domain, though the government offers very liberal inducements for their occupation.

ACQUISITION OF PUBLIC LANDS

The acquisition of public lands (terras devolutas) in the State of Para is regulated by executive decree No. 3791, of January 31, 1921, the principal provisions of which are:

Art. 4. Lands may be acquired by purchase, lease, or by gratuitous cession when provision therefor is made by special law.

Art. 5. Describes the distinction made between lands destined for agriculture, stock raising, or the so-called extractive industries.

Art. 8. In case of purchase the total value of the land is fixed as the price of the land plus costs of surveying.

Art. 9. The schedule of prices for lands acquired by outright purchase is as follows:

(*a*) 100$000 per lot of a maximum of 100 hectares (hectare=2.47 acres) for land destined for farming or stock raising, when situated along railroads or navigable rivers.
(*b*) 1$100 per hectare for tracts of 100 to 1,000 hectares.
(*c*) 1$200 per hectare for tracts of 1,001 to 2,000 hectares.
(*d*) The price is increased progressively at the rate of 100 reis per hectare for each successive 1,000 hectares up to 1 square league.
(*e*) When situated over 3.75 miles from railway or navigable river the price is one-half that fixed above.
(*f*) The scale of prices for lands destined for any of the extractive industries is double that provided above.

Art. 11. Lands in the unexplored regions above the cachoeiras in the rivers to be sold at one-half the prices fixed in the above scale.

Art. 14. Fixes dimensions of each lot of land, as follows:

(*a*) Lots for agricultural and extractive industries in the interior to have measurements of 1,640 to 9,840 feet front by 3,280 to 19,685 feet deep.
(*b*) Industrial concerns may acquire a maximum of 10 such lots.

Art. 20. Payment may be made in five annual installments.

Art. 21. If payment is made in one installment a reduction of 20 per cent from the prices fixed above is granted.

Art. 50. Makes provision for the perpetual lease of public lands in lots of 2,000 to 10,000 hectares or even larger quantities.

Art. 51. Annual rental to be 2 per cent of the sale price of the respective class of lands for tracts of 10,000 hectares or less and 1 per cent for larger tracts.

Art. 53. Lessees are required to initiate development of land within one year after date of signing concession.

CAPITAL REQUIREMENT FOR AGRICULTURAL CONCESSIONS

Art. 57. "The concession of public lands in areas of over 2 square leagues can only be made to agricultural or industrial enterprises which have the necessary capital for their development by means of the intensive and methodical cultivation of rubber, castanha, or other useful plants.

"(*a*) The capital of the company shall be fixed at the ratio of 100:000$000 (100,000 milreis) for each 10,000 hectares which is to be devoted exclusively to the declared purpose of agricultural development.

"(*b*) The concession may be granted in the form of an option for a period of one to two years, within which time the company may be organized in accordance with the laws of the State.

"(*e*) The company shall pay into the treasury of the State at the beginning of each six months a quota of 1:500$000 (1,500 milreis) for the employment of a fiscal (inspector) to be named by the State government. In case the area of land exceeds 100,000 hectares there shall be appointed an assistant fiscal under the same conditions.

"(*f*) The company shall enjoy all the favors in force now conceded by the government, or which may be conceded within 15 years from the date of concession, with the same objective as the present law, including the right of expropriation for purposes of public utility, for account of the company, of any property or improvements which it may be necessary to acquire for the purpose of opening roads destined for taking out the products of the company to the nearest railway or port of embarkation.

"(*h*) The company may reserve part of the area leased to it for the formation of agricultural colonies, from which it may distribute lots of 25 hectares to each family, by means of nominal titles, after two years of settlement and development."

GRATUITOUS GRANTS BY SPECIAL LEGISLATION

Art. 59. Gratuitous grants of State lands may only be made in accordance with special legislation to that effect.

Law No. 1956 of November 17, 1920, provides for the granting of certain favors to "enterprises organized for the purpose of cultivating intensively the lands of the State." Its principal provisions are:

Art. 1. Limitation of export duty to 5 per cent ad valorem, of which 3 per cent would be devoted to the State and 2 per cent to the municipal district.

Art. 2. Conditions of contract:

(*a*) Capital to be fixed at rate of at least 100 contos (100:000$000) for each 10,000 hectares and to be devoted exclusively to development of industry specified.

(*b*) At least two-thirds of personnel to be of Brazilian nationality.

(*c*) Company must be legally domiciled within the State, with a manager or administrator empowered to represent it before the courts.

(*d*) Company must maintain a sanitary post for treatment of such diseases as are common to the particular locality.

Art. 3. The period of limitation of export duties shall be 15 years, and the rate may only be increased thenceforth to the extent of 10 per cent of the privileged rate and at 5-year intervals for a total of 25 years.

Art. 4. During the period provided for by this law the products of the concessionaires can not be taxed with any additional export duty beyond the 3 per cent ad valorem, whether by the State or municipality, either directly or indirectly, either by a tax on production or transportation.

Art. 5. The following industries may enjoy the advantage of this law:

"(*a*) The planting and intensive and methodical cultivation and preparation of rubber, cacao, cotton, tobacco, coconuts, mandioca, and fiber plants.

"(*b*) The extraction or manufacture and refining of vegetable oils, of wood pulp for the manufacture of paper, and of tanning materials."

[For the present export duty levied by the State of Para on rubber see page 113. Regulations governing the acquisition of public lands in the State of Amazonas are described in the report on the Madeira area (Region 5).]

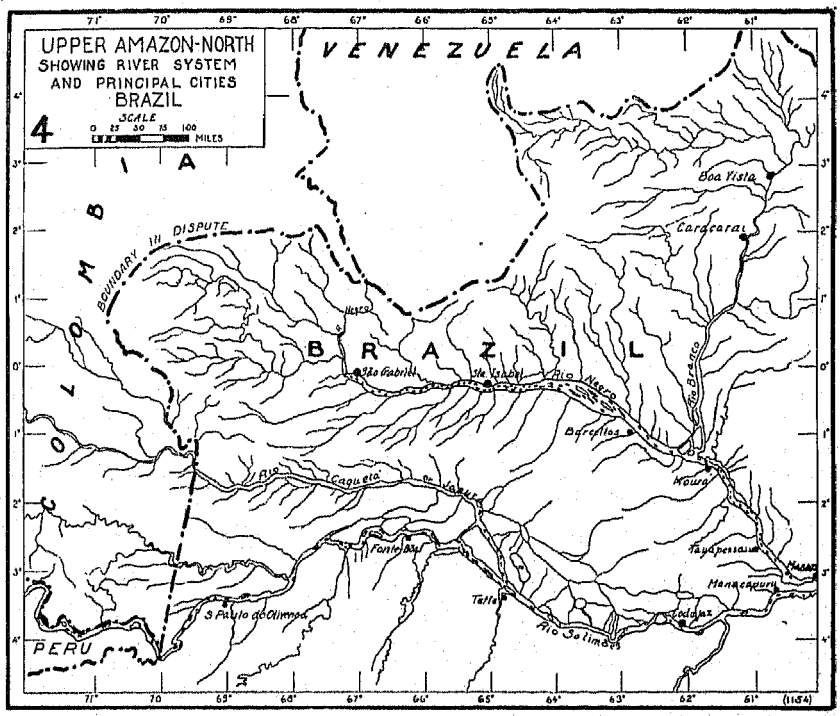


FIG. 29

4. UPPER AMAZON, NORTH

LOCATION AND AREA

The area comprehended in Region 4 includes that part of the State of Amazonas which lies north of the Solimoes, or upper Amazon, and west of Manaos, approximately 300,000 square miles in extent. Its limits of latitude are, roughly, 4° 14′ S. and 5° 18′ N.; of longitude, 59° 30′ as its eastern extreme, 69° 50′ as its western.

The Republic of Colombia lays claim to a wide territory in the western part of this region, extending almost to the principal mouth

of the Japura and to Santa Isabel on the Rio Negro. However, these claims have not been pressed and are not represented by any occupation of the area in controversy, so that for the purposes of this report the region can be considered as a part of Brazil. The boundaries with Venezuela and British Guiana have been fixed.

In the course of the investigations there was covered by actual observation the country bordering the Solimoes from the mouth of the Rio Negro to the Peruvian frontier; also the Negro to the mouth of the Branco, thence up that river to Caracarai.

PHYSICAL FEATURES

Although the valleys of the Negro and Branco Rivers are in close proximity to the city of Manaos, relatively speaking, they seem to be less developed and less known than others much farther away. On account of the (as far as known) poorer soils and the lower annual rainfall in this region it is not considered so favorable from a rubber-planting standpoint as other districts, and consequently the field party did not examine it in as much detail.

NEGRO RIVER

The Rio Negro itself, comes close to being the first in size of the tributaries of the Amazon. At Manaos it is about 4 miles wide; a few miles above it spreads out to a width of 6 to 10 miles; and beyond that for several hundred miles it takes on the character of an inland, island-dotted sea, 10 to 18 miles across. It retains this character until near the town of Santa Isabel, where it narrows down to 4 or 5 miles. The islands, at least to the mouth of the Branco, are all low and subject to inundation in the rainy season. The most characteristic feature of the terra firme is the white clay banks; but the land does not appear to be very high above the level of the river at any place, averaging 30 to 40 feet.

The land north of the Negro, east of the Branco, and south of the campos country, outside of the river valleys, is probably well-drained high land of even elevation. The lands north of the Negro and west of the Branco below the cachoeira belt have been very little explored and not much is known of them, but they probably also are well-drained, rolling to flat upland, except in the low valleys of the river. Granite rocks appear in the Rio Negro near the mouth of the Branco, and according to Whitney [5] again near Santa Isabel.

BRANCO RIVER

The mouth of the Branco is 206 miles from Manaos. This river in its lower reaches has a very wide flood plain (20 miles, more or less), and the river is likewise dotted with many low-lying islands. The banks are characterized, like those of the Negro, by a white clay, and this distinctive feature can be traced for many miles up and down stream. The Branco, as it is ascended, gradually nar-

[5] Whitney, Casper, The Flowing Road. J. B. Lippincott Co., 1912.

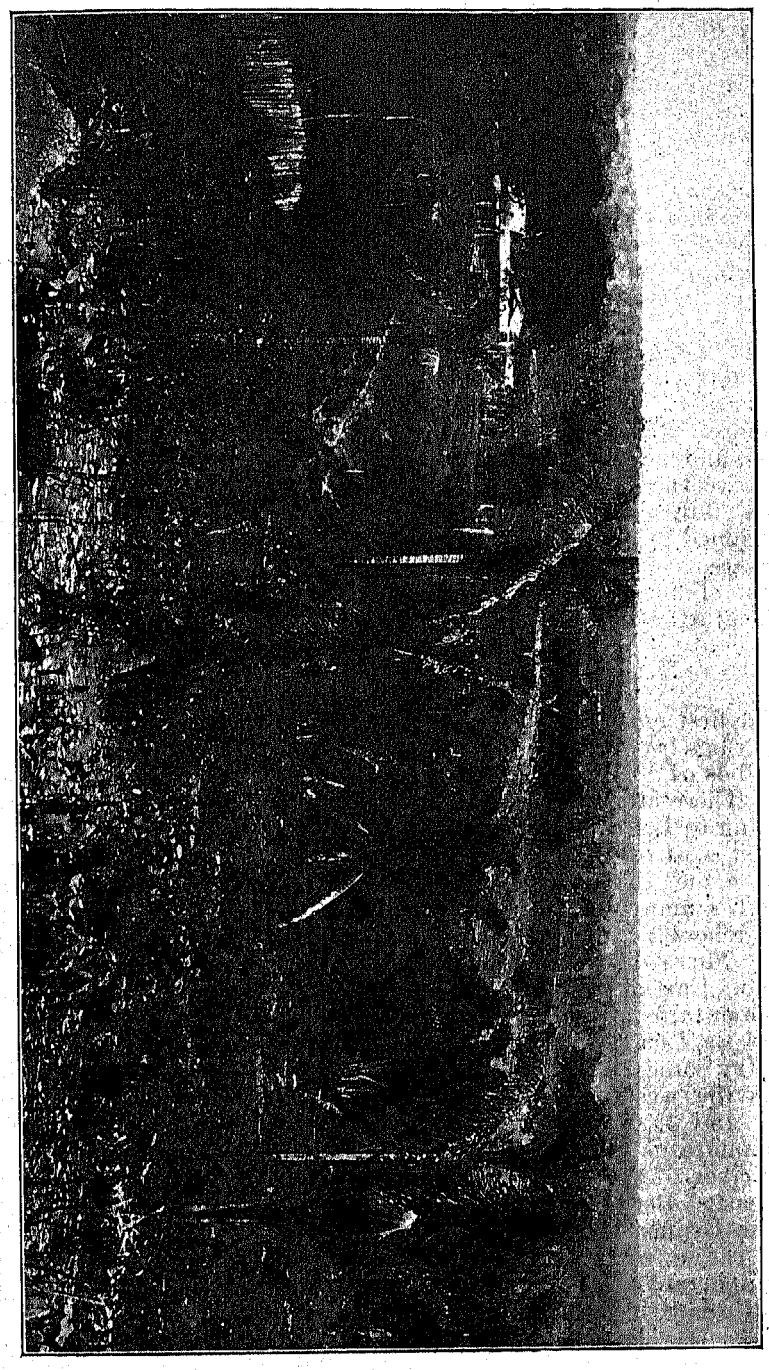


FIG. 30.—General view, sandy upland, near Manaos, Brazil

rows and at the cachoeiras (rapids) at Caracarai is about one-half mile wide in the dry season. As the cachoeiras are approached the banks of the river become higher. At Vista Alegre the level of the land is 50 to 60 feet above the water at low stage. The cachoeiras are produced by an outcropping of crystalline rocks, and in their general features are similar to those of the southern tributaries of the Amazon.

CAMPOS REGION

This belt of crystalline rock is likewise the natural dividing line of two distinct types of terrain, and the whole valley is commonly thought of in terms of this division, namely, the campos region and the lacustrine region.

On both sides of the river, beginning at Vista Alegre, there are natural campos, or open grasslands, the campos on the east (left) side at this place being much the larger in extent. They extend eastward to the frontier of British Guiana, a distance of 185 miles or more. The land is level to rolling, covered with a thin sparse grass, and near the rivers dotted with many clumps of forest.

Above the cachoeiras the campos country proper begins. It extends unbroken, with the exception of certain mountain chains as mentioned below, north into Venezuela and east into British Guiana. The area covered by natural campos is estimated at 13,500 square miles. This open country is used only for livestock, and thousands of head of cattle, horses, and sheep are annually raised here.

MOUNTAIN REGION

The first mountainous region met with is the Serra de Tapirapecu, which lies between the Coratirimani and Branco Rivers, between the parallels of 1° and 2° N. and near (west of) the sixty-fourth meridian. These attain an elevation of over 6,000 feet above sea level, according to LeCointe's map of the region.

Just west of Caracarai there is a small mountainous mass by the same name. The elevations of these are not given, but they can be seen for many miles in ascending the river. At the north end of the cachoeiras there are other mountains to the east, called respectively Serra da Cachoeira, Serra do Castanhal, and Serra da Conceicao. East of these, along the sixty-second meridian, is a long chain of mountains, running approximately north and south, called the Serra da Lua (Mountains of the Moon); beyond these the campos country comes down from the north and extends into British Guiana.

On the west side of the Branco, midway between the parallels of 2° and 3° N. and running east-west, there is the extensive chain of mountains known as the Mocajahy; these lie just to the south of a river of the same name and project into the campos country to the east. Between Cachoeirinha and Boa Vista, on the east side of the Branco and north of its affluent, the Cuitahuau, is a mountain range with an elevation of approximately 3,700 feet, and an important chain farther north between the parallel of 3° N. and the Rio Uraricoera.

SOLIMOES RIVER

In ascending the Solimoes (upper Amazon) from Manaos it was noticed that the river flows mainly along the north side of the valley for some 200 miles. In many places the terra firme is in sight, and the land is high and rolling along the river. From this point toward the Peruvian border it flows mainly along the south side. Beginning at the mouth of the Mamia (230 miles from Manaos) the south banks are very prominent, being 50 to 100 feet and over above the level of the water. The lands of the terra firme in this area, especially on the north side, should prove suitable for rubber plantations.

North of the Solimoes and running almost parallel to it is the Japura River, and the two are connected by many paranas, or canals. The Japura empties into the Solimoes opposite Teffe, but there are two paranas that continue parallel, one as far as Manacapuru. This means that these areas are lower and more swampy than on the south side, but between these rivers and paranas there also exist tracts of terra firme.

Between the Japura and Negro Rivers to the north the country has been little explored. However, it is known that there are not many large rivers and fewer small ones as compared with other parts of the Amazon Valley, so it can safely be concluded that there is a very large area of good, well-drained upland, now covered with virgin forest. It is the home of many uncivilized and partly civilized Indians.

WATER POWER—ELEVATION

In the regions traversed by the field party no location was observed where the rivers could be utilized for generating power because of the low fall. However, on the Rio Urupa, only 50 miles from Manaos, the river has considerable fall, and by the erection of a dam a large quantity of power could be generated.

Manaos is the only place in this area whose elevation is known with any degree of accuracy, it being 147.6 feet. The rate of fall to the mile in the river is very small, so that, outside of the elevated regions above the cachoeira belt to the north, the average elevation of the uplands probably would not exceed 300 or 400 feet.

CLIMATE

Notwithstanding the fact that part of the area embraced in Region 4 lies directly upon the Equator, and that Manaos itself is only 3° 8′ south, the climate is not so severe in its effects on Europeans as would be expected. The climate of Manaos is certainly superior to that of cities of approximately the same latitude in the rubber-growing countries of the East.

TEMPERATURE

The only place at which temperature observations have been made and records kept is Manaos (lat. 3° 8′ S., long 59° 59′ W., alt. 147.6 ft.); these, however, will serve as a general average for the region.

TABLE 33.—MONTHLY MEAN TEMPERATURE, MANAOS, 1911–1919[1]

Months	Mean	Mean maximum	Mean minimum	Absolute maximum	Absolute minimum	Relative humidity
	°F.	°F.	°F.	°F.	°F.	*Per cent*
January	80.0	88.7	74.7	98.6	69.8	80.5
February	80.4	88.9	74.7	96.8	69.8	80.5
March	79.9	87.8	74.5	96.8	69.4	81.1
April	80.0	87.6	74.8	94.3	69.4	81.9
May	78.4	87.8	74.8	95.0	69.8	82.4
June	80.2	88.0	74.8	95.0	66.2	79.6
July	80.9	89.1	74.5	93.6	68.7	77.1
August	81.7	91.0	74.8	96.1	69.8	75.0
September	82.7	92.8	75.0	98.9	70.5	73.0
October	82.9	92.3	75.7	98.9	70.5	74.5
November	82.4	91.6	75.5	98.9	69.8	75.9
December	80.8	89.8	74.8	101.5	68.7	79.8
Year	80.9	89.6	74.8	101.5	66.2	78.5

[1] Meteorological data from bulletins of the Directoria de Meteorologia, Rio de Janeiro.

On the Branco River in January, even directly on the Equator, both days and nights were found to be surprisingly pleasant. Some days the temperature in the early afternoon was high, but the mornings and nights were cool. The open country (campos) is said to have a very agreeable climate. This is due to its elevation and the prevalence of gentle breezes.

RAINFALL

At Manaos the rainy season comprises the months of December to May and the dry season the remaining six months. This division is not exact, since it may vary from year to year, but, generally speaking, there is a 6-month dry season and a 6-month wet season. It is not uncommon for periods of more than three months to pass without any rain.

During the wet season, precipitation may occur at any time of the day or night, but usually the rains come more often in the afternoon than in the morning.

The monthly average rainfall and wet days for Manaos (lat. 3° 8′ N., long. 59° 59′ W.), Sao Gabriel (lat. 0.6° 7′ S., long. 67° 2′ W.), and Boa Vista (lat. 2° 49′ N., long. 60° 41′ W.)—the last-named located in the campos country of the Branco River—were as follows for the periods indicated:

TABLE 34.—AVERAGE MONTHLY RAINFALL AND WET DAYS, MANAOS, SAO GABRIEL, AND BOA VISTA

Months	Manaos, 1911–1919		Sao Gabriel, 1910–1919		Boa Vista, 1910–1915	
	Inches	Days	Inches	Days	Inches	Days
January	8.30	17	6.87	12	0.60	4
February	8.00	17	8.76	12	2.38	6
March	8.05	16	7.41	12	3.74	4
April	8.44	19	5.01	16	5.11	8
May	6.60	18	12.66	16	8.27	15
June	3.92	10	6.81	16	12.98	19
July	1.82	6	7.47	16	9.47	18
August	1.30	7	5.43	11	7.13	17

TABLE 34.—AVERAGE MONTHLY RAINFALL AND WET DAYS, MANAOS, SAO GABRIEL, AND BOA VISTA—Continued

Months	Manaos, 1911–1919		Sao Gabriel, 1910–1919		Boa Vista, 1910–1915	
	Inches	Days	Inches	Days	Inches	Days
September	1.39	6	5.35	11	1.70	7
October	4.59	11	6.09	11	1.72	6
November	4.51	11	7.56	14	.66	4
December	8.19	15	7.82	12	1.18	5
Total	65.11	153	87.24	159	54.94	113

SEASONS

The time of seasonal rains of the Negro and Branco Rivers is almost reversed from that of the area south of the Amazon (Solimoes). In the Branco country the rainy season embraces the months of April–September, the period of heaviest rainfall being May–August; the remaining months constitute the dry season. One result of this difference in seasons is that when the southern tributaries of the Amazon are in flood the northern tributaries are receding, and vice versa. The effect of the dry season is marked. Grass and vegetation near open spaces becomes parched and brown. As in other places, however, no difference is to be observed within the forests; they retain their fresh green appearance all the year.

The rivers, of course, becomes swollen in the rainy season and inundate the varzea lands for varying lengths of time, the higher portions rarely being under water for more than a month or two. The area covered is large, but in comparison with the total extent of the region is insignificant. There is an immense acreage of high, well-drained land on which the water does not stand in the wet season. The difference in level of the rivers between periods of high and low water is rather great, but considering the large area drained and the heavy rains it is not extraordinary.

POPULATION

It is impossible to give more than a rough approximation of the population of this region. However, the following municipal districts lie entirely within the area under treatment. The number of inhabitants given is in accordance with the Federal census of 1920, and allowance must be made not only for the difficulties of census taking in a wilderness of the nature of most of this country, but also for the nomadic character of much of the population.

	Population
Barcellos (Rio Negro)	3,508
Boa Vista (Rio Branco)	7,424
Manaos (Rios Negro and Solimoes)	75,704
Moura (Rio Negro)	1,490
Sao Gabriel (Rio Negro)	15,410
Total	103,536

In addition to these districts most of the population of the municipalities of Codajaz (population 9,376) and Manacapuru (popula-

tion 14,938), whose seats of administration are located on the north bank of the Solimoes, can be included in the area under study.

Most of this region is an absolute wilderness (much of it still unexplored) inhabited by small tribes of Indians. The only parts of it that show any appreciable signs of development are Manaos and immediate vicinity, the upper Branco River (which is the center of the balata industry and a considerable livestock industry), and the country along the north bank of the Solimoes from the Negro River to the town of Codajaz. The rest of it, so far as it is inhabited at all, is populated by isolated groups of rubber or Brazil-nut gatherers or by fishermen. The upper Negro country, which a century ago was a center of considerable activity, is now in a state of complete somnolence. Barcellos, Santa Isabel, and Sao Gabriel are miserable villages, without any importance beyond the little trading that still gives them a certain excuse for existence. Though Manacapuru and Codajaz are places of only a few hundred inhabitants, they have potential elements of greater vitality than the moribund settlements on the upper Negro.

CITY OF MANAOS

Manaos, capital of the State of Amazonas and commercial metropolis of the entire upper Amazon Basin, is situated on the Rio Negro on high ground about 6 miles from its mouth. The city has an attractive and well-drained site, which is deeply cut by ravines in the outskirts. The country to the rear is rolling, with long vistas to the north. It has most of the features of a modern city, with a pretentious public theater, substantial government buildings, and several unfinished structures that stand as monuments to the prodigal days of the great rubber boom. It is paved with cobblestones. The population of the city proper is between 40,000 and 50,000.

The electric light and street railway services are operated by an English concern, the Manaos Tramways & Power Co. (Ltd.), whose general manager is an American. There is also a public telephone system. Water is supplied from the Rio Negro, a well-equipped pumping and filtering station being located a short distance above the city. The principal business interests are affiliated in a chamber of commerce, which is one of the most enterprising bodies of its kind in Brazil.

Labor is not strongly organized, though certain groups of workers have formed unions. Strikes are rare. The largest employer in Manaos stated that though the Portuguese laborer is superior where it is a question of muscle, the native Brazilian workers show greater quickness in mastering machinery and greater inventiveness. He reported, however, that the Brazilian is not so steady a worker as the more stolid Portuguese peasant type, which is common in Manaos.

LABOR

The laboring population outside the city of Manaos is small and scattered. Also, as is the case over nearly all of the Amazon Valley, there is no source near at hand from which any considerable number of laborers could be recruited. The existing laboring element is an extremely uncertain body and highly nomadic in its habits. Accord-

ing as the pecuniary returns offered vary at any particular moment, it engages in gathering rubber or balata or Brazil nuts or in fishing for turtles or pirarucu, but will quickly abandon any of these when the price of the commodity falls to an unremunerative point. This is, of course, not so much the fault of the laborer himself as it is the inevitable result of the economic system which prevails throughout this region, with violent fluctuations in the prices of its exportable products and a limited local market for whatever may be yielded by agriculture or fishing.

Moreover, nothing approaching conditions found in the Acre (Region 7), where a healthy agricultural development has already given a certain stability to the community, is found here. An entirely disproportionate part of the food supply is brought in from

FIG. 31.—Cathedral and plaza, Manaos, Brazil

Manaos instead of being produced in the immediate locality. An example of the results of this system was reported at Sororoca, an establishment on the Branco River. The proprietor of this place informed us that the year before he had taken a large number of balata workers 35 days up the Anaua in canoes (a distance covered in 15 days when the river is full), but that after a month of privations they had to abandon the balataes because of the failure of supplies to arrive from Manaos.

Another phase of the labor situation is the tendency of the men to drift down to Manaos. As a rule, only those who lack the means or initiative to go to Manaos at the end of the season's work remain in the interior. For those who do remain, a small clearing planted to corn, beans, mandioca, and bananas, supplemented by fishing or hunting, will supply the food necessary to live. The dwelling of the caboclo of the Rio Negro Basin or of the Solimoes country is the same type of palm hut found throughout Amazonia. His qualities as a worker and individual are also the same.

HEALTH AND SANITATION

DISEASES

Hookworm is almost universal, 96.4 per cent of the population of the State, according to the Public Health Service, being affected. Malaria also is widespread but varies in frequency and intensity from district to district and from year to year. A zone rated as free of malaria is sometimes contaminated by the arrival of workers from regions that are infected. On the other hand, a zone where malarial fevers are endemic may be cleaned up in a year by the Public Health Service, though the possibility of reinfection is always present so long as there remain anopheles mosquitoes in the locality. The extinction of mosquitoes is in fact impossible except in a very limited area. In certain parts malaria is periodically recurrent during the period when the rivers are falling, at which time the pools of stagnant water left by the receding flood offer ideal breeding places for mosquitoes. In the city of Manaos malarial fevers are endemic in the badly drained outskirts, though conditions have been considerably improved through the energetic action of the Federal health authorities, who have charge of sanitary work in the State.

There is much malaria in the zone of the Branco River and as far as the northern limits of the cachoeiras on the Negro River. As a result of the migration of most of the inhabitants conditions on the Japura are reported to have improved, but parts of the lower Putumayo still have a bad reputation for insalubrity. The immediate zone of the Solimoes (Amazon) has generally been considered relatively healthful, so that persons in the interior stricken with fever often resort to settlements on the high ground of the main river to recuperate. However, in 1922 there were veritable epidemics of malaria in the Solimoes country, especially in the region of the upper river.

Beriberi has become very uncommon, but cases have lately been reported from the balata region of the Branco tributaries. In 1922 there were nearly 200 lepers in the city of Manaos, some of whom were confined in a leprosarium, but most of whom were at large. During the years 1905–1922 deaths from leprosy in Manaos totaled 118. Lepers have also been brought into Manaos for isolation from several points up the Solimoes.

MEDICAL FACILITIES

The only sanitary work being carried on in this region is in the hands of the National Public Health Service. This service operates not only through its fixed posts in Manaos and vicinity but also by means of "itinerant posts," one of the latter covering the Branco River. This traveling service is administered by a subinspector, who goes from place to place distributing quinine, treating cases of hookworm and other ailments, and giving instruction in hygiene. The sanitary work in the upper Solimoes region is in charge of friars who work under the guidance of the Public Health Service at Manaos. Salesian missionaries are doing a somewhat similar work on the upper Rio Negro, and Benedictine monks are establishing a hospital at Boa Vista on the Branco River, which is planned to be a nucleus of sanitary service.

Throughout the immense area under consideration there is not a practicing physician, except in the city of Manaos, where good medical treatment is obtainable. As in most large cities in Brazil, the Portuguese colony in Manaos maintains a hospital for surgical and medical cases, and there is also the usual public hospital conducted by native charitable effort. Finally the Liverpool School of Tropical Medicine has an experiment station there in charge of an English physician of long experience. A small hospital is operated in connection with the research work. The leper colony formerly maintained in the neighborhood of Manaos was closed some time ago by the State government but has since been taken over by the Federal Public Health Service, to be operated with the aid of public contributions. The Rockefeller Foundation has never worked in the State of Amazonas.

It was once remarked by Dr. Oswaldo Cruz that illness was the normal condition of the inhabitant of the Amazon Valley. However, it may be said of this region, as of Amazonia in general, that it is not in itself unhealthful, though the climate undoubtedly predisposes the human organism to certain forms of infection and the long-continued heat tends to debilitate the system. Moreover, agents for the transmission of contagion, such as mosquitoes and other insects, exist in plenty. Though the bites of these different insect plagues may be only highly uncomfortable, it is suspected that some of them other than the anopheles and stegomyia mosquitoes may be the active means of propagating certain forms of infection.

SANITATION PREREQUISITES TO FOREIGN INVESTMENT

The bad sanitary conditions prevailing over much of this region can be ascribed in large measure to the natives' chronically unhygienic ways of living, to defective nutrition (which is extremely common), to inadequate housing, and to frequent and long-continued exposure. The sanitary conditions that form the primary requisite to the establishment and maintenance of any foreign enterprise in this region, as they form the basis of the health of the individual in the Amazon Valley, might be summarized as follows:

1. Selection of dwelling sites well above flood level of river and with complete natural or artificial drainage.
2. Clearing of ground of all forest growth for a considerable distance about habitations, and cropping of grass by cattle or other means.
3. Raising of habitations above ground or rigorous closing of space beneath houses.
4. Preference for tile roofs or even for thatch over galvanized iron.
5. Mechanical protection against mosquitoes by screening of houses and use of securely closed mosquito nets for hammocks.
6. Distribution of quinine in capsule form to those exposed to infection by the anopheles mosquito, and treatment, by means of quinine injections, of those already attacked by malaria.
7. Treatment of natives for hookworm.
8. Quick disinfection of any open wound.
9. Well-balanced and adequate diet of fresh foodstuffs.

10. Boiling and filtering of any suspected water, with preference for water from large river to that from small forest stream.
11. Facilities for shower bathing.

VEGETATION

The vegetation of the region is similar to that of the districts already described. Along the Negro and Branco Rivers the characteristic feature is the absence of tall trees and the uniform height of the trees on the varzea lands. For hundreds of miles the appearance is that of a trimmed hedge on both sides of the river. Only occasionally is a tall Brazil-nut tree seen in some isolated position on a piece of unusually high land. On the Solimoes, the jungle on the varzea land is heavy in places.

An enormous quantity of imbauba (Cecropia) is growing on the river banks and islands of this region. As this is a soft wood, very rapid in its growth, and easily accessible, it would seem that it should have great future possibilities as a source of paper pulp.

On the banks of the Solimoes there exists a large quantity of the rubber-bearing tree Sapium, locally known as tapuru and seringarana. This is not utilized on the upper Amazon (Solimoes), though in some of the rivers of the lower Amazon Basin it is said that the latex of this tree is mixed with Hevea latex or else is sold in the form of scrap (sernamby).

WILD RUBBER

Region 4 occupies a minor position as a rubber-producing area, notwithstanding the fact that Manaos is the main rubber marketing and distributing center of the upper Amazon Valley.

Rubber trees (Hevea) exist on the Branco, Negro, and Solimoes Rivers and their tributaries but not to anything like the extent found on the streams of the south side of the Amazon. The only Hevea of consequence is the benthamiana on the tributaries of the Branco and Negro. This tree is known to exist (and is exploited to a small extent) on the upper parts of the Tapara, Anaua, and Coratirimani Rivers, tributaries of the Branco, and in the forests near Caracarai; also on the tributaries of the lower Negro, especially the Javapiry on the north side and the Jahu and Inini on the south side.

THE HEVEAS OF THE DISTRICT

The great area north of the Negro and west of the Branco is as yet unexplored as regards rubber production. What little exploration has been done has been for balata. Rubber trees are said to exist on the Rio Padoutry and are probably *Hevea benthamiana*, but no commercial exploration has been undertaken. The same may be said of the region between the Solimoes and Japura. To the east of Manaos, rubber trees are known to exist on the Urupa, Uatuma, and Jamunda, which last-named stream forms the boundary line between the States of Amazonas and Para. These also are probably benthamiana. At present very little rubber is being produced on any of these rivers. It is impossible with the present knowledge

and lack of statistics to state the extent of the rubber-bearing areas or whether under different conditions they will ever become a source of increased production.

Most authorities state that the *Hevea brasiliensis* is not found north of the Amazon River. However, at Codajaz, on the north side of the Solimoes 166 miles from Manaos, there are estradas of brasiliensis close to town. Also here are some planted trees, likewise brasiliensis, which grew from seeds obtained from the headwaters of Lake Miua. Seringueiros (rubber workers) here said that trees of the same kind existed on the terra firme on red soil, north toward the Negro River; also on the Badajoz River and lake, where there are several seringaes now producing rubber. From this it would seem that in this region, at least, *Hevea brasiliensis* exists north of the Amazon (or Solimoes) River.

PRODUCTION

Even on the Solimoes and its tributaries, comparatively close to Manaos, the collection of rubber is abandoned at many places at present in favor of other occupations, such as gathering Brazil nuts and fishing. In this section the trees have been in tapping for many years, with the result that the yield is very low. It varies from 250 kilos (550 pounds) on the poorer estradas to 400 kilos (881 pounds) on the best ones per man per season. When the price in Manaos is 4$000 per kilo and under, as has been the prevailing price for some time, the seringueiro simply can not exist on these yields. There has not been any profit for anyone to make the business attractive, and it has gradually dwindled to its present proportions. In some of the areas of easier access and transportation production is still continued in a half-hearted way.

Exports (which can be taken as equivalent to "production" for all practical purposes) from the principal rivers of this area during 1910–1922 were as follows (figures represent metric tons of 2,204.6 pounds):

TABLE 35.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 4, 1910–1922

Years	Hevea			Caucho	Grand total
	Fino	Coarse	Total		
SOLIMOES	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1910	848	195	1,043	28	1,071
1911	693	158	851	14	865
1912	922	198	1,120	29	1,149
1913	501	106	607	5	612
1914	591	135	726	28	754
1915	930	206	1,145	6	1,151
1916	961	197	1,158	16	1,174
1917	982	197	1,179	17	1,196
1918	841	150	991	12	1,003
1919	807	146	953	13	966
1920	557	113	670	27	697
1921	402	55	457	46	503
1922	329	45	374	29	403

TABLE 35.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 4, 1910–1922—Continued

Years	Hevea			Caucho	Grand total
	Fine	Coarse	Total		
NEGRO	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1910	335	139	474	10	484
1911	529	150	679	1	680
1912	391	170	561	4	565
1913	298	98	396	1	397
1914	428	129	557	1	558
1915	411	116	527	1	528
1916	468	130	598	----------	598
1917	396	140	536	----------	536
1918	354	125	479	----------	479
1919	393	123	516	----------	516
1920	314	94	408	----------	408
1921	200	36	236	----------	236
1922	72	12	84	----------	84
BRANCO					
1910	27	5	32	1	33
1911	30	2	32	1	33
1912	24	6	30	----------	30
1913	29	7	36	4	40
1914	22	4	26	----------	26
1915	27	5	32	----------	32
1916	28	6	34	----------	34
1917	36	8	44	----------	44
1918	31	5	36	----------	36
1919	17	3	20	----------	20
1920	15	3	18	----------	18
1921	1½	½	2	----------	2
1922	3	1	4	----------	4
JAPURA [1]					
1910	56	9	65	----------	65
1911	59	10	69	1	70
1912	97	16	113	1	114
1913	77	11	88	1	89
1914	61	8	69	----------	69
1915	40	7	47	----------	47
1916	46	8	54	1	55
1917	41	7	48	1	49
1918	28	3	31	----------	31
TOTAL, REGION 4 [2]					
1910	1,266	348	1,614	39	1,653
1911	1,311	320	1,631	17	1,648
1912	1,434	390	1,824	34	1,858
1913	905	222	1,127	11	1,138
1914	1,102	276	1,378	29	1,407
1915	1,417	334	1,751	7	1,758
1916	1,503	341	1,844	17	1,861
1917	1,455	352	1,807	18	1,825
1918	1,254	283	1,537	12	1,549
1919	1,217	272	1,489	13	1,502
1920	886	210	1,096	27	1,123
1921	603½	91½	695	46	749
1922	404	58	462	29	411

[1] Data for 1919–1922 not available.

[2] Exclusive of the Japurá area for 1919–1922.

COST ESTIMATES

The cost of gathering and preparing rubber in Region 4 seems to be higher than in the Madeira and Acre (Regions 5 and 7), since with current prices very little rubber is being produced. This

is due to the isolated location of the seringaes (rubber properties), to the difficulty and expense of transportation, and probably also to a relative thinness of stand in the forests and to a smaller yield per tree than in the more-favored localities. This is especially true of the Negro and Branco Rivers and their tributaries.

OTHER INDUSTRIES AND RESOURCES

Considering the fact that this part of the country has been settled for centuries the lack of industrial and agricultural development is nothing short of astounding. Nowhere in the whole region does there exist what could be called a farm or a plantation from the American viewpoint. Mandioca, rice, corn, beans, sweet potatoes, and sugar cane are raised, but all in small patches, except possibly a few areas in sugar cane from which are produced sugar and alcohol. Coffee does fairly well. The main fruits grown are oranges and mangoes, both of which bear prolifically. On the varzea lands of the Amazon (Solimoes) some cacao is grown, but not to the same extent as in previous years. No statistics are available as to the acreage of any of these crops nor the quantity produced.

The field party was told that agricultural experiments had been made on the campos lands above the cachoeiras by plowing and planting but that the results were very poor. These open grasslands would therefore appear to be unadapted to rubber planting or general agriculture.

TRANSPORTATION AND COMMUNICATION

OCEAN

Manaos has direct steamship connections with the United States by the vessels of the Booth and the Lamport & Holt Lines. The former company, which has operated in the Amazon Valley for many years, has a bimonthly service between Manaos and New York. The time down river to Para is three days and upriver from four to five and a half days. The time between Para and New York is 12 to 14 days. The first-class passenger fare between Manaos and New York is $130 and second-class $50. Freight rates on rubber and Brazil nuts are: Rubber—in cases, $0.46 per cubic foot; in bales, $1.62 per 100 pounds; Brazil nuts, $1.10 per 100 pounds.

The Lamport & Holt Line maintains an intermittent service between Manaos and New York which it commenced in 1923. Three vessels are employed in this service, and freight rates are the same as those of the Booth Line. Para is the only port of call.

The Booth Steamship Co. also operates a service between Manaos and Liverpool, its ships calling at Para and other places en route. The time between Manaos and Liverpool is 17 to 18 days. The first-class passenger fare is £54–£60 and the second-class £11. Freight rates on rubber and Brazil nuts between Manaos and Liverpool are: Rubber—in cases, 85 shillings per metric ton (40 cubic feet); in bales, 120 shillings per ton weight; Brazil nuts, 110 shillings per ton weight.

An irregular freight service between Manaos and European ports has been established by the Hamburg-South American Line (Hamburg-Sudamerikanische Dampfschiffahrts Gesellschaft). The local German firm of Berringer, Ohliger Co. acts as agent. Freight on rubber in cases to Hamburg is 85 shillings per measurement ton (40 cubic feet) and on Brazil nuts 110 shillings per weight ton.

COASTWISE

Freight service between Manaos and ports south of Para on the Brazilian coast is restricted to the line which the Lloyd-Brasileiro operates between Rio de Janeiro and Manaos. Sailings are weekly and the time between the two cities is 17 to 22 days, depending on stops made. The first-class passenger fare between Manaos and Rio de Janeiro is 482$000 and 572$000 for lower and upper decks, respectively; second-class, from Ceara (Fortaleza) to Manaos, is 72$000. Most of the ships employed in this service are ex-German vessels.

Freight rates by steamers of the Lloyd-Brasileiro from Manaos to Para for transshipment are: Rubber, in cases, 18$000 per ton of 40 cubic feet; nuts, in crates, 1$800 per crate of 1½ hectoliters; cacao, in bags, 25$000 per ton of 1,000 kilos; lumber, 25$000 per ton of 40 cubic feet. There is a charge of 3$000 per ton for loading and of 3$000 for unloading at Para.

The vessels of the Booth Line and of the Lamport & Holt Line carry passengers between Manaos and points on the Brazilian coast at which they call, but are forbidden by Brazilian law from participating in coastwise freight trade. The Amazon River Steam Navigation Co. operates a regular and frequent freight and passenger service between Manaos and Para, where transshipment may be made for points to the south.

The Cia. do Navegação Costeira of Rio de Janeiro recently announced its plan to institute a regular service to Manaos. Para is the present terminus of the Costeira's service.

RIVER

The river system of this area may be illustrated by the following outline:

Upper Amazon (Solimoes).
- Urupa.
- Negro.
  - Cuieiras.
  - Apuahu.
  - Javapiry.
  - Branco.
    - Coratirimani.
    - Anaua.
    - Mocajahy.
    - Tacutu.
    - Uraricoera.
  - Guainia.
  - Uaupes.
- Japura.
- Ica (Putumayo).

Conditions of navigation on the principal rivers may be described as follows:

SOLIMOES RIVER

From the mouth of the Rio Negro to the Peruvian border, about 900 miles, the Amazon is known as the Solimoes. The time of lowest water is August to October. The Solimoes begins to rise in January, attains its greatest height in May, and begins to fall about the middle of June. The seasonal difference in level is 30 to 45 feet, depending on the height of the annual flood and the width of the river at any particular place.

The Solimoes is navigable all the year throughout its length and beyond as far as Iquitos, Peru, for steamers drawing 24 feet, though an experienced river pilot is necessary to take a boat of that draft to Iquitos at low water. During high water any ocean-going vessel could reach Iquitos without difficulty.

The only regular service for the entire length of the Solimoes is maintained by the Amazon River Steam Navigation Co., which operates a monthly steamer of 600 tons between Para and Iquitos. Also, the regular steamer services maintained by this company to the Purus and Jurua provide transportation facilities for the country along the Solimoes as far as the mouths of those rivers.

Among private operators who serve all or part of the Solimoes country are:

B. Levy & Co. (Manaos); run steamer *Rio Jamary* to Remate de Males (Benjamin Constant) on the Javary.

Monteiro de Souza & Co. (Para); irregular service by steamer *Montevideo* between Para and Iquitos.

Strassberger & Co. (Manaos); operate monthly service to Javary by steamer *Herman*.

Sinfronio & Co. (Manaos); occasional voyages to Javary by steamer *Alzira*.

Semper & Co. (Manaos); operate steamer *Marapata* to the Jutahy during the Brazil-nut season, January to June.

Alfredo Castro (Manaos); operates steamer *Cosmopolita* to Fonte Boa during six months of castanha season.

Nicolau da Costa & Co. (Para); operate steamers *Barao do Cameta, Moa, Tejo,* and *Enviru* to the Jurua.

M. Coutinho & Co. (Para); operate steamer *Republicano* to the Jurua.

Amoury & Irmão (Manaos); operate steamer *Angelina* to the Jurua.

Moraes Carneiro & Co. (Manaos); operate small steamer to Badajoz and Copea region.

Mendes & Co. (Manaos); operate launches to parana and lake region to north of Manacapuru and Codajaz.

NEGRO RIVER

The confluents which form the main stream of the Rio Negro rise in southeastern Colombia, but it is still undecided which confluent, the Guainia or the Uaupes, should be considered as the upper course of the Negro. The Guainia flows east across the Colombian plains and then turns south, forming the boundary between Colombia and Venezuela. It enters Brazilian territory in the vicinity of the solitary granite rock of Cucuhy, which rises several hundred feet above the level of the surrounding country, and 500 miles to the south it forms a junction with the Uaupes, which comes in from the west. For some 55 miles from the confluence of the Guainia and Uaupes there is a series of cachoeiras in the Negro. Then for about 130 miles the river is free from rapids to the Cachoeira of Tapuruquara, from which point to the mouth below Manaos the channel is uninterrupted.

The Rio Negro system has water connection with the Orinoco by means of the Cassiquiare, a stream of some size, which enters the Guainia about 55 miles above Cucuhy. Higher up there is also a short portage (10 miles) between the Guainia and the Atabapo, a branch of the Orinoco. However, neither of these routes can be considered of much commercial importance by reason of their great distance from the lower parts of the two river systems which they connect.

The Negro is at its lowest level in the months of August to October and begins to rise in November. The period of high water comprises the months of November to May and the river begins to fall in June or July.

NAVIGABILITY OF NEGRO RIVER

The Negro is navigated by ocean steamers to Manaos, 6 miles from its mouth. For 423 miles above Manaos, that is, to the first rapids at Santa Isabel, there is free navigation throughout the year for steamers drawing 8 feet of water. The section of 130 miles between the Cachoeira of Tapuruquara and the main series of cachoeiras is navigable for boats of 6-foot draft, but a launch with a good engine can pass any of the rapids.

The Guainia is navigable for small craft from its confluence with the Uaupes, about 36 miles above Sao Gabriel, to Marabitanas, a short distance from the frontier. The Uaupes is navigable by launches for about 120 miles from its junction with the Guainia, but its upper course is broken by impassable rapids.

Tributaries of the Negro such as the Javapiry are generally navigable by launches for a certain distance during high water, but at low water are passable only in canoes over most of their course.

FREIGHT AND PASSENGER SERVICE ON NEGRO RIVER

The Amazon River Steam Navigation Co. operates a monthly service between Manaos and Santa Isabel by means of the stern-wheeler *Inca*. This boat draws between 3 and 4 feet of water and has a cargo capacity of about 100 tons. The Manaos firm of J. G. Araujo operates a launch as far as Santa Isabel, where this house has a trading station. Gomes & Co., of Manaos, also run a launch to the same point. These launches draw 2½ or 3 feet of water and tow cargo lighters with capacity for several tons of merchandise. Above the cachoeiras navigation is carried on by smaller launches.

Navigation on the Rio Negro does not have to contend with the floating tree trunks and other débris that strew the surface of the Solimoes, Purus, and some other rivers at high water. However, great familiarity with the channel is needed to steer a safe course at low water, and pilots with the requisite experience are few.

BRANCO RIVER

The Branco River, an important tributary of the Negro, rises in the high country in the extreme north of Brazil between Venezuela and British Guiana. It is formed by the confluence of the Uraricoera and Tacutu, the first of which comes from the Serra Pacaraima

on the Venezuelan border and the other from the mountains to the east which form the frontier between Brazil and British Guiana. From the junction of these streams the Branco River flows south by southeast for 350 miles to the Negro River, which it enters 200 miles above Manaos. The Branco is very wide and shallow. Its water is clear, in contrast to the black water of the Negro. Its bed is marked by numerous sand bars, often of great extent.

The seasonal variations are the reverse of those in the southern tributaries of the Amazon and even of the Negro River. The Branco begins to rise in April or early May and is highest in July. The maximum stage of high water continues through August into September, when the river begins to fall. The period of lowest water is December–March. The difference in level between extreme low and high water is between 15 and 20 feet, depending on the place.

NAVIGABILITY OF BRANCO RIVER

The Branco is navigable all the year from its mouth to Caracarai, about 238 miles, for launches drawing 2 feet of water. For 44 miles above Caracarai there extends a series of six cachoeiras. However, even at low water five of these can be passed by the motogodilles, or small launches, to which goods are transshipped at Caracarai, though launches and lighters are generally pulled through by cables. During the season of high water steamers of 9-foot draft could reach Boa Vista above the cachoeiras in the grassland country. This can be done by utilizing the Cujubim Channel around the cachoeiras, which is dry during low water. A good road is being built around the stretch of the river that is broken by rapids, and the use of tractors or motor trucks on this road should go far toward solving the problem presented here. The dynamiting of some rocks which obstruct the passage would do much to improve conditions of navigation for launches in this part of the river.

FREIGHT AND PASSENGER SERVICE ON BRANCO RIVER

At present there is no regular navigation service on the Branco. Transportation is limited to the launches and lighters of Manaos houses, which trade in the region. The most important of these is the firm of J. G. Araujo, which ships out considerable quantities of balata and cattle from the Branco River to Manaos and sends in merchandise for the population of those districts. In this carrying trade Araujo uses shallow-draft steam or kerosene launches, which tow batelões or cargo lighters. Col. Bento Brazil, of Boa Vista, and the firm of Mattos Paraguay & Co., of Manaos, also operate a few small launches on the Branco.

The Amazon River Steam Navigation Co. formerly maintained a regular service to the upper Negro from Manaos under subvention from the Federal Government, but suspended the service when the subsidy was cut off at the time of the rubber crisis. The Federal Indian Service which worked the National Fazenda of Sao Marcoa, later initiated a similar service on the basis of a subsidy from the State Government, but in turn discontinued the service when the subsidy was no longer forthcoming.

JAPURA RIVER

The Japura River, which rises in the Cerro de las Animas in Colombia, has a total length of about 1,750 miles. It is known in Colombia and Peru as the Caqueta. It reaches the Brazilian border at the mouth of the Rio Apaporis, about 500 miles from the Amazon. Its mouth is ill defined, as the river in its lower course enters a vast region of paranas, furos, and lakes that extends well inland from the main river and over a length of several hundred miles, during which the Japura tends to lose its identity as a separate stream, though the channel that enters the Solimoes opposite the Teffe perhaps has the best right to be considered as its true outlet into the main river.

The Japura is wide and shallow, with great sand banks showing in its channel at low water. At high water small steamers can reach the Cachoeira of Sihare, 544 miles from the Amazon. All navigation stops at Araraquara, 860 miles from the mouth, where the river drops about 100 feet. At low water the Japura is navigable only by launches.

Due to the state of abandonment into which the river has fallen, navigation is limited almost entirely to a single launch which Alfredo Cunha & Co., Manaos, operate to the Colombian frontier.

The paranas and lakes referred to above are navigable by light-draft launches during low water and are accessible by small steamers (drawing 5 or 6 feet) during the season of high water, at which time the Brazil-nut crop is taken out. Some of these lakes, such as Amana, Copea, Codajaz, and Badajoz, are of large extent and are bordered in places by high land.

PUTUMAYO (ICA) RIVER

The Putumayo (Ica) River, which rises in the Andes near the Colombian town of Pasto, has a total length of about 1,200 miles, of which some 200 miles are within Brazilian territory. It is navigable throughout its Brazilian section and beyond into Colombia for steamers drawing 6 to 7 feet of water.

Navigation on the Putumayo is restricted almost entirely to steamers from Iquitos, which trade with the lands of the Arana Syndicate. The only Brazilian boat which makes regular trips to the lower Putumayo is a trading launch from Itacoatiara.

ROAD AND RAILWAY

Roads are almost nonexistent in Region 4. Some years ago the beginnings were made of an automobile road that was to link Manaos with the Branco River region. However, work was abandoned after about 5 miles had been built and at present the road is passable by automobile only as far as Campos Salles, 6 miles outside Manaos.

As mentioned earlier, a road is being built around the cachoeiras of the Branco River from Boa Vista to Caracarai. Other land communication is limited to the trails opened through the forest in the rubber and balata country.

Some time ago American interests entered into negotiations with the State government of Amazonas for a loan of $25,000,000. One of the conditions of the proposed loan was the construction of a

railway from Manaos up through the Branco River country as far as the frontier of British Guiana. Work was never started on this project, as the negotiations were discontinued in 1922.

TELEGRAPH AND CABLE

The Amazon Telegraph Co. (Ltd.), a British concern, maintains a subfluvial cable between Manaos and Para, with stations at all the principal towns on the lower Amazon. At Para connections are made with the cables of the Western Telegraph Co., over which communication is had with New York via Barbados and the Western Union cable to Miami, with Europe via Pernambuco and Madeira, and with Rio de Janeiro and Buenos Aires via Pernambuco. The service is very satisfactory, but necessarily expensive as a result of the small amount of business done in proportion to the capital invested. Rates per word on March 14, 1924, between Manaos and the following points were:

Between Manaos and—	Full rate	Deferred rate
Para	3$750	0$600
New York	11$920	5$960
London	13$190	0$600
Rio de Janeiro	4$350	1$200

The Federal Government maintains a wireless station at Manaos which relays messages to Rio de Janeiro via Para and the land lines or the coast wireless stations. Though equipment for a wireless station was carried up the Branco River to Boa Vista several years ago, it was never installed. However, the Federal Government is now contemplating the establishment of such a station in that region and an additional station on the Solimoes.

PORT OF MANAOS

The port of Manaos, which is located within the area under examination, is the principal distributing and receiving center for the entire upper Amazon Valley, though a considerable amount of this trade is handled directly through Para. Manaos is a federal port of entry and has a customhouse, located in the finest building of its kind in Brazil.

The port works are the property of the Manaos Harbour (Ltd.), an English concern. These works were begun in 1902 and have cost about 18,524,000$000 to date.

PRESENT PORT FACILITIES

In order to solve the problem presented by the great difference in the level of the Rio Negro between the wet and dry seasons, amounting to 40 or 50 feet, floating wharves were adopted. There are two of these wharves, one of which serves for handling overseas shipments and the other for coastwise and local river business. The first is 656 feet long by 85 feet wide, and is supported by 120 floating caissons. This wharf is connected with the warehouses by three aerial cableways. The other wharf, which is devoted to coastwise

and internal river business, is 820 feet long by 75 feet wide. It holds a secondary series of warehouses with 18,700 square feet of storage space. This floating stage is connected with the land by means of an articulated roadway or incline. The total area of the warehouses on shore is 186,000 square feet. The service given to shipping by the port company is excellent.

As for lighterage accommodations, the Booth Steamship Co. has 17 lighters at Manaos, with a total capacity of 5,000 tons of freight. It also has three tugs at that place. The Manaos Harbour (Ltd.) has nine covered lighters of 60 tons capacity, six smaller lighters of 40 tons capacity, and one 200-ton lighter. Its charges are 75$000 per day for the covered lighters, 50$000 for open lighters, and 120$000 for the large lighter. Special terms are offered for Brazil nuts.

Good facilities for making repairs to steamers are offered by the Amazonas Engineering Co. (Ltd.), a British concern, which has well-equipped machine shops and foundries, with a shipway.

PORT CHARGES

Port charges are as follows:

Loading and unloading, 3 reis per kilo (kilo=2.2046 pounds). (Weight according to ship's manifests.)

Wharfage per day: Ocean steamers, 850 reis per meter (meter=3.28 feet); river steamers, 50$000; launches, 20$000.

Handling charges, 200 reis per volume up to 50 kilos; 100 reis per 10 kilos or fraction above basic rate. For produce of the State of Amazonas the rate is 7 reis per kilo.

Transport charges are as follows:

Between pier and floating dock, shipments of products to points within State, 5 reis per kilo. Shipments outbound to points outside State, 300 reis per volume (package) up to 50 kilos and 100 reis for each 10 kilos or fraction over that amount.

No transport charges are levied on foreign or coastwise imports.

Warehousing charges are as follows:

One per cent per month on official value for first month; 1½ per cent per month for second month; 3 per cent for third month, and 6 per cent for each additional month.

PORT MOVEMENT

The movement of the port of Manaos, as represented by entries of vessels, for the years 1913–1922, is shown by the following table:

TABLE 36.—PORT MOVEMENT (ENTRANCES), MANAOS, 1913–1922

Years	Entrances						
	Coastwise	Foreign				From Para	From interior rivers[1]
		United States	Europe	Peru	Total		
1913	107	20	74	16	110	206	877
1914	64	19	42	9	70	137	733
1915	70	20	22	8	50	127	705
1916	63	20	19	8	47	163	787
1917	59	17	7	14	38	162	773
1918	44	6	----	4	10	139	564
1919	42	10	15	17	42	130	570
1920	20	11	13	12	36	134	541
1921	27	7	15	7	29	143	577
1922	26	17	18	15	50	180	612

[1] Steamers and launches.

5. MADEIRA

LOCATION AND AREA

Region 5 comprehends the drainage basin of the Madeira River (with the exception of that part which lies in Bolivia) and extends over part of the two Brazilian States of Amazonas and Matto Grosso, from 3° to 15° south latitude. Its limits to the east and west are defined by the watersheds of the Tapajoz and the Purus. The zone between the Madeira and the Tapajoz contains the largest reserves of virgin rubber in South America.

As this territory does not correspond to any political division, an accurate statement of its area is impossible. However, its extent can be roughly estimated at 250,000 square miles.

The part actually examined by the field party comprised the entire course of the Madeira and the Mamore to a short distance above Guajara-Mirim, including the zone of the Madeira-Mamore Railway and the Abuna River. A minute examination was also made of the virgin rubber country along the Ouro Preto and the Pacanova, two small affluents of the Mamore, which empty into that river a short distance above the terminus of the railway.

PHYSICAL FEATURES

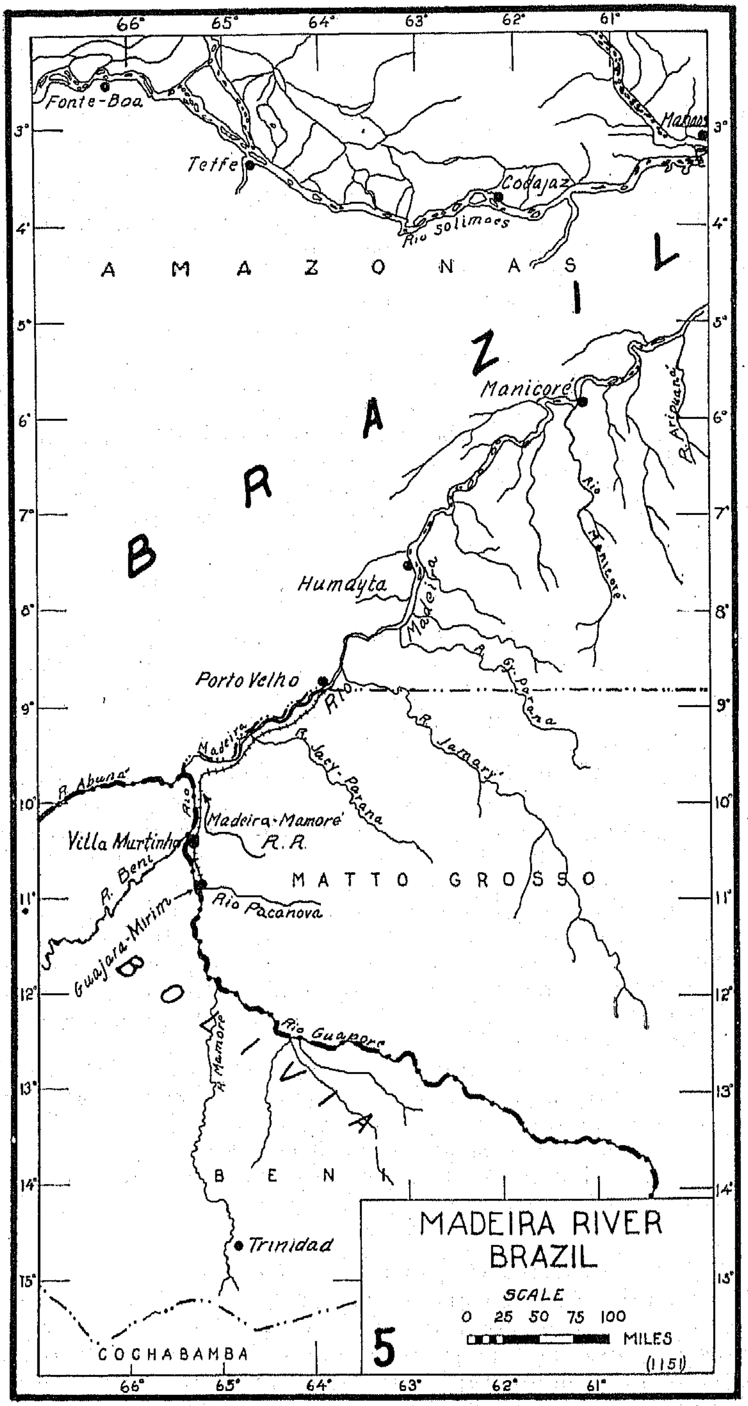
The watershed of the Madeira River extends in a northeast-southwest direction from its formation by the union of the Beni and Mamore Rivers. The Mamore flows in a northerly direction until it meets the Beni. The watersheds of the tributaries of the Madeira, which are practically all on the east side, come in at nearly right angles to the direction of flow of the Madeira; that is to say, most of the rivers having their origin in the highlands of Matto Grosso flow in a northwest direction, or parallel to the Guapore. The lower tributaries, as the Roosevelt, flow nearly north in their whole course.

The Madeira and its tributaries below the cachoeiras present the same general aspect, differing only in degree. All have very tortuous courses. The channel rarely lies in the middle of its flood plain for any distance. The banks are steep bluffs, or terra firme, at times 50 to 100 feet above the level of the water at low stage and always well above them at high water.

The flood plain of the Madeira averages about 4 miles in width. At some places it narrows down to 2 or 3 miles, and at others may widen out to as much as 6 or 7. The affluents of the Madeira, compared to the latter, are small; their flood plains are consequently much narrower, though at times they overflow their banks and cover a considerable area.

VARZEA

In the territory to the west of the Madeira River there is no outcrop of crystalline rock; consequently in the few tributaries on that side there are no rapids or falls. On the east side, however, crystalline rock outcrops for a long distance and all the rivers of any considerable length contain rapids or falls which are a bar to navigation. In the vicinity of the Madeira-Mamore Railway and farther



Fonte-Boa
Teffe
Manaos
Codajaz
Rio Solimoes
AMAZONAS
BRAZIL
Manicoré
R. Aripuaná
Rio Manicoré
Humayta
Madeira
R. Gi. Parana
Porto Velho
Rio
R. Jamary
R. Jacy-Parana
Madeira
R. Abuna
Rio
Madeira-Mamore' R.R.
Villa Murtinho
R. Beni
MATTO GROSSO
Rio Pacanova
Guajara-Mirim
BOLIVIA
R. Mamoré
Rio Guapore
BENI
Trinidad
COCHABAMBA
MADEIRA RIVER BRAZIL
SCALE
0 25 50 75 100
MILES
5
(1151)

FIG. 32

up the Mamore and the Guapore the cachoeiras are only one day's travel in a launch, or 20 to 40 miles. Farther south, as on the Marmellos, they are not encountered for 125 miles or more.

TERRA FIRME

The terra firme lands between the Madeira and the Purus, in the lower stretch of the river, are in general level. In the upper area, opposite the Madeira-Mamore Railway, are low-lying hills known as the Serra dos Tres Irmaos. On the eastern side as soon as the igneous rock is encountered the land becomes extremely hilly and low mountains are visible, which can be seen for many miles. Porto Velho is built on low hills, and some of a height of 200 feet or more are frequently met on the railroad from Porto Velho to Guajara-Mirim, the upper end of the line. From the latter place the rather extensive range of hills to the east known as the Pacanova Hills, some 20 miles away, is distinctly visible. Little is known of these hills or, in fact, of much of the land beyond a thin fringe along the railroad, the reason for this being that the area is occupied by the Parintintin Indians.

In all of the area under discussion the natural drainage of the terra firme lands is ample for the cultivation of crops. In the flood plains of the rivers a large part is under water for one to three months of the year. The period in which such areas are dry is sufficient to mature all crops adapted to the region, and the periodic overflow is a source of perpetual renewal of fertility.

CAMPOS

There is a small area of open grassland (campos) lying between the Madeira and the Purus, in the vicinity of Humayta on the former and of Labrea on the latter. These grasslands are known as the Campos do Puciary and are considered as primary. They embrace an area of approximately 309,000 acres.

Along the railway between the stations of Jacy-Parana and Abuna occasional stretches of open land with a scattered growth of palms and trees are seen. The appearance of such country is very similar to that of the pampas of the Gran Chaco of Bolivia and Argentina. In the rainy season the land is evidently under water, at least for a short period of time, but during the dry season it is covered with grass, and is used to some extent as pasturage for cattle.

WATER POWER—ELEVATION

It might be possible to utilize the headwaters of some of the affluents of the Madeira, where they come down from the highlands of Matto Grosso, for the generation of power, but at the present time such places are remote from all economic activities and extremely difficult of access. In the area examined there are no falls that could be used for the purpose.

Between Manaos and Porto Velho the rise in elevation along the Madeira is very slight. No elevations of any consequence are noted until the hill country is reached on either side of the Madeira-Mamore Railway, and, as these places have been little explored, no published data are at hand to indicate their elevations.

The elevation of Manaos, approximately 1,000 miles from the sea, is only 147.6 feet above sea level, and of Porto Velho 321.5 feet, or a difference of only 174 feet in 695 miles. The only other points whose elevations are known are along the Madeira-Mamore Railway and some of these are: Jacy-Parana, 369 feet; Abuna, 451; Villa Murtinho, 479; Kilometer 344, 561; and Guajara-Mirim, 522. An average of the districts investigated by the field party may be taken as somewhere around 460 feet above sea level.

CLIMATE

Accurate meteorological records are restricted to one place—Porto Velho (lat. 8° 44′ S., long. 64° 0′ W.).

TEMPERATURE

Temperature data are given in the following table:

TABLE 37.—MONTHLY MEAN TEMPERATURE, PORTO VELHO, 1908–1921[1]

Months	6.30 a. m.	11 a. m.	3 p. m.	6.30 p. m.
	° F.	° F.	° F.	° F.
January	76.1	82.1	86.1	82.6
February	76.2	82.1	85.1	82.5
March	76.2	82.8	85.5	82.6
April	76.4	83.2	86.2	83.0
May	75.5	83.6	86.1	83.1
June	73.4	83.1	86.5	83.0
July	72.2	83.0	88.2	85.7
August	73.0	85.4	90.4	86.3
September	76.0	86.3	90.6	86.6
October	76.5	85.2	88.5	85.1
November	76.3	84.2	87.0	83.8
December	76.0	82.5	85.3	82.9
Year	75.4	83.7	87.0	84.0

[1] Monthly Weather Review, United States Department of Agriculture, Vol. 50, No. 7, p. 368.

RAINFALL

Roughly the rainy season begins in December and ends in May. The dry season begins in June and ends in November. The year is, therefore, divided into periods of six months each, but these are not always sharply defined, one frequently overlapping the other. Le-Cointe, in his L'Amazonie Bresilienne, states that at Obidos, on the Amazon River, almost every year there are two periods of more than a month each without any rain, and this is true also of the Madeira. There is no regularity as to the time of day at which the seasonal rains come. They probably come more often in the afternoon or night than in the morning.

The rainfall at Porto Velho seems to be erratic—that is, to vary greatly from year to year. The annual average, taken over a period of 15 years, according to figures of the Madeira-Mamore Railway, is 98.53 inches. Edward D. Mathews, in his Up the Amazon and Madeira Rivers (London, 1879), states that measurements made by him in 1872 and 1873 indicated about 90 inches per annum.

Detailed figures for the years 1909 to 1922, inclusive, are given in the table which follows.

TABLE 38.—MONTHLY RAINFALL, PORTO VELHO, 1909–1922

Months	1909	1910	1911	1912	1913	1914	1915
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
January	11.23	9.78	13.62	14.43	11.25	7.99	5.66
February	13.91	10.42	15.96	7.92	10.48	11.00	5.60
March	13.42	9.81	9.56	8.57	13.08	8.90	6.03
April	8.19	10.83	10.54	7.37	10.12	5.04	3.07
May	0.33	1.87	1.97	5.06	1.12	2.63	2.92
June	.10	.09	1.09	1.08	----------	1.43	----------
July	.02	.50	.17	.07	.13	.09	2.62
August	----------	1.69	.77	.72	1.87	.34	4.91
September	2.72	5.42	1.86	4.26	3.73	.86	6.29
October	7.62	9.28	6.07	10.61	6.26	3.18	5.64
November	6.59	8.31	16.21	10.42	4.40	2.03	11.21
December	19.71	9.12	10.93	9.52	6.57	5.06	9.87
Total	89.84	77.12	88.75	80.03	69.01	48.55	63.82

Months	1916	1917	1918	1919	1920	1921	1922
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
January	20.30	17.53	5.04	8.62	24.82	24.52	28.57
February	13.60	8.78	17.13	21.05	20.31	11.30	24.97
March	9.28	10.53	17.41	25.11	15.91	18.83	32.71
April	11.69	10.05	7.56	12.02	10.64	12.13	9.41
May	4.25	3.84	7.81	6.89	10.24	10.22	4.71
June	1.13	.30	.79	1.41	2.72	2.63	4.15
July	----------	.29	.31	.14	2.21	.51	2.17
August	1.56	----------	3.73	2.24	4.80	4.37	3.20
September	2.72	----------	5.52	6.25	7.41	2.52	2.50
October	3.64	3.69	9.64	22.78	18.33	8.67	9.20
November	11.58	9.15	13.95	19.59	14.83	14.67	8.77
December	12.27	9.00	24.46	17.17	20.77	20.36	16.09
Total	92.08	79.76	113.35	143.27	152.99	130.73	146.45

POPULATION

Region 5 probably has a population of 75,000, or one person to something less than 4 square miles. The Federal census of 1920 gave the following figures:

	Population
Amazonas:	
Borba	17,330
Humayta	12,739
Manicore	16,296
Porto Velho	5,305
Total	51,670
Matto Grosso:	
Santo Antonio do Rio Madeira	18,000
Sao Luiz de Caceres	11,316
Total	29,316

Only part of the two Matto Grosso districts is included in Region 5.

The towns of the region are all small, Porto Velho, the largest and most important, having about 1,200 inhabitants. The rest, including such places as Borba, Manicore, Humayta, Santo Antonio, and Guajara-Mirim, are villages of 200 to 500 people.

RACIAL COMPOSITION OF POPULATION

The population of this region is made up of the elements common to the other parts of the Amazon Valley. The predominant factor is the caboclo. However, there is still a very considerable body of pure-blood Indians in this region. Some of these are civilized and lead a more or less settled existence. Others, such as the Parintintins, are charged with occasionally killing isolated seringueiros (rubber workers).

The presence of savage Indians, though a deterrent to the occupation of certain parts of the Mamore and Guapore country, does not offer a serious problem to the operation of a large corporation. The tribes are small. The more intractable have withdrawn well into the interior, about the upper reaches of the rivers, though small bands of Parintintins sometimes appear on the Madeira at Tres Casas or Calama. The Caripunas, formerly an important tribe along the Madeira, have almost entirely disappeared. The surviving Indians in Matto Grosso are under the special protection of the Rondon Commission.

LABOR

The entire region is underpopulated, and nearly all the rubber properties are undermanned. All of the proprietors complain of the lack of laborers as being chronic in the entire zone of the Madeira. Nor is there any source near at hand from which any large body of workers could be recruited. Very few full-blood Indians are found working as seringueiros, and little importance can be given to this element as a possible source of labor.

The remarks on this subject made in the report on the Acre (see p. 271) are substantially true as applied to the zone of the Madeira, except in the matter of food supply. Agriculture has not developed in anything like the scale which is found in the Acre, though there is still considerable cultivation at points along the main river. However, the bulk of the foodstuffs consumed by the laboring population along the upper reaches of the tributaries, where the rubber industry is more active, is brought in from Manaos.

HEALTH AND SANITATION

DISEASES

Health conditions naturally vary greatly over as large an expanse as that comprehended within Region 5. However, to a greater or less degree there are certain conditions common to the entire area. One of these is the prevalence of hookworm. It is safe to say that at least 90 per cent of the rural population is afflicted with this debilitating parasite.

Malaria is equally widespread but varies greatly in intensity or frequency from one district to another. Certain rivers or localities have the reputation of being unhealthful, while others are considered relatively free from fevers. Among the former are generally included the Abuna, Aripuana or Roosevelt, Jacy-Parana, and Jamary. However, certain stretches of these rivers may be entirely free from

the anopheles mosquito, and so from the danger of fever. The principal centers of malarial infection are the cachoeiras, or rapids, and there malaria is rampant each year following the recession of the flood waters. The same condition is found in the cachoeira region of the Madeira.

Beriberi, which formerly ravaged these regions, is rare now. Yellow fever has not occurred since 1911. Cases of amoebic dysentery are also found, though the disease is not common. However, minor stomach and intestinal complaints are frequent, due to malnutrition and general unhygienic living.

The human organism is peculiarly susceptible to blood infection in this climate, and sores and ulcers resulting from the infection of insect bites or of open wounds are common. Leischmaniosis, a dangerous ulcerous growth produced by a parasite, as yet undiscovered, occurs frequently.

MEDICAL FACILITIES

The National Health Service operates within the State of Amazonas. However, in spite of the competence and zeal of the staff in charge of this work, the resources at their command restrict their activities to the zones bordering the more accessible sections of the rivers.

The most effective sanitary agency in the entire region is that provided by the Madeira-Mamore Railway. Unfortunately, the scope of its work is necessarily limited, even though it draws patients from far up the rivers in Bolivia. The service maintained by the railway company is the result of its experience during construction days, when the heavy mortality among the workers threatened for a time to cause the suspension of the whole undertaking. The center of its service is the excellent Candelaria Hospital, just above Porto Velho on the railway. This hospital is equipped for handling every ailment common to the region, and has, moreover, a modern operating room for surgical cases. The hospital is directed by an American physician of long experience in this field. Not only are all the hospital buildings rigidly protected against mosquitoes by wire screening but all the buildings of the railway company, even to the houses of the workers along the line, are similarly screened. This is the only section of the entire Amazon Valley where this form of mechanical protection against mosquitoes is in general use.

By clearing and draining large areas of land and by teaching the use of quinine the company has transformed a notoriously unhealthful region into one of the most salubrious in the Amazon Valley. The results of its action have shown the possibilities of sanitation in this region when directed by a large organization availing itself of the experience of previous campaigns against tropical diseases.

VEGETATION

The territory embraced within the limits of Region 5 may for all practical purposes be considered as virgin forest. There is a stretch of grassland (campos) between Humayta on the Madeira

and Labrea on the Purus; also more or less cleared fields, small in extent and widely scattered. The forests along the river banks subject to periodic inundation are as a rule heavier than the upland forests. They also seem to become heavier as the cachoeiras are approached.

A census of representative virgin forest made on the upland (terra firme) on the Pacanova River, above Guajara-Mirim, gave results as shown on page 96. The composition of the forests differ little from that of the area to the east in the State of Para, and is described more fully at page 165. The different species of trees are not grouped by themselves in clumps but occur promiscuously through the forest.

The following palms are met with in the Madeira River region: Assahy, bacaba, bacaba-y, paraua, tucuma, jauary, murumuru, urucuri, inaja, mirity (few), maussu or babassu.

WILD RUBBER

The two main rubber-producing trees that grow naturally in this region are the *Hevea brasiliensis* and the Castilla. *Hevea brasiliensis* grows wild on both the upland, or terra firme, and in the flood plains of the rivers on the upper Madeira above the rapids and its tributaries. The Castilla grows on the terra firme only. Below the rapids the *Hevea brasiliensis* grows wild on the flood plains only; while much Hevea is growing on the terra firme, it has been planted by human agency.

It is stated by those acquainted with the territory lying between the upper Tapajoz and upper Madeira, and more specifically above the rapids of the Marmellos, Machado, and Roosevelt Rivers, that the country is very hilly, with a great deal of rock exposed, and that *Hevea brasiliensis* exists in large numbers, at times in clumps, with their roots penetrating the rocky soil. Authoritative information is that here lies the greatest reserve of untapped or "virgin" trees in the Amazon Basin.

The existence of wild *Hevea brasiliensis* on the flood plains of the river is explained by the fact that seeds have floated down in periods of high water. The fertility of the soil and the abundant moisture cause trees in such localities to yield abundantly, but there is no evidence that such localities are the original habitat of the *Hevea brasiliensis*.

SIZE OF WILD TREES

Measurements of forest Heveas are worth nothing for comparison, since the ages are unknown and some of the trees may possibly be very old; but as a matter of general information and to compare the size of Heveas in different localities the following are given:

(*a*) Virgin or untapped trees on land subject to inundation on the Ouro Preto River, a tributary of the Pacanova, the latter being a tributary of the Mamore. Average of 22 random trees, 4 feet 10½ inches.

(*b*) Average of estrada on land of Guapore Rubber Co. of 229 trees, 4 feet. Same location as above, on lowland.

(*c*) Tapped and untapped trees on highland (terra firme) on Saldanha Creek, tributary of the Pacanova River, three hours from

Guajara-Mirim. Average of 18 random trees, 6 feet 1½ inches; the largest of these trees measured 8 feet 5½ inches in girth and was 98 feet in height.

CONDITION OF WILD TREES

Some of the trees of the lower Madeira have been tapped probably 60 years, and undoubtedly most of them over 30 years. (This does not mean continuous tapping, since trees are allowed long periods of rest.) The result is that the tapping bark is about destroyed, and the base of the tree is one solid mass of burrs and protuberances.

FIG. 33.—A virgin tree on the Pacanova River, tapped the first time with a Jebong knife

A peculiar effect of the machadinho tapping is seen on the trunk of forest Heveas which is never seen in Eastern trees: the base of the tree takes on a swelled or "bottle" appearance to a few feet above the tapped surface. Another effect of the machadinho is the production of long, vertical corrugations. On old trees there may be a succession of ridges and hollows running vertically all around the tree, and these may be 4 to 5 inches deep. (See fig. 6, p. 19.)

Tapping generally is done only in the dry season. Inasmuch as this varies for different districts and for different years, no definite time can be indicated. For the lower Madeira it may be said to be

from May to November. On the high terra firme of its tributaries the season is prolonged to eight or nine months, and tapping can be carried on all the year, being interrupted only by days of heavy rainfall. In these regions the season is generally from about April to January.

AVERAGE PRODUCTION PER MAN AND PER ESTRADA

HEVEA

The production per man per season depends upon several factors, among them the length of time the trees have been exploited, whether or not the seringueiro is engaged in the production of his own food, the locality, the number of trees in the estrada, and the individual himself.

On the lower rivers the seringueiros probably do not work more than 120 to 140 days in the tapping season, while on the upper rivers and tributaries the more diligent ones work from 180 to 200 days and the less diligent anywhere from 100 to 120 days. At the Seringal Tres Casas on the Madeira 486 miles from Manaos the average for each seringueiro is 3 kilos (6.6 pounds) of dry rubber per tapping day. At Paraizo, 543 miles from Para, on alluvial land, the production for the best month is said to be 36 kilos (79.4 pounds) per month. The average for the season is probably much lower than this.

At Calama, 574 miles from Manaos, the average for each man for six months' work is 1,000 kilos. The estradas, however, are in the hilly lands of the Machado River above the rapids, many miles away. Tapping is carried on the whole year, but on account of the hilly nature of the country each man works only about six months, collecting 10 to 15 kilos (22 to 33 pounds) of rubber every other day. The number of trees to each estrada ranges from 100 to 200, the average being about 120. Along the line of the Madeira-Mamore Railway and the Mamore and Guapore Rivers and their tributaries the average production per man is from 800 to 1,000 kilos (say 1,765 to 2,200 pounds) of "fine" rubber per season. The seringueiro works two or three estradas.

On the Ouro Preto River seringueiros working three estradas on lowland (varzea), with from 240 to 380 trees to the estrada, were producing in September, 1923, at the rate of 200 kilos (440 pounds) per month. For six months this would give 1,200 kilos (2,645 pounds). The seringueiros at this particular locality stated that farther up the river, several days' travel by canoe, the land was hilly (Pacanova Hills) and the seringueiros could collect from 130 trees as much latex as they were getting from 225 to 240 trees on the Ouro Preto.

It is said that on the high rivers, which means the highlands near the headwaters, a good seringueiro working 200 days during the season on three estradas of approximately 250 trees can produce from 1,400 to 1,800 kilos.[6]

CAUCHO

In the area under consideration there exists an immense amount of Castilla in the forests of the tributaries of the lower Madeira

[6] P. B. de Britto Pereira: Diario Official, Estado do Amazonas, Sept. 7, 1922.

and along the upper Madeira and its tributaries, also on the rivers Mamore and Guapore and their tributaries. Since this tree produces a greater quantity of rubber and since the latex is more easily prepared, much more attention is now paid to caucho than to Hevea. In some localities caucho is produced only during the wet season, when the seringueiros are unable to work their Hevea estradas on the lowlands. In the higher lands it is worked all the year.

In the best localities one tree will yield, on an average, 50 liters of latex, from which can be produced 20 kilos (44 pounds) of caucho. Where one man works both Hevea and caucho near the main rivers he produces about 1,500 kilos (3,300 pounds) of caucho in the season of six months; on the upper reaches it is not uncommon for one man to produce 2,000 to 3,000 kilos (4,400 to 6,600 pounds).

PRODUCTION

Shipments of rubber from the different sections of the Madeira Basin are shown in the table below. By "lower Madeira" is meant the region below Santo Antonio at the beginning of the rapids, or that part comprehended within the State of Amazonas. By "upper Madeira" is meant the region beginning at Santo Antonio, which is comprehended within the State of Matto Grosso. The Abuna, Machado, and Jamary Rivers are given separately. The quantities represent metric tons of 2,204.6 pounds.

TABLE 39.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 5, 1910–1922

Years	Hevea			Caucho	Grand total
	Fine	Coarse	Total		
LOWER MADEIRA	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1910	1,173	211	1,384	137	1,521
1911	1,109	199	1,308	89	1,397
1912	1,067	181	1,248	92	1,340
1913	1,002	164	1,166	126	1,292
1914	1,066	149	1,215	134	1,349
1915	1,126	172	1,298	147	1,445
1916	873	147	1,020	232	1,252
1917	758	123	881	328	1,209
1918	929	167	1,096	445	1,541
1919	936	149	1,085	334	1,419
1920	664	123	787	390	1,177
1921	485	60	545	533	1,078
1922	598	77	675	664	1,339
UPPER MADEIRA					
1910	93	8	101	107	208
1911	96	9	105	96	201
1912	145	17	162	297	459
1913	156	11	167	518	685
1914	262	19	281	557	838
1915	338	34	372	625	997
1916	366	32	398	924	1,322
1917	348	37	385	1,286	1,671
1918	547	45	592	1,306	1,898
1919	577	55	632	1,092	1,724
1920	573	59	632	1,035	1,667
1921	403	23	426	920	1,346
1922	485	37	522	733	1,255

TABLE 39.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 5, 1910–1922—Continued

Years	Hevea			Caucho	Grand total
	Fine	Coarse	Total		
ABUNA	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1910	87	44	131	25	156
1911	123	37	160	51	211
1912	114	5	119	42	161
1913	132	22	154	40	194
1914	157	31	188	48	236
1915	230	53	283	54	337
1916	96	20	116	57	173
1917	75	11	86	99	185
1918	28	13	41	56	97
1919	177	45	222	97	319
1920	116	28	144	43	187
1921	28	1	29	9	38
1922	35	5	40	8	48
MACHADO (GY-PARANA)					
1910	253	34	287	125	412
1911	343	37	380	135	515
1912	488	83	571	459	1,030
1913	401	51	452	334	786
1914	393	33	426	403	829
1915	388	35	423	281	704
1916	346	41	387	287	674
1917	319	37	356	347	703
1918	360	23	383	465	848
1919	337	34	371	512	883
1920	314	30	344	546	890
1921	172	8	180	287	467
1922	121	14	135	125	260
JAMARY					
1910	291	32	323	480	803
1911	372	34	406	396	802
1912	442	36	478	558	1,036
1913	363	41	404	636	1,040
1914	591	36	627	678	1,305
1915	666	46	712	415	1,127
1916	698	56	754	605	1,359
1917	691	47	738	752	1,490
1918	739	65	804	677	1,481
1919	791	62	853	429	1,282
1920	794	62	856	437	1,293
1921	537	29	566	327	893
1922	554	36	590	272	862
TOTAL, REGION 5					
1910	1,807	329	2,226	874	3,100
1911	2,043	316	2,359	767	3,126
1912	2,256	322	2,578	1,448	4,026
1913	2,054	289	2,343	1,654	3,997
1914	2,409	268	2,737	1,820	4,557
1915	2,748	340	3,088	1,522	4,610
1916	2,379	296	2,675	2,105	4,780
1917	2,191	255	2,446	2,812	5,258
1918	2,603	313	2,916	2,949	5,865
1919	2,818	345	3,163	2,464	5,627
1920	2,461	302	2,763	2,451	5,214
1921	1,625	121	1,746	2,076	3,822
1922	1,793	169	1,962	1,802	3,764

PRICES PAID THE SERINGUEIRO

Each proprietor has his own method of fixing the price which he pays the seringueiros. This price is usually about one-half of

the Manaos price and is paid in merchandise. The profits made on the supplies sold to the seringueiro will be around 50 to 75 per cent. In actuality, therefore, he receives much less than one-half the Manaos price.

In September, 1923, the seringueiros on the lower rivers—that is, below Porto Velho—were receiving 2$000 to 2$500 per kilo. The price in Manaos at the time was about 5$200 per kilo for "fine" and 4$100 for "virgin coarse." The general rule seems to be to pay the seringueiro 2$000 per kilo when the Manaos price is from 4$000 to 5$000 per kilo.

Along the Madeira-Mamore Railway and the Mamore and Guapore Rivers and tributaries, on account of higher living costs the seringueiros are paid more. In 1922 one of the largest companies operating in this district paid its seringueiros 2$600 per kilo. This company pays at Guajara-Mirim 60 per cent of the selling price at Manaos. Thus if the price at Manaos is 4$000 per kilo the seringueiro is paid 2$400. He is charged with the freight from his barracão to Guajara-Mirim, and in liquidating 10 per cent is deducted for shrinkage and loss in grading; that is, of each 100 kilos delivered he receives pay for only 90 kilos.

COST ESTIMATES

In this district the purchases of the seringueiro average 1,500$000 for the year, and of the caucheiro 1,200$000. At this place the cost of production is around 1$500 per kilo, or 680 reis ($0.07 U. S.) per pound for "fine" rubber (Hevea). If the rubber worker receives 2$500 per kilo for his season's production of, say, 1,000 kilos, his profit is 1,000$000, or roughly $100 U. S. currency. The seringueiros stated that with a price of 1$500 per kilo they could just break even; that is, they would have no profit on the year's work, but just a living.

The manager of the company on whose property these seringueiros were working stated the company could still produce rubber if the price went as low as 2$000 per kilo in Manaos; below this it could not operate without running the seringueiros into debt, which was against its policy.

Thus, as near as could be determined, the actual cost of producing a pound of rubber, say at Guajara-Mirim, will be around 1$500 per kilo, or $0.07 U. S. a pound. The freight rate from Guajara-Mirim to Porto Velho on the Madeira-Mamore Railway is based upon the official valuation (pauta) published weekly by the Government. As an example, if the price is 5$000 per kilo, the freight rates are:

	Per ton	Per pound
Guajara-Mirim to Porto Velho:		
Fine rubber	590$000	0$270
Sernamby	417$000	0$185
Sernamby de caucho	476$000	0$215
Porto Velho to Manaos	84$000	0$038
Porto Velho to Para	145$000	0$060

OTHER INDUSTRIES AND RESOURCES

In the area under consideration there is little agricultural development, except to meet local needs, and consequently there are no sta-

tistics available as to the acreage or quantity of crops produced. Some of the seringueiros now raise part or all of their food. Many settlers or renters occupy small patches along the rivers which they cultivate, and with them rubber is a secondary matter. These crops, grown for their own use and in some instances for sale or barter in a small way, include rice, beans, corn, mandioca, plantains, and other vegetables.

Many valuable trees that furnish lumber and oil products exist, but they are scattered. In clearing for plantations much valuable wood could be saved, for which a local market is available, and for some of which foreign markets are being opened.

The most valuable timber now being produced, other than for local use, is the cedro, or Spanish cedar, both red and white. This timber can be floated down the river in rafts to the sawmills. The cedro is common on the low or inundated lands of the Madeira and its tributaries and on the highlands of the tributaries. It does not exist along the banks and highlands of the Madeira proper. Woods suitable for cabinet work have a high specific gravity and can not be floated; this adds greatly to the difficulty and cost of getting them out.

During the early days of the construction of the Madeira-Mamore Railway it was found cheaper to import eucalyptus ties from Australia, although the railroad was built through forests practically all the way. At the present time, however, the railroad has a well-equipped sawmill at Porto Velho and cuts its own lumber and ties.

TRANSPORTATION AND COMMUNICATION

RIVER

The general river system of that part of Brazil embraced in Region 5 is shown in the following outline:

Amazon.
- Madeira.
  - Muracutuba.
  - Capana.
  - Maparana.
  - Ferreiros.
  - Abuna.
  - Aripuana-Roosevelt.
  - Mataura.
  - Anhangatinga.
  - Manicore.
  - Marmellos.
  - Uruapiara.

Amazon—Continued.
- Madeira—Continued.
  - Piraiauara.
  - Rio das Flechas.
  - Mahise.
  - Gy-Parana or Machado.
  - Jamary.
  - Jacy-Parana.
  - Mutum-Parana.
  - Mamore.
    - Guapore.
      - Pacanova.
      - Soterio.

The principal affluents of the Madeira, as is the case with most of the great tributaries of the Amazon, flow into it on the east side. Its drainage basin on the west side toward the Purus is very narrow, and the streams, which are relatively unimportant, tend to flow roughly parallel to the main river for most of their course before turning east to reach the Madeira. The Madeira is formed by the junction of the Mamore with the Beni, a Bolivian stream. The Mamore itself above the point where it receives the important Guapore from the southeast is a Bolivian river. The tributaries of the Guapore are short and unimportant.

NAVIGABILITY OF MADEIRA RIVER

The two capital factors in the navigability of the rivers of this region are, first, the great seasonal differences in their levels, and, second, the interruption of their courses in nearly every case by rapids or in some cases by real cataracts. The extreme "spread" in the level of the Madeira between the dry season and the wet season ranges from 40 to 55 feet, being 51 feet at Santo Antonio. The difference of level in the smaller rivers is correspondingly less, though in every case considerable enough to modify radically their conditions of navigation. Thus, some streams that might be navigated during the time of annual flood by the regular river steamers of the Manaos-Porto Velho service offer difficult passage to canoes during the period of low water. A distance which may be covered in a week in April may require two months in September. This condition forces the proprietors of rubber lands on the upper rivers to move out as much of their output as possible during the few months of high water, the more distant seringaes remaining virtually isolated during low water. The rivers begin to rise in October or November and reach their maximum in March or April. At that time the rains begin to slacken and the rivers to fall slowly until the dry season in June or July. Thenceforth until the first rains of the southern summer there is little variation in the level of the rivers that might affect their navigability. The volume of water in the Madeira is also influenced greatly by the melting snows about the headwaters of the Beni and Mamore.

The cachoeiras (rapids), which are a common feature of all these rivers, are formed by the streams breaking through the layers of crystalline rock that extend athwart the general direction of their course. Sometimes these rocks scarcely crop out above the general level of the surrounding country or are visible only where the river has uncovered them; at other times, as in the region of the headwaters of the upper Madeira tributaries which lie within the highland country of Matto Grosso, the spurs of the Serra dos Parecis throw a barrier across the valleys through which the rivers cut their way in rocky canyons. These canyons are strewn with cachoeiras that obstruct the passage of any craft larger than a canoe and are often not navigable even by canoes.

The most famous series of cachoeiras is that which extends for 230 miles from Santo Antonio on the Madeira to Guajara-Mirim on the Mamore, and which constituted the motive for the construction of the Madeira-Mamore Railway. There are 20 of these cachoeiras, with a total fall of 475 feet. Some, such as Santo Antonio and Guajara-assu, can be passed by canoes with ease; others, such as the terrible Cachoeiras Theotonio, Girao, and Riberao, are impassable for craft of any kind at any season.

LIMIT OF NAVIGATION ON MADEIRA RIVER

During the entire year steamers drawing up to 9 feet of water can reach Santo Antonio on the Madeira, 694 miles from the mouth, though Porto Velho, terminus of the railway and about 4 miles below Santo Antonio, is the actual limit of navigation for the large

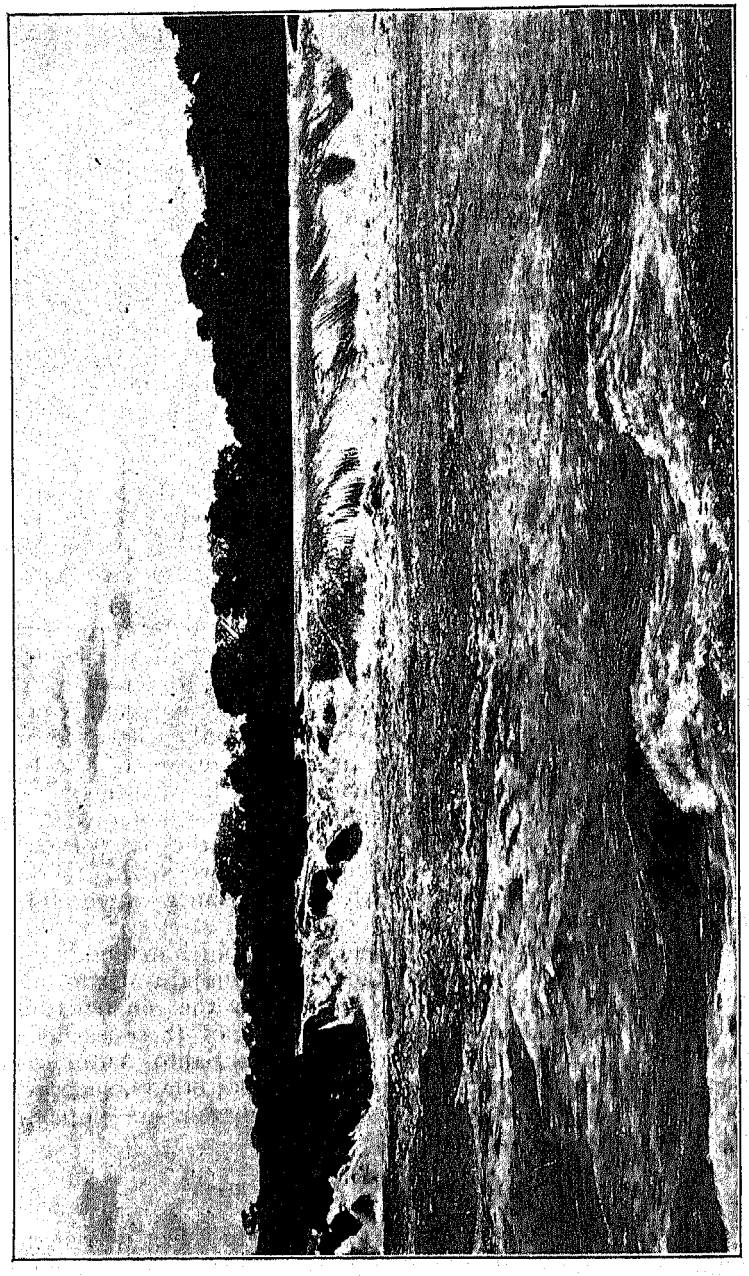


Fig. 34.—Salto Theotonio, near Porto Velho, on the Madeiro River, showing the difficulties of navigation in the cachoeira belts of the upper rivers

river steamers. However, vessels drawing 8 or 9 feet of water are accustomed to tie up at night in the upper part of the river in the dry season. The presence of submerged ledges or rocks at the Marmellos pass and the existence of bars at certain places, though well known to the regular river pilots, require caution in that section of the river at times of low water. Navigation is free throughout the year without the necessity of stopping at night for steamers that draw up to 6 or 7 feet of water.

During the months of annual flood ocean-going steamers could reach Porto Velho without difficulty, and, in fact, during the construction of the railway ships of 7,000 tons and drawing 20 feet of water frequently brought rails and other materials to Santo Antonio. The Madeira probably has an average width of over a thousand yards, and its course is much less sinuous than that of the slow-flowing Purus and Jurua.

NAVIGABILITY OF THE TRIBUTARIES

Of the tributaries of the Madeira, the Aripuana is navigable for the longest distance. During January–April steamers drawing 6 to 8 feet of water can ascend it for 175 miles, but for the remainder of the year navigation on that stretch is confined to launches drawing less than 3 feet. Beyond that the cachoeiras begin and only canoes may pass. This is also true of the Roosevelt, a long affluent of the Aripuana, whose course was only recently explored. The Marmellos is navigable for nearly 150 miles from the mouth; after that it is traversable only by shallow-draft launches or canoes. During the four months of highest water the Gy-Parana, or Machado, can be navigated for about 50 miles from its mouth by boats drawing 5 or 6 feet. However, its course above the point known as Bispo Aquino is extremely broken, some of the cachoeiras having the character of real cataracts. The course of the Jamary is shorter, but conditions of navigability are much the same. The Jacy-Parana, which flows into the Madeira about 50 miles above Porto Velho, has no steamer navigation but is dependent on canoes and very light launches. The extremely small volume of water in the dry season and the great number of snags make travel on this stream especially difficult.

The tributaries of the Madeira on the left (west) bank, such as the Capana and Autas, generally originate in swampy lakes. Due to the weaker quality of the rubber of the interior their navigation is less important than the rivers of the right (east) bank. The Abuna, which forms the boundary between the State of Amazonas and the Republic of Bolivia, is a different type of river. Rapids at Fortaleza directly above its mouth obstruct all navigation at that point, but beyond the river is navigable for launches all the year in spite of the numerous snags in its channel.

FREIGHT AND PASSENGER SERVICE

The principal navigation companies operating a regular freight and passenger service on the Madeira are the Amazon River Steam Navigation Co. and the Companhia Fluvial. The Amazon River

Co. runs steamers from Para to Porto Velho, calling at Manaos; the Companhia Fluvial, which is a subsidiary of the Madeira-Mamore Railway Co., operates two steamers between Porto Velho and Manaos. The Amazon River Co.'s boats leave Para the 7th and 21st of each month for Porto Velho via Manaos; the voyage is made from Manaos in about four days. The Companhia Fluvial has a boat every 20 days. B. Levy & Co., of Manaos, operate an irregular service between that city and points on the Madeira; though they do a general freight and passenger business, their principal interest is in carrying merchandise to their numerous customers in that region and bringing back rubber. There are four or five other independent operators on the Madeira. Most of the steamers used in the Madeira service are of 220 to 440 tons burden.

ROAD

There are few roads in the entire zone of the Madeira, and these are trails of purely local importance. The only exception is the road which follows the national telegraph line across Matto Grosso, but which is largely utilized for making repairs to the line.

The outstanding transportation problem of this region is that of overcoming the rapids in the rivers, a problem solved so far only in the main river. Vast reserves of excellent rubber country exist about the headwaters of the Madeira tributaries that can not be advantageously exploited until this fundamental problem is settled. The alternative possibilities for carrying freight around the obstructed sections of the rivers comprise the construction of light railways of Decauville type or of highways capable of handling motor traffic in the form of either trucks or caterpillar tractors.

RAILWAY

A very important link in the transportation system of Region 5 is the Madeira-Mamore Railway, though it is of greater importance to the Bolivian than to the Brazilian part of the Madeira Basin. While a railway around the dangerous rapids of the Madeira had long been planned, it was not until the treaty of Petropolis in 1903 made provision for its construction that the line was finally built, the first train arriving at Guajara-Mirim in 1913.

From Porto Velho to Guajara-Mirim is 226 miles. The principal intermediate stations are Jacy-Parana, Presidente Marques, and Villa Murtinho, where the railroad receives the rubber output of, respectively, the Jacy-Parana, the Abuna, and the Beni. Due to the decrease in traffic only one train a week is run over the line. This is a combined freight and passenger train, which makes the trip in two days, lying overnight at Presidente Marques or Abuna.

RUBBER SHIPMENTS VIA RAILWAY

The principal article of traffic is rubber, shipments for the years 1915–1922 being as follows (quantities in metric tons of 2,204.6 pounds):

TABLE 40.—RUBBER SHIPMENTS OVER MADEIRA-MAMORE RAILWAY, 1915–1922

Years	Hevea			Caucho sernamby	Grand total
	Fine	Sernamby	Total		
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
1915	2,745	339	3,084	1,341	4,425
1916	2,795	326	3,121	2,011	5,132
1917	2,823	373	3,196	2,743	5,939
1918	2,455	231	2,686	2,408	5,094
1919	2,136	406	2,542	2,119	4,661
1920	2,365	304	2,669	1,781	4,450
1921	1,933	111	2,044	1,210	3,254
1922	1,970	174	2,144	1,207	3,351

Freight rates are graduated according to the current price of rubber at Manaos, the schedule of rates being ratified by the Federal Ministry of Transportation. Though complaint of the high freight rates is chronic among shippers, the necessarily high cost of maintaining the line in condition and the peculiar financial situation of the holding company make any appreciable reduction improbable.

The local headquarters and the shops of the road are located at Porto Velho, whose growth has been entirely due to its position as terminus of the railroad. The home offices of the company are in London.

TELEGRAPH AND CABLE

The national telegraph line from Rio de Janeiro via Cuyaba in Matto Grosso reaches the Madeira at Santo Antonio directly above Porto Velho. Guajara-Mirim and Presidente Marques (Abuna) also are connected up with this great trunk line. Rates are very cheap, but due to the frequent accidents to the wires caused by falling trees, etc., delays in the transmission of messages are common. It is possible to relay messages to foreign points at Rio de Janeiro. The Madeira-Mamore Railway also has its own telegraph service.

There is a national radio station at Porto Velho, which communicates with Manaos, where there are good cable connections with all foreign countries. From Villa Bella, opposite Villa Murtinho, on the railroad, there is radio communication via Riberalta and Viacha-La Paz with the cable lines on the west coast.

The railway company maintains telephone connections between the two terminals of the line.

OWNERSHIP OF LAND AND LAND LAWS

The acquisition of public lands in the State of Amazonas is regulated by Law No. 786 of October 28, 1914. In the State of Matto Grosso it is regulated in accordance with executive decree No. 130 of June 4, 1902. Extraordinary grants may be made by special action of the State Legislatures.

AMAZONAS

In Amazonas public lands may be acquired in lots of 2,500 hectares (hectare=2.47 acres), and each purchaser may acquire a total of 10,000 hectares, or approximately 25,000 acres.

Persons desiring to buy these lands for the extraction of rubber may obtain a provisional title at once, valid for two years. During this time they must survey the property and satisfy the other formalities necessary to obtaining a definitive title at the end of the period allowed. A requirement in such cases is that one-tenth of the area be planted to rubber trees in the proportion of 100 trees to the hectare. The price fixed for lands intended for the extraction of rubber is 600 reis, or about $0.06 U. S. at present exchange, per hectare. This is for lands situated on the banks of rivers, those located back from the rivers selling for 500 reis per hectare. In order to encourage settlement, so-called squatters' rights are recognized as legal when secured by several years of actual occupation of a limited area.

MATTO GROSSO

In the general land law of Matto Grosso provision is made for both purchase and lease. No limit is fixed to the quantity that may be acquired in either way. Land secured by purchase may be paid for at once, which method is to be recommended, or in three annual payments. The purchaser may take possession only after payment of half the price. Land situated over a mile and a quarter from a navigable river or public road is sold at the rate of 3$600 per hectare when destined for the working of rubber; when located on navigable streams or public roads the price is fixed at 5$000 per hectare. On payment of the total sum and the satisfaction of such other formalities as the surveying of the land, definitive title to the property is granted by the Public Land Office at Cuyaba, capital of the State.

Public lands may also be leased for a period of 20 years for the purpose of extracting rubber or other natural products, exclusive of minerals. Any person or company desiring to lease a certain area of land must petition the governor of the State to that effect, whereupon the disposition of the land is settled by public auction, offers being made in the form of sealed bids. The annual rental, which is payable in advance, can not be less than 70 reis per hectare. The large properties of the Guapore Rubber Co. and the Julio Muller Rubber Estates, operated by the Madeira-Mamore Railway Co., are held under lease from the State of Matto Grosso. The vast concession of an American company in the basins of the Juruena and Arinos, confluents of the Tapajoz, was secured under the same conditions.

PUBLIC LANDS AVAILABLE

Some of the large properties along the tributaries of the upper Madeira, such as the Gy-Parana, Jamary, and Jacy-Parana, still lack definitive titles and are liable to reversion to the State. Nevertheless, in the region about the upper courses of these rivers and those of the Aripuana and Roosevelt, and reaching to the Juruena, there are enormous areas still unclaimed and subject to acquisition as rubber lands, either by purchase or by lease.

On the Madeira, which has been settled for a much longer time, property rights are better established, though there are occasional conflicts of title. All titles must be registered in Manaos.

The cost of surveying public lands in both Amazonas and Matto Grosso generally exceeds the original cost of the property. There is

no land market in either State, and no prevailing scale of prices or values, all purchases being the subject of separate negotiation. Prices of land vary according to the current prices of rubber, condition of the estradas, improvements on the property, and transportation facilities.

6. UPPER AMAZON, SOUTH

LOCATION AND AREA

Region 6 comprehends that part of the State of Amazonas which lies to the south of the upper Amazon, or Solimoes, and between the watershed of the Madeira Basin on the east, the Peruvian frontier on the west, and the Acre Territory on the south. It has an approximate area of 280,000 square miles.

The most important rivers within the region are the Purus and the Jurua. The Brazilian side of the drainage basin of the Javary, which forms the border with Peru, is also comprised within the territory under discussion.

PHYSICAL FEATURES

In its topographical features Region 6 has nothing to distinguish it from other parts of the Amazon plain. Except for a small stretch of campos between Labrea on the Purus and Humayta on the Madeira it is covered with virgin forest closely resembling that of the Madeira and the Acre (Regions 5 and 7). It is an area of relatively low elevations—the highest point probably would not exceed 450 feet above sea level—traversed by many rivers, creeks, and rivulets.

Each of the rivers has a rather wide valley, or flood plain, subject to inundation for varying lengths of time during the period of high water but capable of producing various crops during the dry season. As the Acre Territory is approached (and all of them except the Teffe and Jutahy touch or flow through the Acre) the valleys become narrower and the lands higher in elevation. At intervals the rivers touch the high land, that is, the terra firme, which is not subject to inundation, and such places are generally the seat of fazendas or establishments for the seringaes (rubber properties) and castanhaes (Brazil-nut properties) along the rivers or in the interior. The area adjacent to the Acre is more hilly than that bordering the Amazon River.

PURUS RIVER

For the first 250 miles from its mouth the Purus has a very wide flood plain and rarely is there high land of any extent to be seen. Above that point terra firme is frequently encountered, and some of it is rather hilly in character. On the Purus it was observed that most of the terra firme was on the left (or west) side of the valley, though it is well known that large areas of such land exist between the Purus and the Madeira Rivers. In fact, the low range of hills known as the Serra dos Tres Irmaos, which can be seen from the Madeira River, crosses the Ituxy, a tributary of the Purus on the right side, and gives rise to a series of rapids in the river.

Descending the Purus from the mouth of the Acre River, well-drained land not subject to inundation was observed near the mouth of the Inauhiny River and at Sao Miguel, Sao Romao, Rio Pauhiny, Ajuricaba, Quicia, Cachoeira, Hyutanaham, Terra Firme de Sao

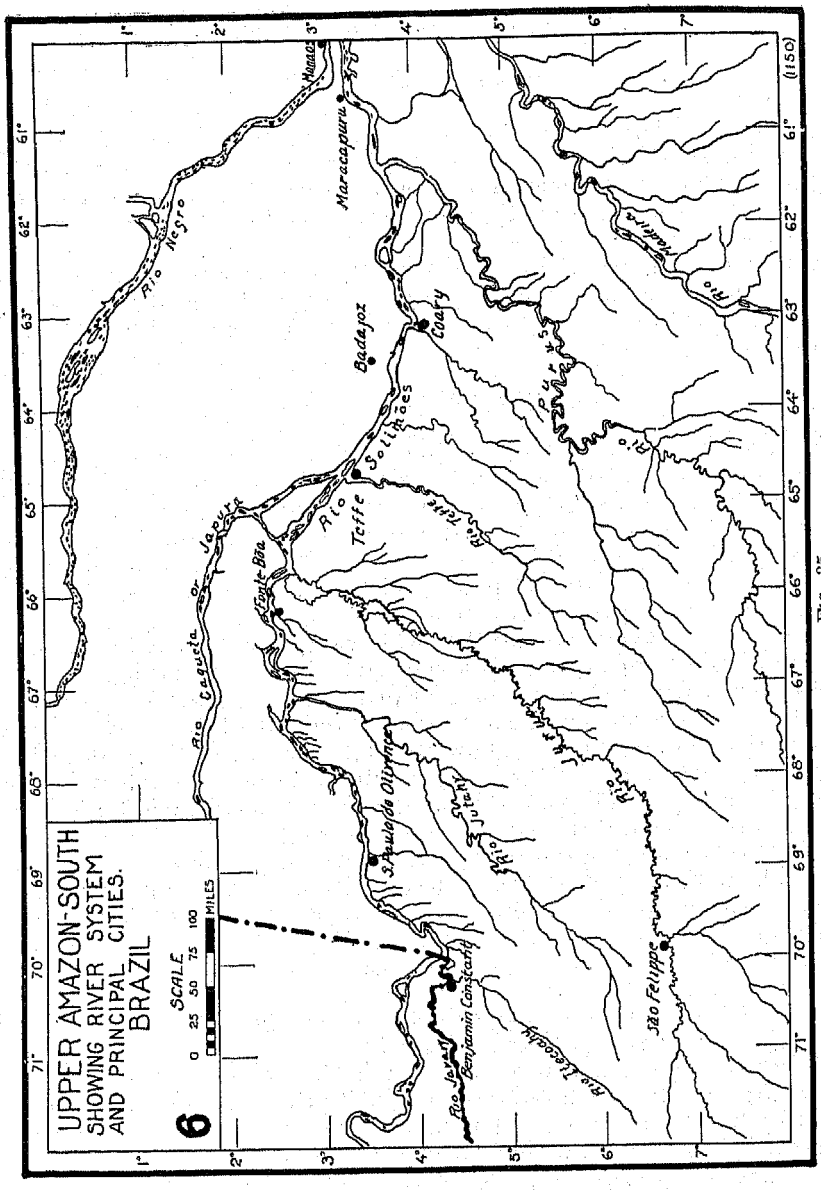


Fig. 35

Francisco, Labrea, Allianca, Nova Olinda, and Cariuacango. Hyutanaham and Sao Francisco are on bluffs more or less 150 feet above the level of the river. Hyutanaham was built as a transfer station of the Amazon River Steam Navigation Co., but never used.

SOLIMOES RIVER

At many places on both sides of the Solimoes (Amazon) the high lands come to the water's edge and areas of high land extend back into the interior. Along the river the bluffs are usually a red layer on top, underlain by grayish material. At some places, however, the land is very hilly and deeply dissected with ravines, and for this reason would prove unsuitable for rubber plantations.

High land was observed at the following stops on the right (south) side of the Solimoes (many such places passed at night are not recorded):

	Miles from Manaos
Mamia	231
Barro Alto	295
Bocca do Ipixuna	303
Caiambe	343
Sitio Izadoro	
Teffe	368
Caicara	373
Foz do Jutahy	635
Fonte Boa	664
Sao Joaquim	
Sao Paulo do Olivenca	773

The lands along the south bank of the Solimoes are generally superior to those on the north side from the standpoint of rubber planting. The stretch from Tracary to Teffe, on account of its proximity to Manaos (Tracary 248 miles and Teffe 368 miles), excellent transportation facilities, and character of terrain, is a most favorable locality for rubber plantations.

TEFFE RIVER

The Teffe River, at the town of Teffe, a short distance from its confluence with the Solimoes, has the appearance of a lake. Its water is black, like the Rio Negro. On both sides of the Teffe high land exists for a considerable distance. This level and gently undulating land covers a large area, extending on the east to the Purus and on the west to the Jurua. It is claimed to be very fertile, producing well such crops as sugar, coffee, beans, bananas, and even cotton.

The other main rivers were not examined by the field party except in their lower courses, due to lack of time, but from information secured from reliable sources and the topographical features that characterize the whole western part of the Amazon Basin it can reasonably be accepted that the foregoing description is correct.

CLIMATE

The climate of the region will not differ materially from that of the Madeira region. The Purus is less than 200 miles from the Madeira, and while it is by some considered to have a higher temperature we could detect no difference.

In the western extremity the climate is approximately the same as that of the Acre.

TEMPERATURE

In the report[7] of Engenheiro Joao Alberto Maso for the year 1911 appear the data given below. Sr. Maso states that these figures are

[7] Delegacia do Ministerio da Agricultura no Territorio do Acre. Relatorio de Delegado, Engenheiro Joao Alberto Maso, 1910, 1911, 1912. Rio de Janeiro, 1912.

the means taken by him over five years, presumably at Senna Madureira, Acre Territory, and should hold good for the adjacent parts of the State of Amazonas.

TABLE 41.—MONTHLY MEAN TEMPERATURE AND RELATIVE HUMIDITY, SENNA MADUREIRA

Months	Temperature		Relative humidity
	Mean maximum	Mean minimum	
	° F.	° F.	Per cent
January	92.3	68.9	91.1
February	89.6	68.0	90.0
March	89.6	67.6	92.0
April	87.9	67.1	96.3
May	90.8	66.2	87.4
June	95.9	53.4	85.0
July	95.9	54.5	82.0
August	96.8	53.2	80.2
September	98.0	59.1	83.7
October	95.7	62.4	86.8
November	95.0	65.6	88.9
December	91.4	67.8	89.8

RAINFALL

In an area so large as Region 6 it is natural the rainfall should vary in amount. It is lighter along the Amazon River in the eastern part than in the western. The section nearest Manaos probably has a rainfall approximating that of Manaos. The Purus, being close to the Madeira River, would have conditions more or less the same as the latter, and the upriver districts more or less those of the Acre Territory.

There is given below the average rainfall for 10 years for the stations at Remate de Males, Sao Felippe, and Coary. Sao Felippe, on the Jurua, is in the interior; Coary is on the Amazon, and Remate de Males on the Javary near its mouth.

TABLE 42.—AVERAGE MONTHLY RAINFALL AND WET DAYS, REMATE DE MALES, SAO FELIPPE, AND COARY, 1910–1919

Months	Remate de Males		Sao Felippe		Coary	
	Inches	Days	Inches	Days	Inches	Days
January	14.74	17	11.64	11	9.48	20
February	11.24	14	13.59	13	10.27	18
March	15.22	16	13.30	13	10.70	19
April	11.55	15	10.38	11	9.80	20
May	10.57	15	6.95	10	8.57	18
June	5.94	12	2.32	10	5.17	15
July	5.65	12	2.58	9	3.18	10
August	6.46	12	4.21	9	2.92	9
September	6.53	12	7.58	10	3.73	9
October	10.77	16	10.15	10	5.79	13
November	10.60	16	12.15	12	5.25	13
December	14.24	17	11.02	11	8.33	15
Total	123.51	174	105.87	129	83.28	179

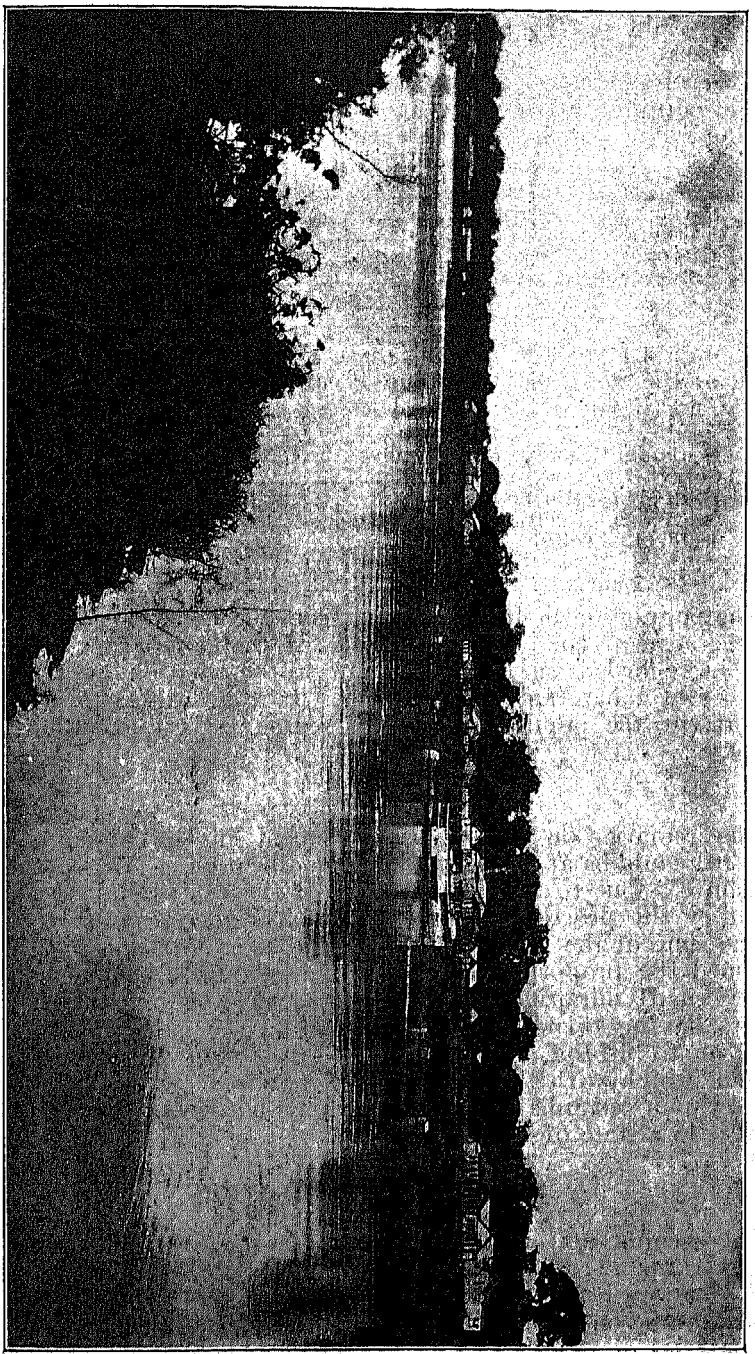


FIG. 36.—Remate de Males, on Javary River near the boundary of Brazil and Peru

POPULATION

No reliable estimate of the population of Region 6 is possible, first, because of the nomadic character of much of the population, and, second, because of the fact that it does not correspond to a single administrative entity or to a group of such units. The following municipal districts lie entirely within its boundaries:

	Population
Canutama (Rio Purus)	9,577
Carauary (Rio Jurua)	8,681
Floriano Peixoto (Rio Acre)	13,717
Labrea (Rio Purus)	17,133
Sao Felippe (Rio Jurua)	16,238
Total	65,346

Though the following towns are situated on the right (south) bank of the Solimoes, their municipal districts comprise also lands on the north side of the river:

	Population
Benjamin Constant (Rio Javary)	10,199
Coary (Rio Coary)	9,688
Fonte Boa (Rio Solimoes)	10,449
Sao Paulo do Olivenca (Rio Solimoes)	12,220
Teffe (Rio Teffe)	12,387
Total	54,943

The population figures are taken from the Federal census of 1920, but because of the scattered nature of the population even these can be regarded only as a distant approximation of the actual number of inhabitants at that time. It is probable, however, that at present the population of this region is between 100,000 and 110,000.

LABOR

The remarks on the laboring element in the Madeira region (p. 240) could be applied with little modification to the population of Region 6. Due to the great decline of the rubber industry in this territory the process of depopulation has gone even further than in the zone of the Madeira, and in the lower Purus and Jurua has assumed the proportions of a veritable exodus. Only a comparatively small minority is still engaged in working rubber, many others having turned for a livelihood to the gathering of Brazil nuts or to fishing. However, the great majority have left the region, which with the exception of certain localities, particularly the Ayapua castanha zone and the lands bordering the Acre Territory, is in a state of frank decay.

HEALTH AND SANITATION

The account of sanitary conditions in the country north of the Solimoes (p. 222) might be substantially reproduced for the region under survey here. The common ailments and sanitary problems are the same on both sides of the main river; the same prevalence of malarial or paludal fevers is found, though of greatly varying

intensity in different localities, and the same almost universal occurrence of hookworm is noted. After a visit of inspection to the upper Solimoes in 1922, the director of the Public Health Service in the State reported that malignant fevers were so rampant on some of the streams of that region that they merited the name of "river cemeteries."

However, at the time of our ascent of the Solimoes health conditions were said by the friars intrusted with the sanitary work of that area to have improved considerably. In fact, certain localities in the Purus and the Jurua, as in the other rivers, have a reputation for salubrity that is borne out by actual observation. However, some places are notorious centers of infection. One such is the village of Labrea, the principal town on the Purus and formerly a center of considerable importance, whose entire population in 1922 was said by an inspector of the Public Health Service to be afflicted with malaria.

WILD RUBBER

PURUS RIVER AND TRIBUTARIES

Lower Purus.—The "lower Purus" area is usually considered as that between the mouth of the river and the town of Labrea. "Fine" rubber (*Hevea brasiliensis*) exists only on the lowlands along the river and the margins of the lakes. The trees on the highlands are "weak," probably *Hevea guyanensis.*

Upper Purus.—The river (and its tributaries) beyond Labrea is known as the upper Purus and is more important from a rubber standpoint. From Labrea to about a line passing through Floriano Peixoto, a town on the Acre River a short distance above its mouth, the lowlands produce "fine" rubber of good quality. The higher lands have only "weak," but up the tributaries two or three days' travel, toward the heads or watersheds, "fine" rubber is again encountered on the uplands. Above Floriano Peixoto the country is similar to that of the Acre Territory and "fine" *Hevea brasiliensis* is found of equal quality.

Inauhiny.—The Inauhiny, belonging in its total length to the firm of Fretes, Ferreira & Co., of Manaos, empties into the Purus not far from the mouth of the Acre River. It has "fine" rubber on the lowlands, and "weak" on the uplands near its mouth, but two days' journey upstream *Hevea brasiliensis* is encountered on both low and high land.

Ituxy.—The Ituxy, which has its source in the Acre Territory, bears the name Iquiry as far as the cachoeiras at Fortaleza, and Ituxy below the falls. From its mouth to Fortaleza it has "weak" rubber along its margins, but above this point the rubber is "fine" on both low and high land and ranks with Acre rubber. The land below the falls is low and swampy; above it is hilly, and this type of topography extends into the Acre. The territory from the mouth of the Ituxy to the Acre border belongs to the firm of Gomes & Co., of Manaos.

Pauhiny.—The lands along the Pauhiny for two days' travel have "fine" only on the low parts. After that "fine" exists on both low and up lands.

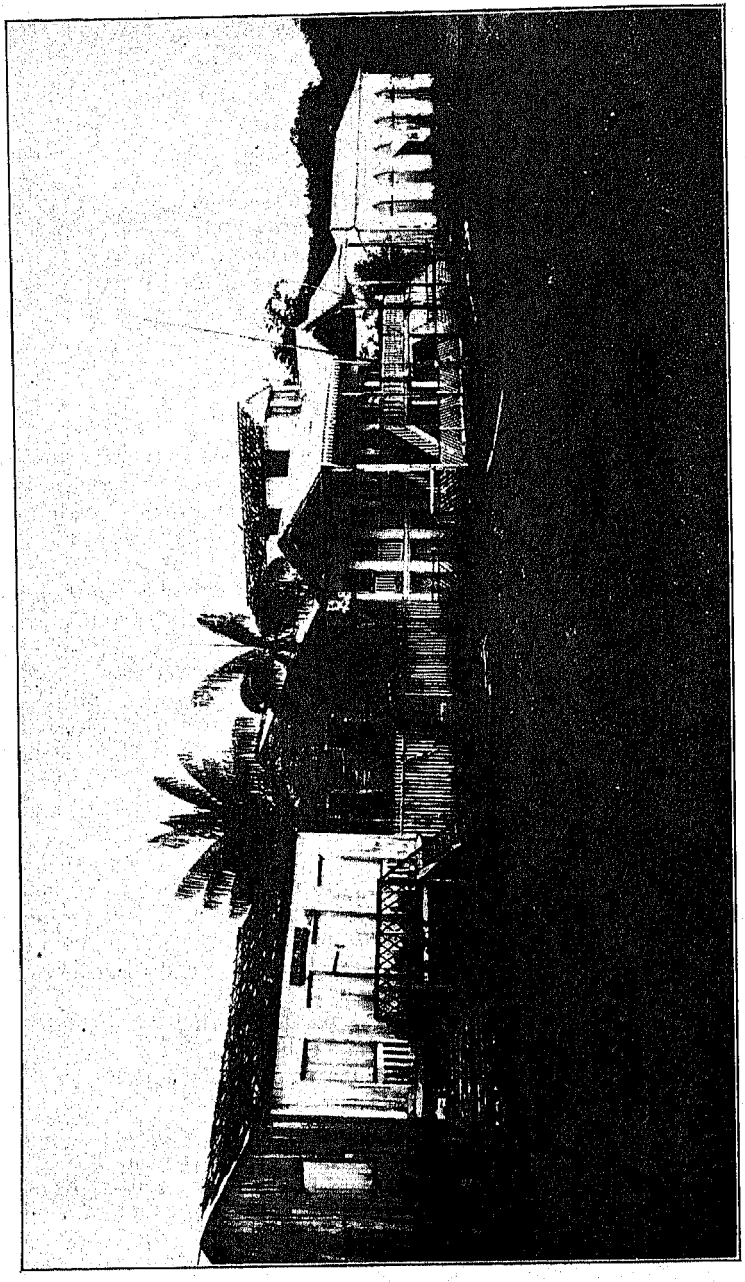


FIG. 37.—Headquarters of the Seringal Cachoeira on the Purus River

OTHER IMPORTANT RIVERS

Jurua.—The land along the lower Jurua is low and swampy for some 150 miles; only "weak" rubber is found in this area. Beyond this point "fine" rubber is found on the lowlands and "weak" rubber on the uplands, as far as the mouth of the Tarauaca, near the village of Sao Felippe. Above Sao Felippe, both on the Tarauaca and its tributaries and the Jurua and its tributaries, the rubber is "fine" on both low and high lands, and this condition continues on into the Acre Territory and Peru.

Teffe.—The trees on the lowlands along the Teffe produce "fine" rubber and are *Hevea brasiliensis.* The upland rubber is "weak." Some upper tributary of the Teffe, therefore, has "fine" around its headwaters, but at Teffe it was not known which tributary it is.

Jutahy.—Estradas of *Hevea brasiliensis* begin on lowlands of the Jutahy a short distance above the point where it joins the Solimoes, some 635 miles from Manaos. Toward its source and in the watersheds of its tributaries "fine," or *Hevea brasiliensis*, exists on both the low and high lands. This region has in the past produced much caucho, now nearly exhausted.

Javary.—A few hours from the mouth of the Javary, which forms the boundary between Brazil and Peru, "fine" begins on the lowlands; the rubber on the uplands being most commonly "weak." Farther up the river and in the watersheds of its tributaries "fine," or brasiliensis, is found on both low and high lands.

CONDITION OF WILD TREES

The trees in the more accessible parts of this territory have been exploited for a long time; they are badly mutilated and consequently give low yields at present. Some of the areas on the Purus have been worked for over 40 years. On the Inauhiny River it was observed that the average size of the trees was rather small. Trees no larger than 18 inches in girth were tapped, and in nearly all cases the trees had been tapped up to 12 to 15 feet by the use of ladders.

In general, the yields are very low in the older sections, due to continuous tapping. Along the Purus the average production per man per season ranges from 300 to 450 kilos (660 to, say,, 1,000 pounds). This is about the average for the other rivers along their lower courses, though the yields are better higher up the streams, In the Iquiry, yields as high as 800 kilos (1,765 pounds) and over are said to be obtained.

In the Jurua, most of the exploitation has been on the lowlands, for reasons of convenience and lack of men, though the trees on the highlands in the upper portions of the river are said to be the better producers. It is understood there are rather large reserves of virgin trees in the upper reaches yet to be exploited when conditions are favorable. On the lower Jurua the estradas are of about 200 trees, and in some of the smaller rivers near by as many as 500 trees are tapped by one man. Trees in tapping had girths at 3 feet from the ground of 2 feet 2 inches up to 7 feet 5 inches, which was the largest size we actually measured.

The Javary has been well worked and has been a very rich river in the past. It has also been the source of great losses. One French company is said to have lost outright 20,000,000 francs in an exploitation scheme, due to poor management.

PRODUCTION

Production (exports) of rubber from the four principal rivers of this area during the years 1910–1922 was as follows (quantities in metric tons of 2,204.6 pounds):

TABLE 43.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 6, 1910–1922

Years	Hevea			Caucho	Grand total
	Fine	Course	Total		
JAVARY	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1910	898	181	1,079	372	1,451
1911	961	197	1,158	261	1,419
1912	891	194	1,085	263	1,348
1913	540	110	650	167	817
1914	481	79	560	111	671
1915	447	95	542	118	660
1916	535	93	628	102	730
1917	596	103	699	104	803
1918	337	45	382	50	432
1919	345	48	393	27	420
1920	176	27	203	35	238
1921	200	25	225	62	287
1922	283	58	341	45	386
JUTAHY					
1910	261	107	368	16	384
1911	227	35	262	24	286
1912	243	43	286	25	311
1913	134	25	159	24	183
1914	219	28	247	15	262
1915	193	31	224	5	229
1916	197	29	226	3	229
1917	168	27	195	4	199
1918	46	12	58	9	67
1919	123	13	136	1	137
1920	42	5	47	1	48
1921	11	1	12	1	13
1922	43	6	49	9	58
JURUA					
1910	1,356	245	1,601	221	1,822
1911	1,671	247	1,918	137	2,055
1912	1,628	254	1,882	138	2,020
1913	1,203	202	1,405	140	1,545
1914	1,051	153	1,204	63	1,267
1915	1,196	185	1,381	47	1,428
1916	1,057	160	1,217	61	1,278
1917	1,227	169	1,396	66	1,462
1918	1,071	126	1,197	35	1,232
1919	1,096	139	1,235	27	1,262
1920	1,060	103	1,163	21	1,184
1921	1,173	63	1,236	15	1,251
1922	1,109	72	1,181	7	1,188
PURUS-ACRE					
1910	2,633	457	3,090	420	3,510
1911	2,581	414	2,995	394	3,389
1912	3,141	475	3,616	490	4,106
1913	2,603	339	2,942	487	3,429
1914	2,559	362	2,921	515	3,436
1915	2,207	402	2,609	373	3,072
1916	2,224	351	2,575	391	2,966
1917	2,219	317	2,536	331	2,867
1918	1,979	273	2,252	198	2,450

TABLE 43.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 6, 1910–1922—Continued

Years	Hevea			Caucho	Grand total
	Fine	Coarse	Total		
PURUS-ACRE—continued	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1919	1,881	257	2,138	136	2,274
1920	1,396	217	1,613	93	1,706
1921	927	81	1,008	61	1,069
1922	844	108	952	43	995
TOTAL, REGION 6					
1910	5,148	990	6,138	1,029	7,167
1911	5,440	893	6,333	816	7,149
1912	5,903	966	6,869	916	7,785
1913	4,480	676	5,156	818	5,974
1914	4,310	622	4,932	704	5,636
1915	4,133	713	4,846	543	5,389
1916	4,013	633	4,646	557	5,203
1917	4,210	616	4,826	505	5,331
1918	3,433	456	3,889	292	4,181
1919	3,445	457	3,902	191	4,093
1920	2,674	352	3,026	150	3,176
1921	2,311	170	2,481	139	2,620
1922	2,279	244	2,523	104	2,627

COST ESTIMATES

Owing to the scant yields on the lower Purus, the Solimoes, and the lower parts of their tributaries, rubber gathering can not be carried on at present prices, and what little is produced is only a side issue. On the richer areas of the upper rivers, and especially in those large areas controlled by commercial firms in Manaos, Para, and Iquitos, it is possible to continue operations and to keep up some production by the exchange of merchandise for the rubber collected by the seringueiros.

On the Javary one of the largest owners stated that he could produce at 2$000 per kilo, due to the profit on merchandise. With a price of 2$800 per kilo in Manaos this estate has been paying the seringueiros 2$000 per kilo, or $0.09 U. S. per pound. At Mamia on the Solimoes, on the other hand, the owner of a property which has 300 estradas stated that he could not work them or afford to take the risk when the price was below 4$000 per kilo in Manaos. The costs on the upper Purus, Jurua, and Javary will probably approximate those of the Acre Territory (Region 7), since conditions are almost identical.

The freight from Remate de Males, near the mouth of the Javary (on the Peruvian border), to Manaos is 60 reis per kilo. Other expenses in Manaos, such as port charges and shrinkage deductions, bring the total up to 500 reis per kilo. Thus the rubber which has cost the merchants 2$000 per kilo (in merchandise) on the Javary costs 2$500 laid down in Manaos. These prices are too low to attract seringueiros, and consequently there is an increasing number of men either leaving the districts or engaging in other occupations.

TRANSPORTATION AND COMMUNICATION

RIVER

The fluvial system of this region may be represented as follows:

Solimoes (upper Amazon).
- Purus.
  - Tapaua.
  - Mucuim.
  - Ituxy (Iquiry).
  - Pauhiny.
  - Inauhiny.
  - Acre.
  - Yaco.
- Coary.
- Catua.
- Teffe.

Solimoes (upper Amazon)—Continued.
- Jurua.
  - Tarauaca.
    - Jurupary.
    - Embira.
  - Gregorio.
  - Moa.
- Jutahy.
- Jundiatuba.
- Itecoahy.
- Javary.
  - Curuca.

FREIGHT AND PASSENGER SERVICE ON PURUS RIVER

The only regular navigation service in both the Purus and the Jurua is maintained by the Amazon River Steam Navigation Co. This company operates large steamers monthly from Para via Manaos to the point known as Cachoeira in the Purus or to the mouth of the Acre, depending on the season. From either terminus lighter-draft steamers carry freight and passengers to upriver points in the Purus, Yaco, and Acre. In 1912 the company put in an elaborate installation at Hyutanaham, a short distance below Cachoeira, which was to be the transshipping and repair station for the upper Purus and tributaries. Shops and concrete warehouses with facilities for easy and rapid loading and unloading of goods were installed. A comfortable hotel and other buildings, all in the same general style of those of the Madeira-Mamore Railway, were erected. Two tanks for fuel oil, with capacity of 4,617,000 gallons, also were built. At this point the company possesses 17,000 acres of land, with a frontage of some 8 miles on the river. The houses are on bluffs 100 to 200 feet above the river and in one of the best locations on the entire Purus. However, this fine plant has not been used since 1915 and is now in charge of a caretaker. Other private operators who run an irregular service to the Purus, especially during the season of high water, are: J. G. Araujo, Manaos; Ferreira Costa & Co., Para; Nicolaus & Co., Para; Bitar Irmãos, Para; Sinfronio & Co., Manaos; J. Carneiro da Motta, Manaos; M. Coutinho & Co., Para; Cunha & Co., Manaos; and F. Caldas, Para.

The present volume of business on the Purus, as on the Jurua, does not justify the existence of all these independent shipping services. The operation of even a small steamer costs as much as 500$000 per day, and from this figure daily expenses vary up to 800$000 and 1,000$000, depending on the size of the vessel. This fleet of independent boats dates from the days of the high prices of rubber, when each of the large trading or "aviador" houses of Para and Manaos and even some of the rubber proprietors on the upper rivers began operating steamers on their own account. Many river boats, both of the Amazon River Co. and of independents, are tied up at Para and Manaos for lack of freight. Some of the private operators have

recently sought to participate in the subsidies paid by the Federal Congress for the maintenance of a navigation service on certain rivers.

FREIGHT AND PASSENGER SERVICE ON JURUA AND JAVARY RIVERS

The Amazon River Steam Navigation Co. operates a monthly steamer on the upper Jurua to a point below Sao Felippe, determined by the seasonal stage of the river, where freight is transshipped to light-draft sternwheelers for the upper rivers to beyond the border of the Acre Territory. The only obstacles to navigation in the Jurua are low bars, which appear in the dry season, but there are no rock passages, as in the Purus. During the time of high water steamers drawing 9 feet could navigate freely to the Rio Breu, on the Peruvian border. During much of the year the large steamers of Nicolau da Costa & Co. go far up the Jurua and Tarauaca.

The most important operator to the Jurua is the Para firm of Nicolau da Costa & Co., the largest owners of rubber properties on that river and its affluents. Other private operators are: M. Coutinho, Para; Amoury & Irmão, Manaos; and Sinfronio & Co., Manaos.

The regular monthly steamers of the Amazon River Steam Navigation Co. call at Remate de Males, on the Javary. Private concerns of Manaos which operate steamers to this place are B. Levy & Co., J. G. Araujo, Strassberger & Co., and Sinfronio & Co.

NAVIGABILITY OF PURUS, JAVARY, ETC.

Navigation on such important tributaries of the Purus as the Ituxy (called Iquiry above its cachoeiras), the Pauhiny, the Tapaua, and the Mucuim is limited to launches or in time of extreme low water to canoes, at least on their upper reaches. This is true also of the larger tributaries of the lower Jurua and of such direct affluents of the Solimoes as the Coary, the Teffe, and the Jutahy, the last-named a river of considerable size and formerly a good producer of rubber. These tributary streams offer avenues of penetration into the rubber country of the interior, remote from direct access to the main rivers, but transportation by them is slow and costly, especially when they are low.

The Javary, which forms the border with Peru, is navigable all the year to the mouth of its affluent, the Curuca, for vessels drawing 6 feet of water; above that it and its tributaries are navigable for launches. At high water launches go up the Paraguassu to a point where the whistle of a steamer on the Jurua can be heard. The usual limit of steamer navigation on the Javary is the town of Remate de Males, or Benjamin Constant, which is always accessible for boats drawing 9 feet of water. Above Remate de Males navigation is limited to launches.

ROAD—TELEGRAPH AND CABLE

Roads as generally understood are nonexistent in this region. The only trails that might be classed as such are the picadas cut through the forest on rubber properties and largely abandoned since the de-

cline of that industry. A road constructed several years ago from Labrea on the Purus across a wide stretch of open campos country to Humayta on the Madeira has long since been permitted to grow up in underbrush.

The only telegraphic installation within this area is the Government wireless station at Labrea on the Purus, which communicates with the central station at Manaos. There is no telegraphic connection of any kind in the vast territory contiguous to the Solimoes from the mouth of the Negro to the Peruvian border, though a bill introduced in the last Congress at Rio de Janeiro provided for the establishment of a wireless station at Teffe.

7. ACRE TERRITORY

LOCATION AND AREA

The Federal Territory of the Acre forms a rough isosceles triangle lying in a corner of Brazil between Peru and Bolivia, with the base separating it from the State of Amazonas. The boundary between the Acre and Amazonas is formed by a straight line running southeast from the source of the Javary to the point on the Abuna known as Extrema. The western boundary with Peru follows the crest of the low Serra de Contamana, beyond which lies the basin of the Ucayali. The frontier with Bolivia follows the Acre, Rapirran, and Abuna Rivers (a short sector of the border between the Acre and the Rapirran has not yet been defined). The Territory lies between 7° 9′ and 11° 5′ south latitude.

Except for the limited zone tributary to the Abuna, the Acre Territory lies within the upper basins of the Jurua and the Purus, by which it communicates with the Amazon. No accurate survey of the Territory has ever been made, and its area as given in different Brazilian works varies from 152,000 square kilometers to 191,000 square kilometers (square kilometer=0.3861 square mile), with the actuality probably nearer the second figure.

In our investigation we covered the course of the Acre River to the Bolivian border at Cobija and thence descended to where it enters the Purus in the State of Amazonas. We also ascended the Abuna to the point known as Sao Luiz, from where we traversed the intervening country to the Acre River. Several reconnaissance trips were also made inland from the river, the longest of these being from Itu to Palmares.

PHYSICAL FEATURES

The general topographical features of the Acre Territory resemble very closely those described in the regional reports covering the Madeira-Mamore section and Bolivia (Regions 5 and 8).

The Acre has no large rivers comparable to the Madeira or the Beni within its borders. On the other hand, the three main rivers that traverse the Territory—Acre, Purus, and Jurua—while smaller in size and volume, have no rapids. Consequently during the period of high water this territory is more accessible than might be supposed from its apparently isolated position. In the Departments of Alto Acre and Alto Purus the streams have a general flow of a little

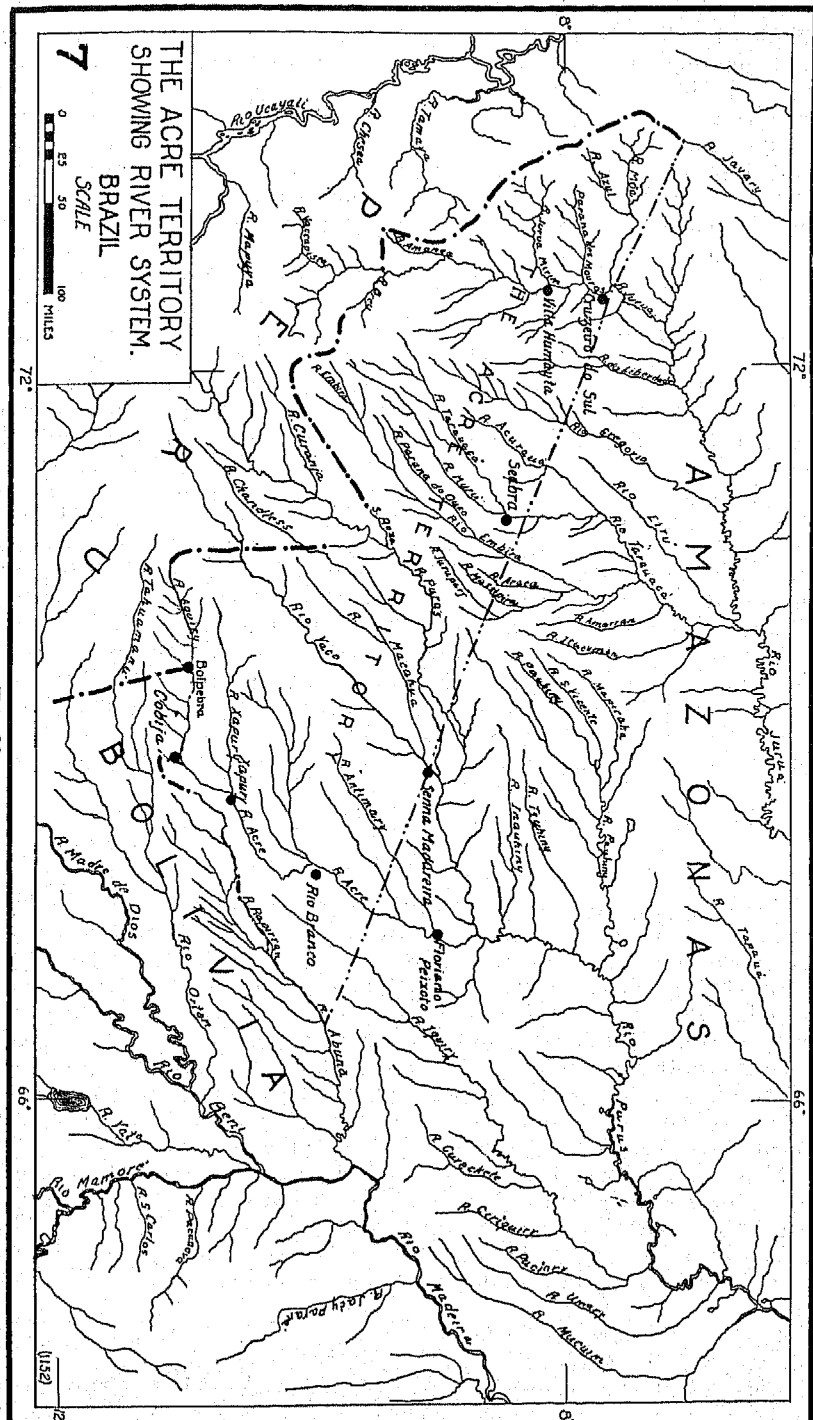

THE ACRE TERRITORY
SHOWING RIVER SYSTEM.
BRAZIL
7
SCALE
0 25 50 100 MILES
AMAZONAS
BOLIVIA
Cruzeiro do Sul
Seabra
Senna Madureira
Floriano Peixoto
Rio Branco
Cobija
Bolpebra
Rio Ucayali
R. Javary
Rio Jurua
Rio Purus
Rio Acre
R. Abuna
Rio Madeira
Rio Mamore
R. Madre de Dios
Rio Beni
Rio Iaco
Rio Tarauaca
Rio Envira
R. Macahua
R. Antimary
R. Curanja
R. Chandless
R. Mucuim
R. Ituxy
R. Tapaua
72°
66°
8°
12°
(1152)

FIG. 38

north of east. In the other two departments, Tarauaca and Alto Jurua, the flow is more toward the north, but changes in the State of Amazonas to almost due east. The longer rivers have their origin in the neighboring Republic of Peru, in the watershed between the rivers flowing east in Brazil and those flowing north in Peru.

The numerous small streams and rivers, in cutting their valleys and channels, have given rise to the formation of many hills, so that the Territory exhibits in many places a much more hilly nature than is generally realized. These hills are not very high, ranging from about 50 feet to possibly 200 feet or more. Between many of the rivers there are few branches or affluents entering at right angles. This results in rather large areas of level or gently undulating land having a northeast-southwest axis; that is, parallel to the general direction of the rivers. These areas when cleared make splendid pastures for cattle and are good sites for fields of cultivated crops.

The flood plains of the large rivers are similar to those already described, though they are on the average somewhat narrower. The rivers are characterized by high banks of terra firme along one side of the flood plain and at many places the channel lies along these bluffs for considerable distances. The Acre Territory probably does not have 1 per cent of varzea, or lowland subject to overflow. On the contrary, it is a high, well-drained section, adapted to the cultivation of all tropical and subtropical crops and fruits and to the raising of livestock when the jungle is cleared.

It is not possible to give average elevations for the region. The elevation of the city of Rio Branco (the capital of the Territory) is stated to be 787 feet above Para. It is judged the elevations of the whole Territory will run between 750 and 1,200 feet above sea level, but no definite measurements were made by the Survey party.

CLIMATE

TEMPERATURE

There are no official temperature records available for a sufficient length of time to give an accurate mean. The absolute maximum and absolute minimum given for Pennapolis (Rio Branco) for the year 1909 (see p. 79) are the only official data that have been published. The mean temperature will not vary greatly from that of eastern Bolivia and the Madeira-Mamore region.

In the middle of the day it is hot in the sun, the hottest hour being around 2 p. m, but in the shade even at this time it is not uncomfortable. It becomes very hot and disagreeable before rains. The nights are pleasant, requiring a light blanket for comfort.

This region is subject in a marked degree to the cold wind blowing from the south in May, June, and July, known as the friagem. In a half hour's time the thermometer may drop from 92° F. to 46° F. It has been known to drop as low as 41° F. These winds blow for 3 or 4 days at a time and are recurrent at intervals of 10 days or more.

The dry atmosphere allows of a more rapid evaporation of perspiration and, combined with a relatively low temperature in the shade, makes the climate much more agreeable than would be supposed from its geographical location.

RAINFALL

Lieut. Achilles Peret, of the Brazilian Army, the Government surveyor at Rio Branco, is authority for the statement that the average yearly rainfall for the Acre Territory is around 2,250 millimeters, equivalent to 88.5 inches—about the average of the neighboring district of Bolivia and the Madeira-Mamore region.

There seems to be no regularity in the time of day of the seasonal rains. They probably occur more often in the afternoon and night, but rains may occur for several days in succession, followed by intervals of several days of clear weather.

The dry season is as pronounced here as in other parts of the Amazon Valley. It sometimes happens that little or no rain falls for three months, this extreme dry period being usually May, June, and July. At these times the grass in cleared places becomes parched and dry. In the forests, however, little difference is to be observed; the forests retain their perpetual green color. Certain trees, however, shed their leaves at this time.

POPULATION

According to the census of 1920 the population of the Acre Territory was 92,379, divided as follows among the different districts: Cruzeiro do Sul, 15,490; Rio Branco, 19,930; Senna Madureira, 21,141; Villa Seabra, 20,421; Xapury, 15,397. These districts correspond to the five principal towns of the Territory and their tributary country. Of the five, Seabra and Cruzeiro do Sul are in the basin of the Jurua, and the other three in that of the Purus.

Practically the entire rural population is engaged more or less directly in the rubber industry, or at least is dependent on it. The towns are small, their population ranging from 1,000 to 2,000.

LABOR

The Acre was largely settled and its rubber industry developed by immigrants from Ceará and the other States of northeastern Brazil, including Maranhao and Piauhy. This is still the principal labor element of the region, though supplemented by the younger generation born in the Acre and by a certain number of natives of the States of Amazonas and Para. Oriental labor has never been used in the Acre, as it has in Bolivia, and the only foreigners engaged in working rubber are a few Peruvian caucho hunters.

POSSIBLE SOURCES OF ADDITIONAL LABOR

One possible source of additional rubber workers is Ceara and the other regions of the northeast that have already contributed the bulk of the Acre's population. The Cearenses were formerly driven to emigrate in large numbers to the Amazon Valley by the devastating droughts to which their State is subject. They remain in their own State as long as they can make a living there, and tend to drift back when economic conditions improve at home. The high cost of transportation from the Acre to Ceara constitutes an obstacle to this repopulating tendency. Also, the development of agriculture on a

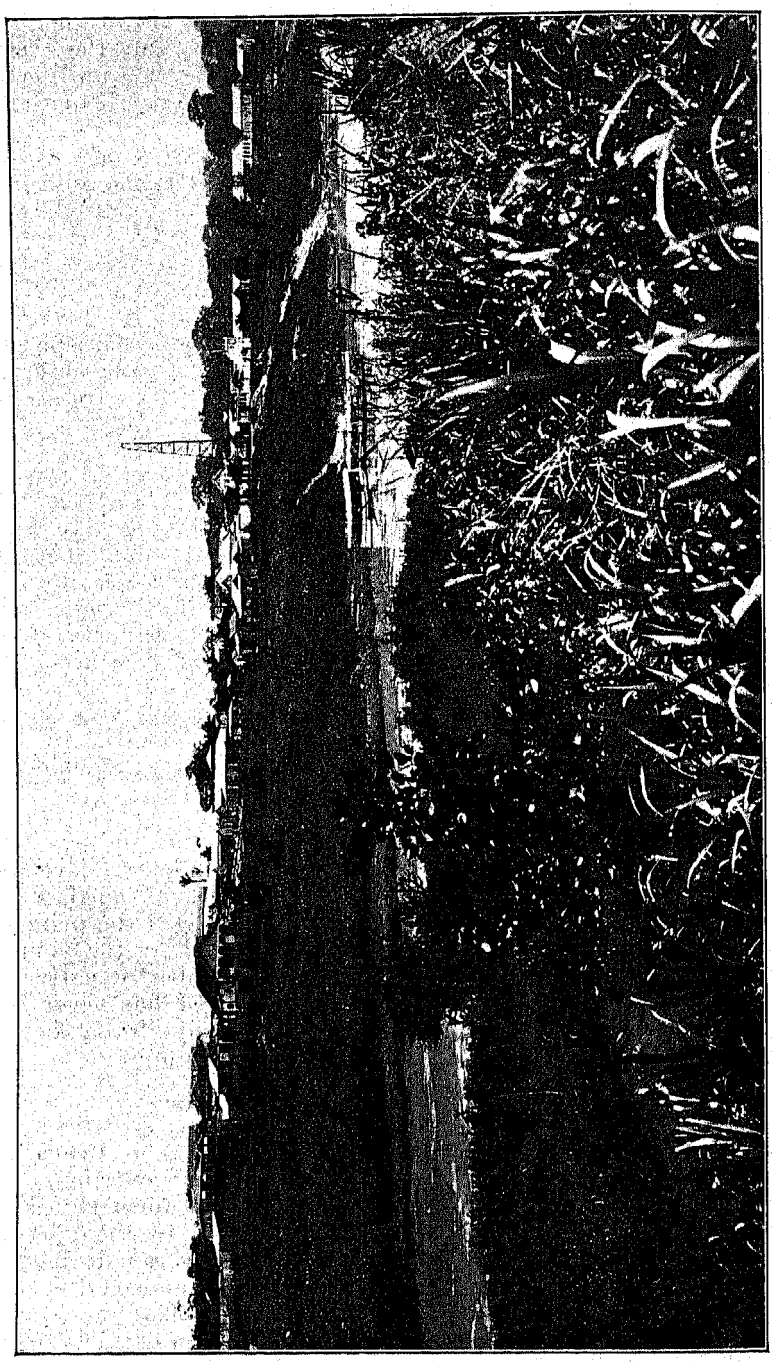


FIG. 39.—Rio Branco, capital of the Acre Territory. The town is built on both sides of the Acre River; only the north side being shown here

considerable scale in the Acre has greatly improved living conditions in that region, as well as reducing the cost of subsistence, and has served as a deterrent to many who might otherwise have returned to the northeastern States.

However, it must be remembered that, once separated from its birthplace, this element develops strong nomadic habits and is inclined to leave one locality or class of work as soon as better opportunities, even though clearly momentary, are offered in another field. In this way the attraction of the higher wages to be had in the balata workings and in the Brazil-nut forests draws off a certain number of rubber workers, though this process has been more evident in the lower Purus than in its upper tributaries. On the other hand a marked rise in the price of rubber may bring back as quickly a part of this floating population. The most famous movement of this kind was the great exodus from the Acre after the ruinous crisis in the rubber industry and after the second phase of the crisis following the close of the war. At both periods large numbers descended the Purus and Jurua to Manaos in the river steamers or in canoes or on improvised rafts. A considerable number of laborers have also moved across the border to work rubber on the Bolivian side. Finally, it is safe to say that only with great difficulty could 10,000 or 12,000 additional laborers be obtained from the ordinary sources available within Brazil.

QUALITY OF LABOR

As a worker the seringueiro of the Acre shares the same general characteristics of his fellows throughout Brazilian Amazonia. He is disposed to be indolent, but his indolence is in part pathological, the result of hookworm or malaria. Part of it can be attributed to the climate, which makes effort difficult during the heat of the day, and predisposes the seringueiro to while away these hours in his hammock. Part of it is the racial inertia of the caboclo; part the lack of the stimulus of frequent inspection of his work or the competition of other workers, inevitable from the solitary nature of his occupation. Finally, he lacks the ambition that would lead him to produce more and earn more and so improve his lot in life.

However, the seringueiro is capable of strong devotion to the employer in whose fair treatment he has confidence and who shows a paternal interest in his welfare. This personal element is of considerable importance in the direction of labor in the rubber country and in some cases has been responsible for the formation of a body of loyal workers attached to the property and to the coronel-patrão—for the outstanding proprietor in the Acre is always a "colonel." In these circumstances the seringueiro is not capable of greater effort than under other direction, but he shows qualities of discipline that are foreign to his normally nomadic and uncertain nature. He seldom is much concerned for the future, and is accustomed to spend whatever surplus may fall to him on the liquidation of his account in celebrating a feast day or in the purchase of nonessentials. He makes these purchases either at the property store or from some itinerant Syrian trader.

The seringueiro, though usually illiterate, is not lacking in intelligence. He is easily teachable, as has been shown by the facility

with which he learns the use of the tapping knife as a substitute for the traditional machadinho. Long experience has given him to a high degree the woodman's peculiar resourcefulness. This special sense is not only a valuable asset in his work, but at some time has saved nearly every seringueiro from death by starvation through losing his way in the forest. While the average seringueiro is physically slight, he has considerable muscular strength and a remarkable capacity for enduring privation.

FOOD SUPPLY

The crisis in the rubber industry brought about a veritable revolution in the food supply in the Acre.

Since that time the Acre has become steadily more self-sufficient in the matter of food, and it is now the custom for the seringueiro to plant a small garden in the clearing about his hut. The food which is not produced there is bought at the barracão, where it is raised to supply the needs of the property not filled by the seringueiro's own garden patch. Some articles are still brought in from Manaos, Para, and other parts of Brazil.

The principal items in the seringueiro's diet are beans, coarse mandioca flour or farinha, bananas or plantains, corn, rice, coffee, and sugar. All these could be produced in abundance within the Territory. Some rice, coffee, and sugar are still brought in from outside, but in a few years the Acre should be able to supply its own needs in these articles. Some properties, such as Palmares and Sao Pedro on the upper Acre, are now self-sufficient communities in the matter of food, and even have a surplus to sell. Such fruits as the orange, lemon, mamão, mango, pineapple, alligator pear or "abacate," caju or cashew, and watermelon all grow in abundance. Beans are planted in great quantities on the fresh alluvial deposit left on the river banks by the annual flood and harvested before the water rises again. Coffee of very good quality bears well, and sugar cane grows well wherever planted.

Meat is supplied by xarque, or jerked beef, from southern Brazil, though it is not so widely eaten as formerly; dried fish (from the Solimoes or the lower Purus or Jurua), fresh fish, game, and chickens, and frequently fresh meat from the barracão. Good hogs can be raised with little effort. Several hundred head of excellent cattle graze on the large clearing to the rear of the town of Rio Branco, and there are over a thousand more on the Fazenda Palmares and a large flock of sheep. The same condition on a smaller scale is to be found throughout the Acre. Some cattle are, however, still brought in from Bolivia.

It would be easy to produce a varied and cheap food supply for an indefinite number of laborers in the Acre.

HEALTH AND SANITATION

The Acre Territory has one of the most healthful of tropical climates, and persons who take elementary precautions can enjoy really robust health. We saw many persons who had lived 20 or 30 years in the Territory who had ruddy complexions and full physical vigor. Though the middle of the day is usually hot, sunstroke is unknown and the nights are always refreshingly cool.

DISEASES

In traveling in the Acre mosquitoes were encountered in few places, the largest number being found in the towns, where they were mostly of the innocuous, though extremely annoying, culex variety. On the other hand, the seringueiro who lives along the river bank, with the jungle close to his house, or who lives in the depths of the forest, sleeping without a net and exposed to mosquitoes on the early morning round of his estrada, is liable to malarial attacks; that is, providing there are anopheles mosquitoes in the vicinity and that they have been infected by the blood of malarial persons. Fortunately, these conditions are far from being universal. However, the seringueiro's habits are as a rule so unhygienic and negligent that he readily acquires any ailment to which he happens to be exposed.

No work such as the Rockefeller Foundation carried on against the hookworm in southern Brazil in cooperation with the Brazilian sanitary authorities has been undertaken in the Acre. Hookworm is widespread there as a result of the seringueiro's habit of going barefoot except where he goes shod in the crude rubber sandals of his own manufacture.

Stomach and intestinal complaints are common, but are generally the results of malnutrition or of the habit of drinking water of whatever origin. However, beriberi has disappeared, as the population has come to depend on local production of food.

Infected wounds of all kinds are frequent. Some of these are simple cases of infection of cuts or scratches, against which the seringueiro has no defense at hand. Others are more serious wounds, and still others are due to the infection of the bites of different insects and parasites, such as the bicho de pe, which burrows into the foot and deposits eggs under the skin. The seringueiros are often afflicted with malignant ulcers which have developed through lack of early attention. Sometimes these are the manifestations of the serious form of infection known as leischmaniosis.

MEDICAL FACILITIES

The Federal Government has not yet established a branch of the National Health Service in the Territory. However, the local administration has lately taken some steps to distribute medicines.

A small public hospital has been established in the capital of the Territory, Rio Branco, by private endeavor, but its facilities are still inadequate, and, moreover, its usefulness is limited to a small part of the region.

Trained physicians are to be found only in the towns, but the larger agricultural establishments maintain pharmacies—often well stocked, as the one we saw at Iracema—in charge of a pharmacist who also performs the functions of physician on the property.

VEGETATION

The vegetation of the Acre Territory is very uniform. It is all virgin forest except for a few pasture areas. The most extensive of these, about 7,000 or 8,000 acres, is on the property Capatara, near the town of Rio Branco. These fields were probably cleared by

Indians or Bolivians in years past. There are also many other areas serving as pastures which have been cleared more recently.

On the trails in the Acre there was noticed a considerable growth of a variety of bamboo that was not observed in the other districts to so great an extent. This bamboo is usually on low or poorly drained land, though some exists on the red, better-drained soils. The small bamboo is called taboca and a larger kind taquarassu. It is stated that good rubber trees are frequently found on the taboca land, but none were observed by the field party. The bamboo gradually chokes out other vegetation.

FOREST GROWTH

As far as a cursory examination can show, there is little difference in the density of jungle in the Acre and in the rest of the Amazon Valley. A few big trees, like the castanheira, some measuring 17½ feet in circumference and larger, with a sprinkling of a few smaller trees and a maze of underbrush, vines, and saplings make up the average forest. On a hectare (2.47 acres) of virgin forest near Porvir on the Acre River the number of principal trees, with their local names, was as follows:

Name of tree	Number	Per cent
Abiu (Lucuma)	13	4.2
Angelica (Dicorynia)	22	7.1
Breu	36	11.7
Farinha secca	14	4.5
Macucu (Licania)	10	3.2
Orelha de Burro	20	6.5
Pama	51	16.5
Ucuuba vermelha (Virola)	30	9.7
Miscellaneous	112	36.6
Total per hectare	308	100.0

At present the little lumber that is being produced is used for local consumption only. Lumber is imported from Manaos or Para for house construction along the river banks and adjacent thereto. Many of the woods have intrinsic value and are good for construction purposes, cabinet work, and interior decoration. However, the thin stand in the forests and the difficulty and expense of getting them out make them of little commercial value at this time.

WILD RUBBER

All of the Acre Territory lies within the zone of the natural habitat of the *Hevea brasiliensis*. Here the tree finds qualities of soil, climate, and natural conditions well suited to its development. It is, so far as known, the only species of Hevea in the Territory. In former years much Castilla, or caucho, existed in the district, but most of it has now been exhausted.

The *Hevea brasiliensis* grows on both the lowlands along the river and the hilly upland which may be miles away from a river. Along the river banks it occurs rather close together, and such places are the sites of many fine estradas. In every case the best trees and the closest stand were found in hilly, rolling, and undulating land.

DENSITY OF HEVEA IN THE FORESTS

No general rule can be laid down as to the average number of Heveas per acre; it varies in different localities. Large areas may be encountered with very few Heveas, and then other places where they are rather close together.

A noticeable fact in this connection is, however, that those places showing the largest number of trees are invariably high, well-drained land, usually red in color. This is well illustrated on the trail leading from the Acre River at the Seringal Itu (Villa Afarinha) to the center at Palmares, a distance of about 15 miles. In the first 10 miles there are only 30 Heveas within an estimated distance of 100 feet on either side of the trail. The land here is rather level, with some of it low and covered with a growth of bamboo and wild bananas. For the next 5 miles is hilly, well-drained land, and here there are 241 trees. In the first 10-mile stretch there is only 1 Hevea to 8 acres, while in the last 5 miles there is an average of 2.4 trees to the acre. In the whole stretch of 15 miles the average is 1 tree to 1.3 acres.

DENSITY ALONG SAO LUIZ-NOVA OLINDA TRAIL

On the trail between Sao Luiz on the Abuna River and Nova Olinda on the Acre River, a distance of about 60 miles, there were counted 760 Heveas within 100 feet on each side of the trail. These were distributed as follows: First 10 miles, 225 trees; next 15 miles, 235 trees; next 15 miles, 150 trees; next 20 miles, 150 trees (mostly in last 5 miles). The first 10 miles were over high rolling land with a soil red in color. In the other stretches there was considerable low and level land that was not so well drained, which was light in color and on which grew much bamboo.

In the first section there was an average of 1 Hevea to the acre, in the second section the average was 1 tree to 1.5 acres, in the third section 1 tree to 2.4 acres, and in the fourth section the average was 1 tree to 3.2 acres.

In the whole stretch of 60 miles the average is 1 Hevea to slightly less than 2 acres. This probably is a fair cross section of the country; and it appears, therefore, that in its natural habitat the tree occurs on the average once in every 1.5 to 2 acres.

In marking out the estradas, however, only those localities can be chosen where the stand is denser than the above average, in order to allow the tapper to work the requisite number of trees in the customary time.

SIZE OF WILD TREES

Measurements were made of representative trees in an estrada at Orion on the Abuna. They were on alluvial land close to the river bank and had been so badly mutilated with the machadinho that many were dying from borers and disease. Measurements 3 feet from the ground gave an average girth of 6 feet.

Measurements of trees on an estrada at Campinas, about 25 miles from Sao Luiz, on the trail between the Abuna and Acre Rivers, gave an average girth of 6.85 feet. One tree measured 14 feet 4 inches in circumference; it was 71 feet to the first branch and 139 feet to the top.

The largest clump of large trees seen in the Acre was on the property of Col. Honorio Alves, on the trail between Itu and his home, Palmares. These were on a hill of red clay soil, with much iron concretion in evidence. Ten trees, no two of which were closer together than 60 feet, had the following measurements 3 feet from the ground: (*a*) 13 feet 11 inches; (*b*) 8 feet 10 inches; (*c*) 6 feet 11 inches; (*d*) 9 feet 1 inch; (*e*) 6 feet 3 inches; (*f*) 5 feet 7 inches; (*g*) 5 feet 2 inches; (*h*) 10 feet 7 inches; (*i*) 9 feet 4 inches; (*j*) 4 feet 9 inches.

Within 150 yards of this clump were two trees measuring 12 feet and 11 feet 10 inches, and near by were others measuring 14 feet 2 inches, 9 feet 2 inches, 12 feet 2 inches, and 11 feet 5 inches. Colonel Alves stated that when he opened the estrada 30 years ago there was included a Hevea 23 feet 2 inches in girth. It yielded at the time 8 liters of latex per tapping, equivalent to about 7 pounds of dry rubber.

Many other trees were measured within the territory, all averaging about the same as those noted above. These measurements will give an accurate idea of the size of old Heveas now standing in their original home.

CONDITION OF WILD TREES

The tapping surface of trees that have been tapped for many years is a mass of burrs and protuberances. The bark is very thin. Most of the trees have been tapped up to 12 or 15 feet. Many trees have been ruined and destroyed by the system of tapping in use. It is probable that at least one-third of all the trees are now in a state of descanso, or rest.

Most native writers and some foreigners uphold the system of tapping in use and claim that when properly carried out it is calculated to preserve the production of the latex indefinitely. This might be, and probably is, true where the tapping is carried out properly; but the fact remains that the system is not being properly conducted, with the result that the trees are being gradually destroyed. The evidence bearing this out, which was seen by the field party, is unmistakable in this regard, and the prophecy can be made that in the course of relatively a few years—say, 30 to 40—there will be few forest *Hevea brasiliensis* trees left in the Acre Territory unless the system is modified.

It is well known that since the beginning of the rubber industry the centers of production have been constantly shifting farther up the rivers, due to the lower properties becoming unproductive through long and improper tapping. Thus Lieutenant Herndon,[8] in his Exploration of the Valley of the Amazon, states: "About 35 miles below Gurupa commences the great estuary of the Amazon. * * * At this point we turned into a small creek and ran for days through channels varying from 50 to 500 yards in width between innumerable islands. This is the india-rubber country." At the present time this area is of minor importance as a rubber-producing district.

[8] House Document No. 53, Thirty-third Congress, Washington, pp. 325–326.

YIELDS OF WILD TREES

When the estradas were first opened in the Acre Territory they were of about 120 trees on the average, and gave an average yield of 12 kilos (26.5 pounds) of rubber in a day of tapping. The estradas are now composed of 180 to 200 trees and give 7 to 8 kilos (15.4 to 17.6 pounds) per day of tapping. The present average for a seringueiro is from 600 to 800 kilos in a season. In the years 1911, 1912, and 1913 the average production on some seringaes was about 1,200 kilos. The seringueiro now spends some of his time in hunting, fishing, and working his field or garden, hence has less to devote to rubber collection. The average number of days worked by the seringueiro is from 130 to 150. He taps two or three estradas (in rotation)—probably three more often than two.

Only about one-third of the possible production is being attained, due to lack of labor and to lack of capital on the part of the proprietors to bring in additional labor. It is estimated that there are 40,000 estradas in the Acre, with a possible production of some 7,000 tons per year.

COLLECTION AND PREPARATION

The methods of gathering and preparing the rubber are the same as described on page 22, save that in the Acre region, because of the scarcity of the urucuri nut (*Attalea excelsa*), wood is mainly used for smoking. For this purpose the trees with the local names of maparajuba, carapanauba, pao d'arco, abiurana, faveira amarella, and aracaseiro are considered the best.

The tapping season is longer here than in most of the Amazon Valley—it begins in April and ends the 1st of January—and tapping could be carried on all the year with the exception of days of heavy rain.

PRODUCTION

The production of rubber in the Acre Territory during the years 1911–1922 is shown by the following table, in which the production (stated in metric tons of 2,204.6 pounds) is divided according to river of origin. It is worth noting that the only section of the Territory that has maintained anything like its early output is the zone of the Acre River. The basin of the upper Purus and of its tributary, the Yaco, produced in 1922 less than one-third of its output in 1911, while the region tributary to the upper Jurua, including the important zone of the Tarauaca, produced about half.

TABLE 44.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 7, 1911–1922

Years	Hevea			Caucho	Grand total
	Fine	Coarse	Total		
XAPURY-RIOZINHO	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1911	2,450	529	2,979	384	3,363
1912	2,777	627	3,404	511	3,915
1913	2,486	452	2,938	744	3,682
1914	2,397	483	2,880	761	3,641
1915	2,285	421	2,706	266	2,972
1916	2,922	458	3,380	681	4,061
1917	3,483	619	4,102	865	4,967
1918	3,862	565	4,427	498	4,925

TABLE 44.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 7, 1911–1922—Continued

Years	Hevea			Caucho	Grand total
	Fine	Coarse	Total		
XAPURY-RIOZINHO—continued	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1919	3,964	569	4,533	246	4,779
1920	3,329	524	3,853	242	4,095
1921	2,135	238	2,373	137	2,510
1922	2,647	363	3,010	134	3,144
YACO					
1911	2,767	202	2,969	1,074	4,043
1912	3,096	261	3,357	1,181	4,538
1913	2,335	174	2,509	1,269	3,778
1914	2,535	238	2,773	793	3,566
1915	2,100	284	2,384	616	3,000
1916	1,354	270	1,624	537	2,161
1917	1,266	120	1,386	330	1,716
1918	950	150	1,100	424	1,524
1919	777	137	914	338	1,252
1920	918	129	1,047	229	1,276
1921	937	126	1,063	228	1,291
1922	973	108	1,081	183	1,264
TARAUACA-TEJO					
1911	2,282	347	2,629	379	3,008
1912	2,170	329	2,499	491	2,990
1913	2,182	318	2,500	524	3,024
1914	1,686	244	1,930	357	2,287
1915	2,148	283	2,431	311	2,742
1916	1,618	243	1,861	291	2,152
1917	2,137	297	2,434	350	2,784
1918	1,771	230	2,001	264	2,265
1919	1,087	232	1,919	152	2,071
1920	1,671	217	1,888	79	1,967
1921	1,405	111	1,516	49	1,565
1922	1,384	121	1,505	55	1,560
ABUNA					
1911	156	6	162	1	163
1912	294	11	305	7	312
1913	298	13	311	56	367
1914	349	10	308	19	387
1915	219	10	229	6	235
1916	135	15	150	12	162
1917	407	49	456	33	489
1918	413	36	449	19	468
1919	435	51	486	20	506
1920	374	22	396	6	402
1921	185	8	193	4	197
1922	220	16	236	2	238
TOTAL, REGION 7					
1911	7,055	1,084	8,739	1,838	10,577
1912	8,337	1,228	9,565	2,190	11,755
1913	7,301	957	8,258	2,593	10,851
1914	6,967	984	7,951	1,930	9,881
1915	6,752	998	7,750	1,199	8,949
1916	6,029	986	7,015	1,521	8,536
1917	7,293	1,085	8,378	1,578	9,956
1918	6,996	981	7,977	1,205	9,182
1919	6,803	989	7,852	756	8,608
1920	6,292	802	7,184	556	7,740
1921	4,662	483	5,145	418	5,563
1922	5,224	608	5,832	374	6,206

COST ESTIMATES

The prefect of the Department of Alta Jurua, in his report for the second quarter of 1913, says that the average production in that district at that time was only 400 kilos because of the "pauperized" condition of the trees (due to overtapping), and that the average expenses of a single man were, at a minimum, 1,200$000 per year. From this he deduced the cost to be 3$000 per kilo. At the present time the average production has not increased, and the cost of food and supplies (in case the seringueiro purchased all his food) would probably be about the same as in 1913. It would appear, then, that the actual physical cost of production there to-day would be not less than 3$000 per kilo, or $0.14 U. S. per pound at present exchange.

On the Acre and Purus Rivers production seems to be higher. On some properties the seringueiros purchase as low as 300$000 worth of goods per annum from the patrão; if they had to purchase all they consume it would cost a single man at least 1,200$000 and a married man more. The average production for this calculation may be taken at 600 kilos. If these figures are approximately correct, a rough estimate then would be around 2$000 per kilo for those districts, or $0.09 U. S. per pound.

The freight rate from the upper Acre to Para is 180 reis per kilo by the steamers of the Amazon River Steam Navigation Co. and from 150 to 250 reis per kilo by privately owned boats. The fixed charges for taking a kilo of rubber from the interior to Para are made up approximately of transport (mules) to the river bank 100 reis and freight, taxes, etc., 300 reis, to which must be added a commission of 1 per cent on the gross selling price.

TRANSPORTATION AND COMMUNICATION

RIVER

The Acre Territory lies almost entirely in the upper basins of the Purus and the Jurua, two of the most important tributaries of the upper Amazon, or Solimoes. A comparatively small zone in the southeastern part of the Territory lies in the drainage basin of the Abuna, an affluent of the Madeira. The scheme of the fluvial system of the Territory may be represented by the following diagram:

Purus.
- Ituxy-Iquiry.
- Acre.
  - Andira.
  - Riozinho.
  - Xapury.
- Yaco.
  - Canamary.
  - Macahua.
- Chandless.

Jurua.
- Tarauaca.
  - Embira.
    - Jurupary.
  - Acuraua.
  - Muru.
- Gregorio.
- Riozinho do Liberdade.
- Moa.

Abuna.

Distances from the principal points on these rivers to Manaos are given below. These figures are taken from the map of the Acre by Joao Alberto Maso.

Purus River system.—Mouth of Yaco, 1,303 miles from Manaos; Senna Madureira, 1,320; Guanabara, 1,663; mouth of Acre, 1,175;

Rio Branco, 1,351; Xapury, 1,499; Brasilea, 1,545; Labrea, 768; Hyutanaham, 895; Cachoeira, 920 miles.

Jurua River system.—Mouth of Tarauaca, 1,371 miles from Manaos; Cruzeiro do Sul, 1,795; Villa Seabra, 1,631; mouth of Embira, 1,495; mouth of Tejo, 1,984; mouth of Breu (frontier), 2,060 miles.

These rivers are all of a uniform character, varying only in size. Their courses are sinuous, meandering in great curves across the alluvial plain that stretches with a slight fall from the last foothills of the Andes to the Amazon. The larger rivers frequently cut across the neck of these ox-bows, thereby shortening their course and quickly turning the old channel into a lake. The banks of the Purus and Jurua in their lower reaches are generally bordered by a wide flood plain, which is inundated during part of the rainy season. The lands along the rivers within the Acre Territory are much less subject to flooding than those bordering the lower rivers.

SEASONAL DIFFERENCE IN WATER LEVEL

The seasonal difference in the level of these rivers is very great and constitutes the decisive factor in their navigability. The difference is over 50 feet in some parts of the Purus and over 40 feet in the Jurua, which accounts for the periodical inundation of a wide zone along their banks. Even the tributaries rise from 20 to 30 feet during the rainy season.

The two main rivers begin their annual rise in October with the early rains in their upper reaches. Generally these first rises are only in the nature of freshets. However, from November on there is a fairly steady rise, culminating in March, when the rivers are at their extreme high stage. On the first report of the annual rise numerous steamers leave Manaos and Para for the Acre with merchandise, returning in December with cargoes of rubber. After April the rivers fall again until August or September, when they remain fairly stationary until the first freshets. This schedule of rise and fall is, of course, not rigid, varying somewhat from year to year.

Though these rivers are generally free from the cachoeiras which interrupt navigation in the Madeira and its tributaries, there are some difficult passages, strewn with rocks or sand bars, that affect their navigability during low water. One is the series of rocks in the channel of the Purus at the point incorrectly known as Cachoeira. Between this point and the mouth of the Acre River there are several such obstacles, one of the best known being at Ajuricaba. Within the Acre Territory the principal obstacles to navigation consist of shallow stretches (where the rivers spread out at the sharp bends in their course) and snags. The Acre River is quite free from snags, but many sand bars are uncovered at low water.

SERVICE OF AMAZON RIVER STEAM NAVIGATION CO.

Navigation of the Purus is divided into three distinct stages, corresponding to as many different types of river boats. The large steamers of the Amazon River Steam Navigation Co., which ply out of Para and Manaos and draw 8 or 9 feet of water, terminate their

voyages either at Cachoeira or at the mouth of the Acre River. They can reach the former point all the year and do make it their regular terminus during low water; the rest of the year they go as far as the mouth of the Acre. During the four months of highest water, January to April, they could reach the frontier of Bolivia or Peru but for economy in operation limit their voyages to the mouth of the Acre.

At that point, or during low water at Cachoeira, they transship their cargo and passengers to flat-bottom sternwheelers that draw 3 to 4 feet of water. These boats, known locally as chatas, are over a hundred feet long and have a cargo capacity of about 125 tons. During the months when the steamers from the Amazon ascend the Purus only to Cachoeira the chatas meet them there and carry their cargo up to the mouth of the Acre River, where it is in turn transshipped to launches for points up the Acre or the Purus-Yaco. However, during the months of high water, when the larger steamers regularly go as far as the mouth of the Acre River, the chatas relay their cargo between that point and the more important places on the Acre and the Yaco, one chata serving each of these rivers. The usual terminus of chata navigation on the Yaco is Senna Madureira, though by no means the limit of navigability at that season. The chatas ply up the river to the towns of Rio Branco and Xapury or even to Cobija on the Bolivian border, where they receive the rubber sent across from the Tahuamanu River. In some years these boats are able to reach the Territory's capital, Rio Branco, throughout the year.

Above the limits of chata navigation cargo is gathered for shipment or distributed for consumption by means of launches of 3-foot draft or less. These launches have a cargo capacity of 3 to 15 tons, which can be greatly increased by means of the batelões which they tow. Batelões, or large canoes, are frequently converted into very serviceable launches by installing a motogodille, or detachable motor, at the stern. This type of craft has proved of immense utility in making accessible the smaller rivers and shallower stretches of the larger streams that would otherwise be altogether without transportation facilities beyond the crude native canoe paddled by the seringueiro.

RIVER SERVICE OF PRIVATE LINES

In addition to the boats of the Amazon River Co. a number of private trading companies and individual merchants operate steamers from Manaos or Para to points in the Acre Territory. A few of these belong to large proprietors of the district, who use them to carry out the rubber produced on their seringaes and to bring in merchandise for their stores. Though mostly of the same general type of construction, the open, screw-propelled, wood-burning steamer popularly known on all the Amazonian rivers as gaiolas, or bird cages, these boats vary considerably in size and cargo capacity. They seldom have a regular schedule or regular ports of call, sailing when they have sufficient cargo or when the water in the rivers permits, and calling wherever signalled or there is cargo to leave. Freight rates on them are generally a matter for bargaining and are only kept within reason by the competition of the Amazon

River Co., which serves as a stabilizer for the river traffic of this whole fluvial system. The principal operators of this class are: Para—Moreira, Gomes & Cia., S. Bitar & Irmãos, Jose Florencio da Silva, Coutinho & Cia., Raimundo Vieira de Lima; Manaos—J. A. Leite & Cia., J. Carneiro da Motta, S. A. Armazens Andresen, Guilherme Pereira, Aluizio de Araujo & Cia.

NAVIGABILITY OF PURUS, ACRE, ETC.

The navigability of the rivers of the Purus system may be illustrated by the following table, which shows the different draft of boat capable of reaching the points denoted during each period of the year, it being understood that all these are accessible for steamers drawing 8 or 9 feet during the four months of January to April:

TABLE 45.—NAVIGABILITY OF STREAMS OF REGION 7

Destination	Distance from Manaos	Draft during—			
		May	June–July	August–November	December
	Miles	*Feet*	*Feet*	*Feet*	*Feet*
Purus River:					
Cachoeira	920	8–9	8–9	8–9	8–9
Mouth of Acre	1,175	3–5	3–5	3–5	7–8
Mouth of Yaco	1,303	3–5	1–2	1–2	3–5
Cocama		1–1½	1	1–1½	2–3
Acre River:					
Rio Branco	1,351	3–5	3	3	3–5
Xapury	1,499	3–5	1½	1½	2–3
Porto Ancon		1–1½	1	1	1–2
Yaco River:					
Senna Madureira	1,320	3–5	1½	1½	3–5
Guanabara	1,663	1–1½	1	1	1–2

The Purus is navigable at all seasons for ocean-going steamers of 18 or 20 foot draft as far as Labrea.

The conditions of navigation in the Jurua system are largely similar to those of the Purus and its tributaries. Sao Felippe, near the mouth of the Tarauaca, corresponds to Cachoeira in the Purus as the ordinary terminus of the regular Amazon River Co.'s steamers from Para and Manaos. Thence chatas of the same type as those employed in the Purus transship cargo either to the upper Jurua or to the Tarauaca and its affluent, the Embira. During exceptionally dry years the Amazon steamers may not be able to reach Sao Felippe during two months of the year, but from the end of November to the end of April they could reach Cruzeiro do Sul or Seabra with ease. The chatas ascend to the mouth of the Tojo in the Jurua and to Seabra in the Tarauaca without difficulty from October to April or May. However, in the driest months the chatas only reach respectively Cruzeiro do Sul and the mouth of the Embira. Beyond these points transportation depends on launches of an average draft of 2 feet, as in the Purus system.

Navigation in the Abuna, in the southeastern zone of the Acre Territory, is described in the report on Bolivia. (See p. 313.)

ROAD

In order to solve the problem of connecting the four departments of the Territory that correspond to the basins of the upper Jurua, the Tarauaca, the upper Purus, and the Acre Rivers, a plan for a system of trunk roads was drawn up several years ago. In the absence of such roads the only communication between these districts is around by the mouth of the Tarauaca or of the Acre, or in the case of the two main rivers the only connection is the roundabout one by the Solimoes. Former territorial administrations carried out part of this program, to the extent of opening a road through the forest between the capital, Rio Branco, on the Acre River, and Senna Madureira, on the Yaco (near its junction with the Purus), a distance of about 128 miles, and another and longer road linking the Purus with the basin of the Tarauaca. However, little care has been taken of these roads and the jungle has rapidly encroached on them, greatly reducing whatever utility they were designed to have—mainly the transportation of foodstuffs from one region to another. They would also serve for taking out rubber from the zones bordering on their course.

Numerous minor trails serve certain properties or localities or connect some of the smaller streams. There are several such roads between the Abuna and Acre Rivers, the best being those between Sao Luiz on the Abuna and Nova Olinda on the Acre, and the old trail between Santa Rosa do Abuna and Capatara on the upper Acre, over which cattle are driven across from Bolivia. These roads are used for mule traffic; though generally quite passable during the dry season, they are deep in mud for long stretches during the rainy months. The deposits of iron concretions that are frequently encountered could be used for surfacing roads, but corduroying is now resorted to in many places where the roads cross low ground.

Acre Territory is endowed by nature with a system of waterways that, in spite of all the difficulties incident to navigation during the dry season, provides good facilities for transportation. Any plans for improving the transportation system of the region should be based on this essential condition. Roads, for example, should be planned with a view to their utility as feeders for the rivers. Something could be done in utilizing important roads by using motor trucks or caterpillar tractors where heavy traffic might be developed.

RAILWAY

Various schemes for railways have been discussed in the Acre. However, most of them are fantastic and impracticable, not only because of the physical difficulties involved in their construction but because of the more serious problem of financing them. The best known of these schemes are those for a railway across the Territory, cutting the lines of the rivers at right angles to their course, and another to connect the capital, Rio Branco, on the Acre River with Labrea on the Purus. In the present stage of the Territory's development both of these can be dismissed as unfeasible from every standpoint. A more practical plan is that for a light railway

between the Abuna and the Acre (discussed in the report on Bolivia, p. 324), which would give a much-needed outlet to the rich zone of the Abuna.

TELEGRAPH AND CABLE

There are no wire lines in the Acre, but the Government maintains a chain of wireless stations at the five principal towns of the Territory—Rio Branco, Xapury, Senna Madureira, Seabra, and Cruzeiro do Sul. Of these Senna Madureira serves as a central station through which all messages pass; it communicates with Manaos through Porto Velho. These stations are also in touch with the more powerful Bolivian station at Cobija.

At Manaos the subfluvial cable of the Amazon River Telegraph Co. offers excellent, though expensive, communication with foreign countries, relaying at Para over the lines of the Western.

OWNERSHIP OF LAND AND LAND LAWS

No cadastral survey has ever been made in the Acre, nor is there any agency for the registration of land titles. There are certified public land surveyors, and surveys of a large number of properties have been made; but there is no public office where deeds to property can be filed, as a result of which condition the legal position of land titles is still precarious. Much of the existing confusion is due to the hasty granting of titles; in some cases two or three conflicting titles cover the same tract of land.

The most effective title in the Acre has been that of actual occupation, the direito de posse, secured by priority of settlement, continued exclusion of rival claimants, and clear demarcation of boundaries. The original pioneers in the Territory, on ascending the rivers in their canoes, were accustomed to mark out a certain distance along the river bank by cutting the bark of a tree at either extremity of the claim, usually with some other distinctive sign of ownership; sometimes they chose a convenient creek as the boundary. Property lines back from the river offered a much more difficult problem and were a subject for later arrangement. (It was in this field that there developed the bitter and often bloody contests for land that were a prominent feature of the early history of the Acre.) However, many occupants have established their ownership so effectively and clearly, in relation to both their neighbors and the territorial government, that any disturbance of their de facto property rights is highly improbable.

LEGALIZATION OF TITLES

The federal law governing land concessions and property rights in the Acre Territory was issued as decree No. 10105 on March 6, 1913, but has never been put into execution for lack of the necessary appropriation. The law declares that, on the organization of the machinery for which it provides, all occupants of lands must submit to the Directoria do Terras, or land office, within three years, evidence to show the validity of their ownership. In default of such evidence the lands in question will then revert to the Government,

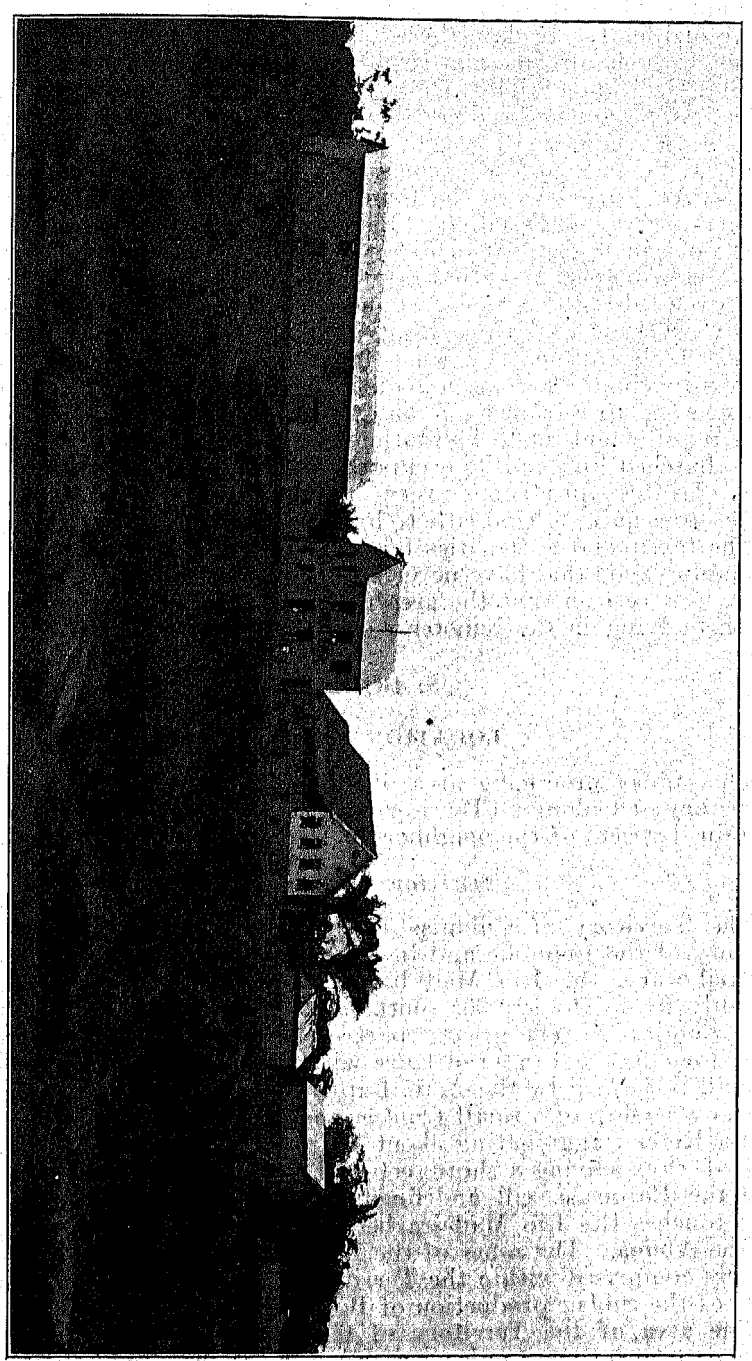


FIG. 40.—Headquarters of the Seringal Iracema, on the Acre River, Acre Territory. Illustrates the better type of headquarters of rubber properties

whereupon they may be acquired by public purchase to a maximum amount of 100 square kilometers (38.6 square miles).

According to the law there are to be considered as state lands "those which are not matter of private domain by some form of legal title" and "those not comprised within concessions or held by actual possession and capable of being revalidated or legalized." There are recognized as legal the titles granted by the Republic of Bolivia, the State of Amazonas, and the former Independent State of the Acre previous to the foundation of the four Departments of the new Federal Territory. Lands of which the actual possessor is the original occupant or direct heir thereto are subjects for legalization, provided, first, that acquisition of the land in question was not attended with violence; second, that the property is being effectually worked; and third, that a habitation has been put on the land. It is sufficient evidence for the second requirement that a beginning should have been made in the development of the property by opening up estradas for the extraction of rubber or Brazil nuts. The requirement as to habitation may be satisfied by the erection of a thatched hut, and its occupancy by the owner or his representative. In these provisions every opportunity is given to the serious settler to acquire a legal title to his property.

The territorial authorities have no information as to the amount of public lands that have never been the object of settlement. However, it is certain that the area of such lands is very limited, most of them lying in the remoter parts of the upper Jurua Basin.

8. BOLIVIA

LOCATION AND AREA

The rubber-producing area of Bolivia is largely confined to the Territory of Colonias (Territorio de las Colonias del Noroeste) and certain districts of the neighboring Department of El Beni.

TERRITORY OF COLONIAS

The Territory of Colonias is situated in the northwestern extremity of the Republic and lies to the west of the Rio Beni and of its tributary, the Rio Madidi. Its boundaries may be taken as roughly 9° 45′ to 12° 30′ south latitude and from 65° 30′ to 70° west longitude. The greater part of the northern boundary of the Territory, as fixed in accordance with the treaty of Petropolis with Brazil, is formed by the Acre, Rapirran, and Abuna Rivers. However, ownership of a small frontier zone between the Ina and Chipamanu Rivers, aggregating about 460 square miles, has not yet been settled, thus leaving a short sector of the frontier between the Acre and the Rapirran still undefined. To the northeast the Territory also touches the Rio Madeira between the mouth of the Beni and of the Abuna. The zones of the Abuna, Orton, and Madre de Dios Rivers comprised within the Territory account for much the largest part of the rubber production of Bolivia.

The area of the Territory of Colonias, including the disputed zone, is 32,300 square miles, according to the surveys of the Military Topographic Commission in that district.

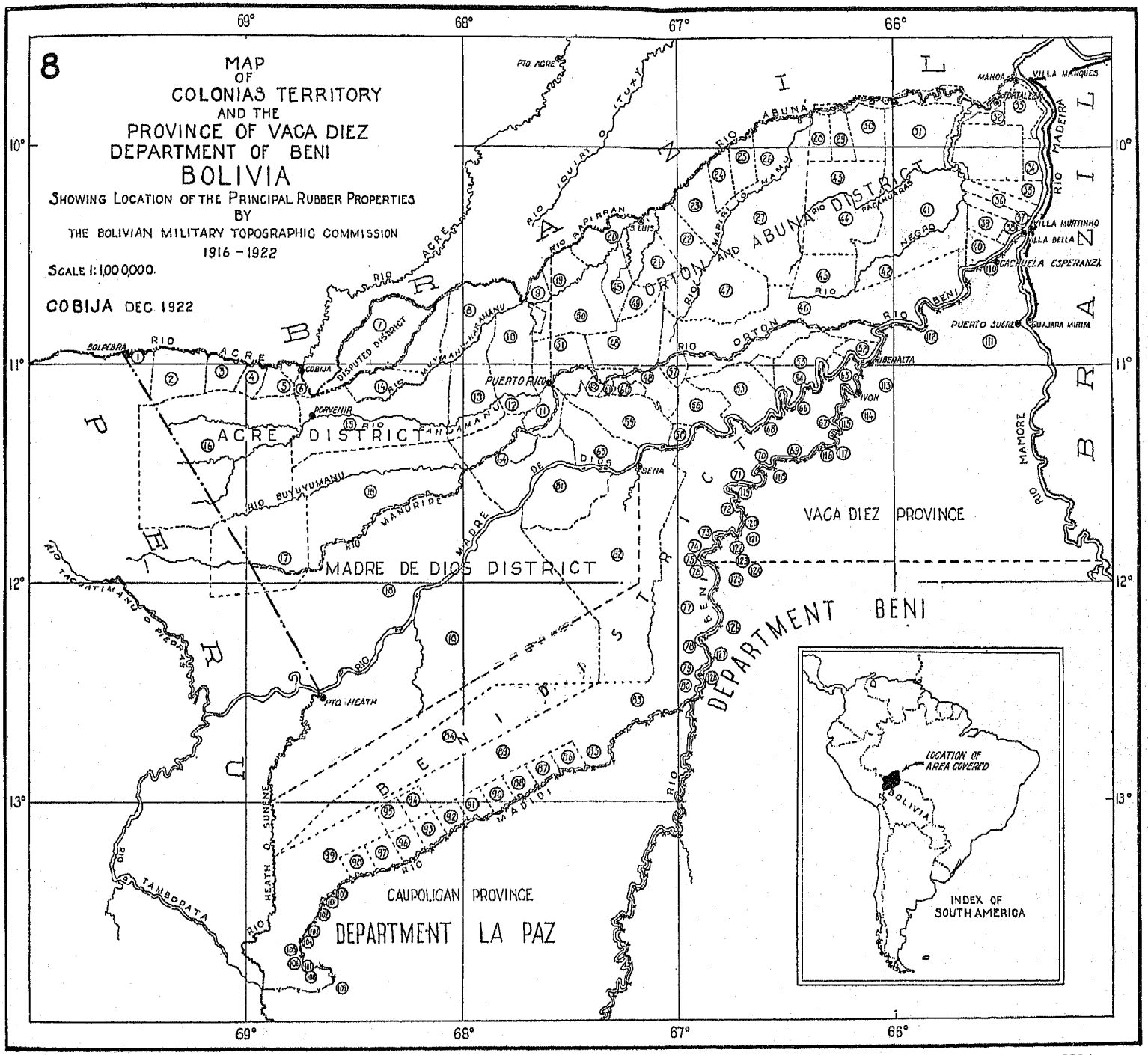


FIG. 41

46540°—25. (Face p. 288.)

DEPARTMENT OF EL BENI

A second and much less important area is constituted by certain districts of the neighboring Department of El Beni. This area includes a belt along the right bank of the Beni River, extending upriver to the vicinity of Cavinas and a short distance inland to the edge of the vast plains of Mojos. It also includes a narrow belt of forest land along the lower Mamore and a third zone bordering the Itenez (Guapore) and some of its affluents, such as the Baures and the Paragua. This latter zone extends well over into the northeastern part of the Department of Santa Cruz, where the industry centers about Concepcion de Chiquitos, the headquarters of the Anglo-Bolivian Rubber Estates (Ltd.), which point lies south of the sixteenth parallel of latitude. The quality of the rubber here is weak. However, due to the great remoteness of most of this region, it can not be taken into consideration at the present time as a possible field for the planting of rubber.

A small quantity of rubber is produced in the Mapiri district of the upper Beni Basin and is usually exported via Sorata to Mollendo. However, the elevation at which this rubber is found might prove unsuitable for Hevea. Aside from probable adverse climatic conditions, rubber that might be produced at lower altitudes in this region and in the country to the northeast of Cochabamba could not be marketed economically because of the great cost and difficulty of transporting it over the intervening ranges of the Andes to rail points on the plateau.

SECTIONS VISITED BY FIELD PARTY

For purposes of this investigation attention was confined to the Territory of Colonias, where natural conditions are largely similar to those prevailing in the adjacent Brazilian Territory of the Acre. The only exception possible to this would be the northern part of the wedge between the Beni and Mamore Rivers, lying within the Province of Vaca Diez, of the Department of El Beni. It is worth noting in this connection that the plains of Mojos extend across the road which connects Riberalta with Guajara-Mirim on the Mamore, opposite the terminal of the Madeira-Mamore Railway, and so are well within the district in question.

The following sections of Bolivian territory came under our immediate observation:

1. Rio Mamore, to a short distance above Guajara-Mirim.
2. Rio Beni, to Ivon, four hours above Riberalta.
3. Rio Madre de Dios, to Sena, three days above Riberalta.
4. Rio Abuna, to Sao Luis, near mouth of the Rapirran.
5. Cobija, on the Rio Acre, to Porvenir on the Rio Tahuamanu.

PHYSICAL FEATURES

The area under consideration lies within the great Amazon Basin and near its western edge. The whole region is characterized by two topographic features only, a low-lying area along the river banks, which in the rainy season is subject to inundation, and higher land (tierra firme) extending back from the flood plains. This high land is not inundated by the rise of the rivers. There are no hills

or mountains, and this uniformity causes the country to present an exceedingly monotonous appearance to the traveler.

The rivers and streams of this area flow in a general northeast direction, with the exception of the Mamore. The Acre River passes into Brazilian territory and empties into the Purus, a tributary of the Amazon. The Beni and Mamore come together at Villa Bella to form the Madeira, which at this place flows nearly north. The Abuna empties into the Madeira at the extreme northeast point of Bolivia, Manoa, opposite the town of Presidente Marques in Brazil.

FLOOD PLAINS AND TIERRA FIRME

These rivers, whether large or small, are in their general aspects very much the same. All are tortuous in their courses, due to the flatness of the country. The channels, though winding, are well defined and usually narrow, thus furnishing a sufficient depth even at low water for small launches and flat-bottomed boats. Where the channels lie for a considerable distance along one side of the valley, the banks are steep bluffs (tierra firme); where slippage or caving has occurred, which is often the case, a complete profile section of the soil and underlying formations can be observed. The channel of the Beni, as of the Madre de Dios also, is usually on the right side of the valley; bluffs 50 to 150 feet high are frequently passed. On the Abuna River the bluffs alternate; sometimes they occur on the right or Bolivian side, and at other times on the left or Brazilian side.

The flood plains of the rivers are, in general, rather narrow. They may vary from about 1 mile to 4 or 5 in width. In those places where the tierra firme begins at the water's edge, it extends unbrokenly until another creek or river is reached, thus forming level or gently undulating plains suitable for the cultivation of various crops or for cattle grazing.

Both the flood plains and the tierra firme are flat for the most part; only rarely is an elevation above the surrounding country seen, and nothing mountainlike was encountered. The country in the western and northwestern part of the area, around Cobija, is rather hilly. Many small creeks and ravines cut the country into rolling hills, the average height being about 80 feet, though some are over 100 feet.

On the tierra firme there is a gradual slope toward the rivers, furnishing a natural drainage sufficient for agricultural purposes. On the flood plains there are many depressions which tend to hold water and form small lakes or ponds when the flood waters recede at the beginning of the dry season. The tierra firme lies from 50 to 200 feet and more above the rivers.

ELEVATION[9]

This area, though some 1,500 miles in an air line from the mouth of the Amazon at Para, is relatively very low above sea level, the altitude at Riberalta being only 522 feet. The town is about 100 feet above the river at low water. The elevation of Manoa, at the mouth of the Abuna River, is 452 feet and of Puerto Sucre, opposite

[9] Authorities on elevation: Riberalta, Comision Topografica Militar Territorio de Colonias del Noroeste; same, Cobija; same, Bolpebra; Manoa, Madeira-Mamore Railway; Puerto Sucre, Madeira-Mamore Railway.

Guajara-Mirim in Brazil, 525 feet. The elevation of Cobija, the capital of the Territory, on the Acre River is given as 985 feet, and of Bolpebra, at the corner of Brazil, Peru, and Bolivia, 1,165 feet.

The elevation increases very slowly as one goes west until the spurs of the Andes are reached. It is believed the average for Region 8 will not be far from 600 to 700 feet above sea level.

CLIMATE

TEMPERATURE

A two years' record [10] of meteorological data is available for Cobija (lat. 11° 1′ S., long. 68° 46′ 47″ W.; alt. 985 feet):

TABLE 46.—MONTHLY MEAN TEMPERATURE, COBIJA, 1909–1910

Months	Monthly mean	Mean monthly maximum	Mean monthly minimum	Months	Monthly mean	Mean monthly maximum	Mean monthly minimum
	° F.	° F.	° F.		° F.	° F.	° F.
January	76.1	86.5	69.8	August	73.0	86.9	63.1
February	75.9	85.5	70.7	September	76.3	90.5	67.1
March	74.3	83.7	69.8	October	75.9	88.2	68.7
April	74.8	85.1	69.6	November	76.3	88.0	69.1
May	70.9	81.3	63.7	December	75.6	85.6	69.3
June	70.7	81.5	63.0				
July	71.1	82.6	61.7	Year	74.4	85.8	67.1

This table shows the mean annual temperature for Cobija to be 74.4° F. The mean annual temperature for Porto Velho (lat. 8° 48′ S., alt. 250 feet), the nearest point where meteorological readings have been kept for a number of years, is about 81° F.[11] While probably a longer series of readings might show a higher mean annual temperature for Cobija, yet the lower latitude and higher elevation of this point as compared with Porto Velho indicates a much lower temperature. The absolute maximum temperature registered was 97.2° F. and the minimum 49.1° F.

Temperature observations made by Ripeau [12] in 1900 in the center of a group of Hevea trees at the "Chaco Perspectivo" near Riberalta (lat. 11° S., alt. 522 feet) are as follows:

TABLE 47.—MONTHLY MAXIMUM AND MINIMUM TEMPERATURE, "CHACO PERSPECTIVO," 1900

Months	Day		Night		Months	Day		Night	
	Maximum	Minimum	Maximum	Minimum		Maximum	Minimum	Maximum	Minimum
	° F.	° F.	° F.	° F.		° F.	° F.	° F.	° F.
January	86.1	79.2	78.8	70.8	August	82.0	80.6	76.6	73.7
February	83.8	80.2	77.3	70.3	September	80.0	82.0	79.5	73.7
March	81.3	76.8	73.5	67.6	October	86.7	80.9	78.8	74.1
April	82.4	79.1	77.0	69.9	November	86.0	82.0	79.5	71.6
May	77.0	68.1	73.0	69.2	December	83.8	80.6	79.1	70.3
June	73.4	63.3	68.3	60.0					
July	77.0	71.7	73.4	69.8	Year	82.0	77.0	76.2	70.1

[10] Met. Zeitschrift, 1911 and 1912; pp. 416 and 430, respectively.
[11] See Monthly Weather Review, Washington, Vol. V, p. 368, 1922.
[12] Ripeau, Felix, Caoutchoucs Amazoniens et Asiatiques, p. 8. Paris, 1914.

Although not so stated, the maxima and minima probably refer to average and not to absolute temperatures.

TEMPERATURE IN SOUTHERN DISTRICTS

Temperature readings said to have been made by Dr. E. R. Heath will give some idea of the conditions for the more southern parts of the region under consideration (San Antonio, lat. 12° 26′ S.; Reyes, lat. 14° 20′ S.).

TABLE 48.—MONTHLY MAXIMUM AND MINIMUM TEMPERATURE, SAN ANTONIO AND REYES, 1878–1880

SAN ANTONIO, 1878-79

Months	Maximum		Minimum	
	Absolute	Average	Absolute	Average
	° F.	° F.	° F.	° F.
May	97.0	86.5	57.9	69.6
June	97.0	87.4	64.9	67.3
July	95.9	91.2	56.8	66.2
August	97.9	92.1	59.0	68.5
September	100.9	90.3	59.9	68.5
October	99.0	90.3	66.9	69.8
November	93.9	88.9	64.8	67.5
December	93.9	88.7	68.0	72.3
January	97.0	88.0	70.0	72.7
February	93.9	88.2	70.0	72.5
March	93.9	88.0	70.0	72.0
April	93.9	88.3	68.0	72.1
Year	100.9	89.1	56.8	70.0

REYES, 1879-80

October	95.0	88.3	64.9	72.0
November	93.9	88.9	68.0	74.8
December	93.9	86.5	72.0	74.8
January	93.9	86.9	71.8	77.9
February	93.9	86.9	68.0	72.1
March	91.9	85.1	70.0	76.6
April	85.8	79.5	64.9	71.8
May	88.0	88.2	66.9	71.1
June	88.0	80.8	54.0	68.9
July	90.0	86.2	61.0	70.5
August			57.0	
September				
Year	95.0	85.6	54.0	73.0

As this region, together with the Acre Territory of Brazil adjoining it on the north and adjacent parts of Peru, contains some of the best-developed and highest-yielding natural Hevea of the Amazon Basin, the low temperatures are of importance as indicating that the temperature range in which planted Hevea can do well can be considerably extended beyond the limits of the generally accepted minimum of around 60° F.

The atmospheric changes from the heat of the day to the cold of the night are rather accentuated and are said to be a frequent cause of respiratory affections and rheumatism. The days are hot, the

hottest part being around 2 p. m.; but the nights are cool and pleasant, and a light blanket is required practically every night. Climatically, the area varies little from the rest of the Amazon Basin, and from that standpoint offers no obstacle to colonization and development.

RAINFALL

Rainfall at Cobija for the two years, 1909 and 1910, averaged:

TABLE 49.—MONTHLY RAINFALL, COBIJA, 1909–1910

Months	1909	1910	Two-year average	Months	1909	1910	Two-year average
	Inches	*Inches*	*Inches*		*Inches*	*Inches*	*Inches*
January	6.7	9.0	7.8	August	1.9	1.0	1.5
February	14.0	3.3	8.6	September	1.3	4.2	2.8
March	8.1	21.8	14.9	October	10.2	8.5	9.4
April	8.4	6.2	7.3	November	6.1	6.2	6.2
May	.9	3.8	2.3	December	8.2	13.3	10.8
June	1.9	.3	1.1				
July	.5	.5	.5	Total	68.2	78.1	73.2

The average rainfall for the same two years at Porto Velho was 83.5 inches.

RAINFALL IN SOUTHERN DISTRICTS

Some notion of the precipitation farther south, at San Antonio and Reyes, can be obtained from records furnished by the office of the military delegate at Riberalta and said to have been made by Dr. E. R. Heath.

TABLE 50.—MONTHLY RAINFALL AND WET DAYS, SAN ANTONIO AND REYES, 1879–1881

Months	San Antonio, 1879		Reyes			
			1880		1881	
	Inches	Days	Inches	Days	Inches	Days
January	15.0	23	9.2	14	6.5	8
February	10.0	22	5.6	9	6.9	8
March	16.4	24	6.1	9	11.1	13
April	11.4	21	.8	2		
May	3.8	11	[1] 1.0	0		
June	.4	6	[2] 3.3		3.9	9
July	(2)	1				
August	.5	2	1.0	2	1.7	3
September	[3] 1.4	5	[4] 4.1			
October	8.3	10	7.7	11	2.1	5
November	9.1	13	7.3	9	3.5	12
December	11.3	21	10.8	13	1.3	3
Total	87.6	165	55.9	78	37.0	61

[1] San Antonio. [2] Trace. [3] San Antonio to Itnez. [4] San Antonio to Reyes.

Cobija is the only station in the region for which humidity figures are available. For this station the annual average relative

humidity at 7 a. m. was 94.5 per cent, at 2 p. m. 67.5 per cent, at 9 p. m. 85.5 per cent, with a mean average of 85.5 per cent. Relative humidity as low as 30 per cent was recorded in August of each year. The high 7 a. m. average indicates that the atmosphere reaches the dew point during the nights, even in the dry season, for the driest months show a mean monthly average of 92 per cent at that hour.

SEASONS

Three or four months have been known to pass without a drop of rain, though this is rather unusual. The rains generally begin in October, at which time the rivers also start to rise, caused partly by the local rains but in large measure by the melting snows of the Andes. Precipitation increases in volume during November, with the heaviest rains of the season falling in December, January, February, and March, then begin to slacken in April, at which time the rivers subside, and May has little rain. June, July, August, and September are comparatively dry. The rivers reach their lowest stage during these months.

There seems to be no regularity in the hour for the seasonal rains. They may come at any time of the day or night, and may occur for several days without interruption. Probably, however, they occur in the afternoon more frequently than in the morning.

ECONOMIC EFFECT

At the time of the heaviest rainfall it is customary to stop all rubber tapping on the upland for six weeks, as the rains interfere with the collection of the latex and even make walking in the forests difficult. On the lowlands tapping is entirely stopped during the rainy season, since the land is covered with water and in many instances part of the tapping surface of the trees is submerged. High-water marks 12 to 15 feet up the trunk were noted on trees along the rivers. While it is true that a large area of land is covered with water during the rainy season, and thus for one to three months put out of use for any productive purpose, the area is small compared with the area not flooded.

The seasonal rains, with the consequent rise and fall in the rivers, have an important economic effect on the life of the region. The rivers are the main, and in most part the only, means of transportation. Consequently, in places distant from the main rivers the native collects his rubber in the dry season, and brings it out in canoes and launches when the rivers rise. This is one of the reasons why the dry season is the principal time of production.

POPULATION

The official census returns of 1900 give the population of the Territory of Colonias as 6,883, of the Department of El Beni 25,119, and of the Department of Santa Cruz 151,062. In 1918 an official estimate was: Colonias, 49,761; El Beni, 50,265; Santa Cruz, 327,382. However, figures for such scattered populations as these can only be approximations to the actual number. An estimate prepared for us by a special committee of prominent citizens of Riberalta put the population of Colonias at 20,000 and of Beni at 30,000,

including 5,000 in the Province of Vaca Diez, which totals, from casual observation, would appear reasonably accurate. The army officer in charge of the topographical survey of the Territory, and who had unusual opportunities for observation, estimates the population of the important sector between the Manuripe-Orton-Beni and the Acre-Rapirran-Abuna at 8,000 to 10,000. This estimate corresponds to the years 1918–1920, which were spent in that region. The distribution of this population by nationalities was roughly: Bolivians, 25 per cent; Brazilians, 35; Peruvians, 10; Syrians, 8; Europeans, 5; Japanese, 2; miscellaneous, 15.

LABOR

In the Territory of Colonias and in the Department of El Beni the majority of the rubber workers are Bolivians, either Indians or mestizos (cholos). A very considerable proportion of these were born in the rubber country. The Province of Caupolican, of the Department of La Paz, which is located in the lower Andean foothills of the upper Beni, has also furnished many laborers to this region. The Department of Santa Cruz was formerly drawn on heavily for workers. These came down from the lands in the basin of the upper Mamore, including the vicinity of Santa Cruz itself, and from the Bolivian side of the Itenez, well into the Chiquitos country between Santa Cruz and the Paraguay River. The possibilities of this latter source have nearly been exhausted, due to the severe drain on the population in the early days of the industry, amounting to virtual depopulation in certain districts of the Provinces of Nuflo de Chaves and Velasco. The neighborhood of Trinidad, the capital of the Department of El Beni, has also supplied some laborers, but the population of this region is small. The rubber properties in the Department of Santa Cruz along the Itenez and its affluents depend on the local labor supply.

A few Peruvians are generally found on each property in the Territory of Colonias. They specialize in the extraction of caucho, and drifted around from the Ucayali country or from the upper Madre de Dios in search of new reserves of caucho. Brazilians constitute the predominant element in the zone between the Abuna and the Acre and the Orton and its confluents. Very few are employed to the south of these rivers.

POSSIBLE SOURCES OF ADDITIONAL LABOR

The Bolivian proprietors assert that they could probably obtain 2,000 or 2,500 additional laborers for the entire region in case of need by scouring the customary sources of supply. In the first place, some former rubber workers, now engaged in farming small patches of land along the rivers, could be brought back to their old occupation by the inducement of higher returns for their work. The Province of Caupolican, the upper Mamore region, and Santa Cruz could be drawn on for several hundred, but the chances of securing laborers from any of these sections largely depend on the strength of the economic pressure in the locality to force emigration to regions where more profitable employment can be found. At present

a laborer could probably be brought from Caupolican or Santa Cruz for between 100 and 150 bolivianos, exclusive of advances made to him. It formerly cost as much as 1,000 bolivianos, due to the high premium paid to labor agents. Sometimes the expense of transporting laborers to the rubber properties is avoided by bringing them in as part of the crew of river steamers or as drivers of cattle "trooped" across from the Mojos plains. The Province of Apolo, in the Department of La Paz, and the Province of Caupolican could furnish a certain number of laborers, but the Apolistas, as the inhabitants are called, have the reputation of being inferior workers.

ORIENTAL LABOR

A certain number of Japanese have been employed during the last six or eight years. These Japanese entered Bolivia from Peru by way of the Madre de Dios. However, most of them have left the rubber forests because of the decreased remuneration offered by the proprietors on account of the fall in the price of rubber, and for other reasons. Many have settled in the towns, including about 300 in Riberalta and a considerable number in Trinidad, where they have largely monopolized the local business of small shopkeeping or work as gardeners, barbers, tailors, and at other trades. The number of Chinese is insignificant.

It is improbable that any considerable number of Japanese would be obtainable within the areas practicable as sources; that is, from the immediate locality of the rubber country or from the coast districts of Peru. It is virtually certain that any large development in this part of Bolivia would have to depend on the introduction of laborers from the Orient. The consensus of opinion among the important proprietors is unfavorable to any considerable increase of the Japanese element, but no opposition is found to the Chinese, although the qualities of Chinese labor are known only by hearsay.

There are two alternate routes available for importing oriental laborers. The first of these is by steamer direct from the port of embarkation in the Orient to Porto Velho on the Rio Madeira, which is accessible for ocean-going steamers for over half the year. Then the route would be by the Madeira-Mamore Railway and the Bolivian rivers to destination. The second alternative is by steamer direct from the Orient to Mollendo in Peru. Thence the route would be by the Southern Railway of Peru to Tirapata, overland by road to the head of navigation on the upper system of the Madre de Dios, and down this river to the rubber country. The time consumed in actual traveling between Mollendo and Riberalta would approximate 15 to 20 days, probably nearer the latter. The season of high water in the Madre de Dios (November to May) should be utilized for the introduction of laborers by this route, as also for the Madeira route. No data are at hand for calculating the cost of bringing in labor by either of these routes.

QUALITY OF LABOR

As a rubber worker the native Indian or mestizo commonly is lacking in intelligence and initiative, but he is as a rule physically robust. The Indian is docile and easily managed. However, he is not given to persistent and long-continued effort, but is disposed to work only three or four days a week.

The Brazilian is a more productive laborer than the Bolivian, but is charged by the Bolivian proprietors with being much more exigent than the native laborers in the matter of accommodations and treatment, and with being more excitable, intractable, nomadic, and addicted to brawls. The Brazilian caboclo excels the Bolivian Indian in intelligence and initiative but not in physique. He is much more of an individualist than is the Bolivian and prefers to work on task or contract work. He is not a success as a wage laborer and is not so amenable to working in gangs as is the oriental.

The Japanese is intelligent, industrious, and more productive than any other element employed. However, he has to be treated

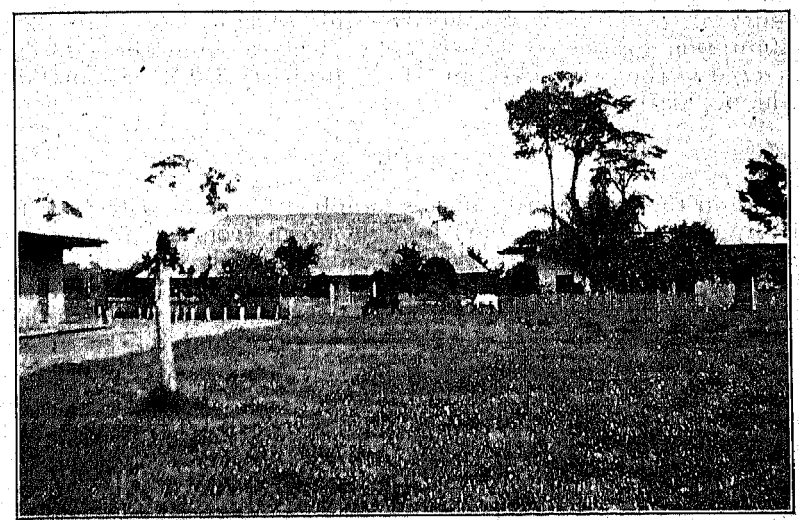


FIG. 42.—Headquarters of the property "Porvenir" on the Rio Tahuamanu, Bolivia

with even more regard for his feelings and rights than does the Brazilian. He is objected to on the ground that he damages the trees in his eagerness to produce more rubber, and that his frugality leads him to buy but little merchandise. He prefers to take payment in money rather than in goods, contrary to the system prevalent on the rubber properties, and is also disposed to send the bulk of his surplus earnings to Japan.

FOOD SUPPLY

The crisis in the rubber industry brought about a revolution in the diet of the population of the rubber-producing regions. During the years of high prices of rubber the tapper preferred to devote all his time to rubber and to buy imported foodstuffs rather than to raise his own food. The proprietors also favored this system, due to the large profits made in selling food to the personnel of their properties. During that time the rubber worker became accustomed to buying high-priced canned goods, such as salmon,

sardines, asparagus, and fruit. He even bought canned sweet potatoes, a vegetable that can be grown locally with almost no effort.

With the fall in the price of rubber, and the consequent radical curtailment of his income, the laborer was no longer able to buy imported foodstuffs as before and was forced to begin cultivating food for his own consumption. The Japanese set an example, especially in the cultivation of rice and vegetables. In fact, it is only since the settlement of the Japanese that the population of Riberalta has been able to eat fresh vegetables such as lettuce, onions, and cabbage. It is now the general custom for each laborer to cultivate a small patch of ground, on which he works when rubber tapping is suspended. It is also common for part of the cleared land in the vicinity of the property headquarters to be planted to crops for the consumption of the personnel. The produce from these tracts is delivered to the administration of the property, which apportions it to the population as needed.

MEAT AND OTHER ARTICLES

Meat in the seringuero's diet is supplied by game killed by himself, by charqui (jerked beef) brought down from the plains of the Mojos, or by cattle that are either raised locally or driven across from the Mojos country to the rubber properties on the Beni and its tributaries. The larger rubber properties now generally have herds of from 50 to 200 head of cattle on land cleared in the vicinity. Suarez has large herds on the low grasslands about Trinidad, in which region there are also many thousands of wild cattle without owners. Though fish abound in the rivers, little fishing is done, contrary to the practice in Brazil, where fish is an important article of diet.

Also contrary to the custom in Brazil, beans are eaten very little in Bolivia. Sugar is produced locally at such places as Ivon, near Riberalta, or brought down from Santa Cruz. Coffee is grown in the region, but is also imported from Santa Cruz and to a less extent from Brazil. However, local consumption could easily be met by the planting of more trees. Wheat bread is not eaten by the rubber workers. Much of the corn produced is used in the preparation of chicha, the native drink, common to most parts of Bolivia. Mandioca, which has a heavy starch content, is usually eaten boiled rather than in the form of flour, as in Brazil.

SYSTEM OF PAYMENT

The scale of remuneration of the Bolivian seringueros is graduated according to the current trend of rubber prices. It is generally fixed yearly for the entire territory by agreement of the principal proprietors and is not changed during the year, whatever the fluctuations that may occur in the price of rubber. During the year 1923 the scale of compensation in force was 12 bolivianos per arroba of 11½ kilos (about 25 pounds). However, only in exceptional cases is any considerable amount of money paid to the seringuero.

Rubber turned in at the barracon by each seringuero is credited to him at the rate established for the year, and against this credit he buys merchandise at the property store. His purchases include not

only a certain amount of foodstuffs but his working equipment—that is, his machadinho, machete, tin cups for collecting latex, etc.—cotton cloth and clothing, rifle and cartridges, and such extra purchases as his necessities or whims dictate.

HEALTH AND SANITATION

DISEASES

Malaria is endemic in certain regions, especially near the rapids and in areas subject to prolonged annual floods. In these latter malaria is more prevalent during the months when the rivers are falling after the rainy season, at which time anopheles mosquitoes breed in large numbers in the stagnant water. Certain rivers have the reputation of being more unhealthful than others, as in the case of the Abuna. The tierra firme, or higher unflooded country, is much more healthful in this respect, and considerable areas are comparatively free from mosquitoes, of either the anopheles or the culex variety. Among the towns of the region, Riberalta and Cobija enjoy much better health conditions than Villa Bella and Manoa on the Madeira, due primarily to the higher sites on which they are built.

The wide prevalence of hookworm is probably the principal factor in the physical debilitation of the native population of the rubber districts of Bolivia as of the Amazon Valley in general.

Digestive disorders are frequent, due to defective or inadequate nutrition or to polluted drinking water. However, beriberi has virtually disappeared since the crisis in the industry forced the population of the rubber districts to grow their own foodstuffs.

MEDICAL FACILITIES

Sanitary methods are extremely rudimentary or altogether lacking. The only measure taken by the Government in this direction has been the establishment of a hospital at Riberalta, directed by a competent physician. However, its usefulness is largely limited to a small zone around Riberalta.[18] Serious cases of illness among the better-to-do classes are generally treated at the excellent hospital maintained at Candelaria, near Porto Velho, Brazil, by the Madeira-Mamore Railway Co. and headed by an American doctor of long experience in the region. The large barracons, or rubber establishments, have pharmacies under the charge of a man who also acts as physician on the property, treating wounds, etc., among the workers. These pharmacies carry a wide line of drugs and proprietary medicines, among which are featured the American pain dispellers and other panaceas so popular among the rubber gatherers of the entire Amazon Valley.

The seringuero, or rubber collector, lives without the most elementary precautions against disease. He seldom uses a mosquito net, and he could not protect his hut with wire netting, granting it were within his means. In fact, netting is rarely used in the towns or by the proprietors or administrators of the rubber estates, nor is the hospital at Riberalta barred against the entrance of mosquitoes.

[18] The decree of September 11, 1922, providing for the obligatory distribution of quinine has not yet been put into effect.

The seringuero seldom goes to the trouble of taking quinine until he has a serious attack of malaria, although on the books of one company were found entries of frequent sales of quinine to the rubber workers. The seringuero is exposed to accidents of one kind or another, wounds in the feet or legs being the most common, yet he seldom possesses even such a fundamental prophylactic as tincture of iodine. The necessity for his exposure to the weather in the dank forest during the rainy season and his habit of drinking water wherever he finds it are other factors that reduce the laborer's efficiency and diminish the number of his working days by frequent illness.

However, the climate in itself is far from unhealthful and certain localities are even quite salubrious. Where sanitary conditions are bad they are the result of neglect of the ordinary rules of hygiene. Clearing and draining the ground about the barracons for a considerable radius and keeping down the grass by cutting or pasturing cattle on it generally accomplish the elimination of the mosquito from the inhabited zone. The Suarez establishment on the Tahuamanu is an excellent example of what can be done in this connection. The foreign manager at this place, as at the other barracons in the territory, enjoys excellent health.

VEGETATION

The vegetation of this part of Bolivia is very similar to that of the whole Amazon Valley. It is subject to much the same general climatic conditions, though in some respects it differs from the lower Madeira and main Amazon regions in that *Hevea brasiliensis* is found on the higher lands, or tierra firme, as well as on the flood plains.

The view as one travels along the rivers soon becomes extremely monotonous. The streams seem to be inclosed between high walls of solid green vegetation. Only the presence of an occasional sand bar or bluff or the entrance of a creek serves to vary the aspect. On the sloping parts of the banks the ground is covered in places with tall rank grass; other parts are covered with a luxuriant growth of wild cane. Intermingled with this, for miles at a stretch, there is a thin curtain of the light, fragile, whitish-stemmed Cecropia. From the edge of the banks proper there extend trees of varying size, in places much bamboo and a thick growth of vines and underbrush.

The view from the river or even from trails is deceptive. After penetrating the first screen of vegetation the forest is not so dense as it appears from the outside. A few exceedingly large trees with their lower branches intermingled with the upper ones of smaller trees and a rather heavy growth of lianas (vines) and very small trees underneath present from the outside the appearance of a dense, impenetrable jungle. The lower parts of the land, subject to inundation, are characterized by the presence of bamboo, large herbaceous plants with banana-like leaves, and palms with the local Bolivian names of chonta, mutacu, pachuba, atata, and cussi.

TREES OF THE BOLIVIAN FOREST

The most characteristic tree on the lowland is the ceiba, known in Brazil as sumaumeira. This is the silk-cotton tree whose pod pro-

duces the well-known kapok, although here, while used locally, it is not an article of commerce. This is the largest tree seen along the river banks, sometimes attaining a girth of 25 feet or more and a height of over 100 feet. Another prominent tree is the tenteiro, characterized by its purplish blossoms. This tree is, in general, of smaller size than the ceiba. Trees common on the flood plains include: Soft woods—palo santo, ambaiba (*Cecropia* sp.), ochoco (*Hura crepitans*), huhillo, quecho, sangre de toro (*Virola* sp.), patuhui (*Sterculia* sp.), pacai (*Inga* sp.), caricari (*Parkia* sp.), oje, and pelato (*Sapium* sp.); hardwoods—guiabate (*Calycophyllum spruceanum*), palo maria, bi grande (*Genipa americana*), and tajeiro (*Tecoma* sp.).

On the tierra firme the most prominent trees are the Brazil-nut tree (*Bertholletia excelsa*), Spanish cedar (*Cedrela*), and the *Hevea brasiliensis*. Here as elsewhere the Brazil nut is the largest tree of the uplands, its great height causing it to stand out prominently above the surrounding trees. Brazil nuts are not gathered to any extent for commercial purposes, since the freight rates are so high as to make exploitation unremunerative.

Among other trees in the uplands are those belonging to the gutta-percha family (Sapotaceae), which in other regions of the Tropics produce gutta-percha, balata, and chicle (chewing gum) of commerce. It is only recently that the gums of this character in the region under consideration are being collected for exportation. Investigations are being made regarding the possibilities of exploiting these gums on a larger scale. These investigations include an exploration of the forests to determine the amount of the products available and the value of the gum of the different species. It is stated that a tree known here as abiurana (*Lucuma* sp.) produces a gum locally called gutta-percha, and that this, together with chicle, collected from a number of other species of the family Sapotaceae and also Apocynaceae, in the early part of 1923 formed shipments to England amounting to 5,000 pounds.

COST OF CLEARING JUNGLE

Inasmuch as no land was being cleared at the time the field party was in the region, no first-hand data could be obtained concerning the cost of clearing. Very little land has been cleared. Around the principal establishments are small clearings of 100 to 200 acres made for pasture or for growing food crops.

As representative of the methods used in clearing jungle and the cost, an area of 500 acres planted to cotton can be taken. It is located at Conquista, 100 miles above Riberalta, on the Madre de Dios River. The timber on the area was felled and burned over. Any logs not destroyed by the first burning were allowed to remain on the ground to rot.

Twenty-five day-wages (jornales) are stated to have been required to cut and burn 1 hectare (2.47 acres). The wages paid were 3 bolivianos per day, making a total cost of 75 bolivianos per hectare. The wages were paid in merchandise at a profit of 75 per cent or more. If wages were paid in cash the cost would approximate 2 bolivianos per day per man, or a total cost of 50 bolivianos per hectare. Taking

the boliviano at its average exchange value for 1923 of $0.303 U. S., this would give $6.13 per acre.

Virgin tropical forests vary greatly in density, and it is important for the rubber grower who plans to clear for planting to know how much woody material has to be cut to make such a clearing. A rough estimate would be 125 trees, 6 inches and over in diameter, per acre. In size the percentages run about as follows:

	Per cent
Below 2 feet 6 inches in diameter	97
Below 2 feet in diameter	95
Below 1 foot 6 inches in diameter	90
Below 1 foot 3 inches in diameter	85
Below 1 foot in diameter	75
Below 8 inches in diameter	40

A method of clearing practiced in this part of the Amazon Valley is to fell the jungle, allow it to dry during the period of light rainfall, and burn just before the heavy rains begin. The land is planted with an annual crop or allowed to grow up to grass. The next dry season the tall dry grass is fired and most of the logs and stumps are destroyed by this second burning. In this way clearing is done cheaply, but at the expense of the time factor.

In that part of Bolivia bordering the Abuna River and in proximity to Brazil all payments are made in Brazilian currency. In the Acre region clearing by the above method, which leaves the ground fairly clear of logs and small stumps, has been done for 200$000 per hectare, or 80$000 to 100$000 per acre (equal at the average rate of exchange for 1923 to $8.24 to $10.30 U. S. per acre). With the approach of the milreis to par the cost per acre would correspondingly increase.

WILD RUBBER

Hevea brasiliensis grows as a forest tree on both lowland and upland all over this district. Caucho, a species of Castilla, formerly existed in great numbers on the upland, but except in certain isolated localities the larger trees have been cut down.

The rubber-bearing areas of Bolivia are, with some unimportant exceptions, in the hands of a few powerful individuals and companies. The unit of production, the estrada, covers many acres, and consequently the land is held in large blocks. There are practically no small individual producers, although the land itsef has a very low or only a nominal value. The following will indicate the vast areas controlled by a few firms:

Name of company	Estradas	Acres
Suarez Hermanos	21, 265	16, 080, 704
Seiler & Co.:		
Own	1, 143	1, 720, 324
Control	424	
Alfredo W. Barber & Co	1, 500	1, 720, 000
Societe Picollet (Picollet y Cia.)	1, 500	1, 171, 812
Total	25, 832	20, 701, 900

It is estimated there are about 40,000 estradas (average, 180 trees to the estrada) in Bolivia. The above firms, therefore, control over one-half of the total rubber-producing areas.

SIZE AND CONDITION OF WILD TREES

Measurements taken of tapped and untapped representative trees on the Sena property of Suarez Hermanos, on the Madre de Dios River, showed that the average circumference of the trees at 3 feet from the ground was 6 feet 11⅝ inches for the former and 5 feet 3⅜ inches for the latter. The trees measured were on tierra firme. On the Abuna River measurement of many trees on the lowland subject to inundation gave an average of 6 feet in circumference at 3 feet from the ground.

The extraction of rubber has been the main industry in a large part of this region for 40 years; naturally the most accessible trees have been the most heavily tapped. The proprietors of the large properties on the Beni and Madre de Dios are now giving more care to their trees, and the trees are not being tapped so severely as in Brazil. In the Abuna River section, where practically all the seringueros are Brazilians, supervision has not been so good and the remaining trees are in a worse condition than farther inland. In this region it is not uncommon to see trees that have been absolutely ruined and that have been tapped from platforms up to 18 or 20 feet above the ground.

It was possible to view only a small proportion of the trees, because they are thinly scattered through the forest over thousands of square miles of territory. From those examined the conclusion can be drawn that, considering the system in use, the trees are in fairly good shape. However, in comparison with the excision, or knife, system of tapping used by the rubber producers of the Far East the trees are badly mutilated. Probably only about one-third of the total number of trees are being tapped, one-third are recuperating from previous tapping, and one-third are untapped for lack of labor.

AVERAGE PRODUCTION PER MAN AND PER ESTRADA

Due to exigencies of climate, the tapping season is divided into two periods known as fabricos. The first, or primero fabrico, begins about the middle of September and stops about the middle of February. The second, or secundo fabrico, begins about the middle of April and stops about the middle of July. These dates vary in different localities and in different years. The period from July to September is the dry season, and during this time the seringueros are engaged in agricultural work, planting their crops of rice, maize, yuca, etc. In the wet period (February to April) they build new houses, mark out new estradas, work for the patron for wages, or do nothing at all.

On account of the lack of statistical data it is not possible to determine the average over the whole rubber-producing area of Bolivia. From information secured and all data available the average production of the Territory of Colonias per man per year is about 1,350 pounds of dry rubber.

Each tapper covers two or three estradas. Probably over 50 per cent are working three; that is, the tapper works each estrada every fourth day. The number of trees to an estrada varies greatly, but on the average it is from 150 to 180.

COLLECTION AND PREPARATION

The method of gathering the latex from the tree is similar to that employed over the whole Amazon area and is fully described at page 22. Practically all the Bolivian properties are using the machadinho. However, the larger proprietors are beginning to experiment with knives. Suarez Hermanos and Seiler & Co. introduced the Amazonian knife on their properties during 1923. It is expected that this reform in tapping will prolong the life of the trees and increase their yield. A British company, the Anglo-Bolivian Rubber Estates (Ltd.), of the Chiquitos region has been using knives for tapping for several years, and it is understood with excellent results.

Smoking is done in the same way as in other regions of the Amazon, and the balls are approximately of the same size, averaging about 40 to 50 kilos. The best grade of Bolivian rubber is known on the Manaos market as "Bolivian fine," and ranks in quality and price with Acre (or Federal) rubber. A lower grade is classified as "upriver fine." The other grades, "entre fine" (medium) and "sernamby" (scrap), are similar to those produced all over the Amazon Valley.

The method of gathering and preparing caucho is likewise the same as universally employed in the Amazon Valley. It consists in felling the tree, collecting the latex, and allowing the latex to coagulate naturally. The coagulum is then wrapped in bundles of 50 or 60 kilos and shipped in this state.

PRODUCTION

Statistics on actual production of rubber in Bolivia are lacking, and instead, as in all the other rubber-producing regions of the world, the official export figures are used.

The following table shows the total exports of all classes of rubber from Bolivia from 1890 to 1922:

TABLE 51.—PRODUCTION (EXPORTS) OF RUBBER, REGION 8, 1890–1922

Years	Tons	Years	Tons	Years	Tons
1890	294	1901	3,465	1912	4,080
1891	345	1902	1,903	1913	5,143
1892	363	1903	1,745	1914	4,485
1893	394	1904	1,571	1915	5,055
1894	633	1905	1,678	1916	4,917
1895	820	1906	1,930	1917	5,842
1896	1,141	1907	1,831	1918	4,288
1897	1,074	1908	2,607	1919	5,347
1898	3,156	1909	3,052	1920	3,759
1899	2,140	1910	3,118	1921	2,844
1900	3,496	1911	3,646	1922	3,079

The following table shows Bolivia's production of rubber by Departments for 1914–1922:

TABLE 52.—BOLIVIAN PRODUCTION OF CRUDE RUBBER, BY DEPARTMENTS, 1914–1922

Years	La Paz	Colonias	Cochabamba	Santa Cruz	El Beni	Total
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1914	190	3,933	----------	204	149	4,485
1915	186	3,991	----------	179	699	5,055
1916	208	3,895	----------	206	608	4,917
1917	221	4,936	----------	267	418	5,842
1918	66	3,833	2	163	224	4,288
1919	123	4,484	3	378	359	5,347
1920	62	3,228	----------	139	330	3,759
1921	9	2,400	----------	142	293	2,844
1922	11	2,644	----------	210	205	3,079

This table shows the Territory of Colonias to be the leading rubber-producing section of Bolivia; for the years 1914 to 1922 its exports formed 84 per cent of the total for the entire Republic. The chief exits for the rubber from this region are Cobija, Abuna, and Villa Bella. The rubber that passes through Cobija is carried by water transportation down the Acre, Purus, and Amazon Rivers to Manaos or Para. That which passes through Villa Bella and Abuna generally crosses the river to the Madeira-Mamore Railway and is transported by rail to Porto Velho, thence transshipped to Manaos or Para for the markets of Europe and the United States. Small quantities of rubber, especially some of that produced in the southwestern corner of the Territory, pass the customhouse at Porto Heath into Peru and are transported by river and pack animal to the nearest point on the railroad leading to Mollendo, Peru, and thence shipped to the country of destination.

The Department of El Beni, with a total export of 3,285 tons for the years 1914 to 1922, stands second to the Territory of Colonias in the amount of rubber produced, although the Department of Santa Cruz of late years is overtaking it. Most of the rubber collected in El Beni passes through the customs at Villa Bella and is shipped by rail to Porto Velho, thence by steamer to Manaos or Para. Small quantities originating in the southern part of the department find their way by river and overland to a customhouse on the railroad, usually Oruro, thence are transshipped by rail to the coastal ports of Arica and Mollendo.

In the nine years from 1914 to 1922 the Department of Santa Cruz produced 1,897 tons, or 5 per cent of the total. Formerly most of the rubber from this department left the country through Porto Suarez or its subsidiary port of San Matias, both on the eastern boundary of the Republic and near to water transportation on the Paraguay River in Brazil. It was carried by steamer down this river, eventually reaching the United States or England by direct consignment or through Montevideo, Uruguay. Small quantities of rubber from this department reach the customhouse of Yacuiba on the southern border of the Republic, and thence are transported by rail via Embarcacion, Argentina, to River Plate points for shipment. Another small lot reaches Oruro for rail shipment to the coast.

The small quantity of rubber produced in the Department of La Paz reaches the railroad at La Paz or some subsidiary customs point

and the coast generally at Mollendo, Peru, though some of it is carried to the Chilean port of Arica. This is currently known on the market as Mollendo rubber and is of a slightly different quality from the other grades produced in Bolivia.

EXPORTS, BY COUNTRIES OF DESTINATION

The following table shows the exports of rubber from 1912 to 1922 from Bolivia by countries of destination:

TABLE 53.—BOLIVIAN EXPORTS OF CRUDE RUBBER, BY COUNTRIES OF DESTINATION, 1912–1922

Years	United States	Belgium	France	Germany	United Kingdom
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
1912	88	521	477	1,169	1,811
1913	175	440	1,028	881	2,593
1914	419	157	575	481	2,846
1915	4,646	----------	68	16	314
1916	4,291	----------	320	----------	176
1917	4,927	----------	427	----------	328
1918	3,610	----------	352	----------	150
1919	3,472	----------	570	----------	1,150
1920	1,829	----------	235	11	308
1921	814	----------	255	51	582
1922	1,814	----------	149	43	136

Years	Argentina	Brazil	Uruguay	Other countries	Total
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
1912	----------	----------	10	4	4,080
1913	----------	----------	26	----------	5,143
1914	----------	----------	----------	7	4,485
1915	10	----------	----------	2	5,055
1916	4	109	13	4	4,917
1917	24	----------	70	66	5,842
1918	----------	----------	156	20	4,288
1919	----------	----------	131	15	5,347
1920	16	1,312	14	34	3,759
1921	2	1,127	10	3	2,844
1922	----------	848	80	9	3,079

The share of the United States during this period was: 1912, 2 per cent; 1913, 3 per cent; 1914, 9 per cent; 1915, 91 per cent; 1916, 87 per cent; 1917, 84 per cent; 1918, 84 per cent; 1919, 65 per cent; 1920, 49 per cent; 1921, 29 per cent; 1922, 59 per cent.

PRICES PAID THE SERINGUERO

The lowest price ever paid in Riberalta for "fine" was 10 bolivianos per arroba (25 pounds), and at this the merchants just made expenses. Since the seringuero was paid in merchandise on which a profit of at least 75 per cent was made, he actually received goods at cost price f.o. b. Riberalta of about 5.75 bolivianos for his arroba. The cost price, therefore, on this basis was 0.23 boliviano per pound ($0.07 U. S. at exchange of $0.303).

In September, 1923, the price paid the seringuero for "fine" was 12 bolivianos per arroba, paid in merchandise, equivalent to 0.28 boliviano ($0.085 U. S.) per pound.

On the lower Abuna a prominent proprietor and merchant stated that he considered a price of 14d. per pound in London, with exchange as of the middle of October, 1923, as the limit at which they could work. This, taking exchange at £1=$4.53, would be the equivalent of $0.264 per pound, London. It cost in September, 1923, to transport a pound of rubber to London and sell it about 0.33 boliviano, or $0.10 U. S. On this basis the price the seringuero would receive in merchandise would be $0.164 ($0.264 minus $0.10) per pound.

At Cobija and in that part of Bolivia adjoining the Acre Territory, where Brazilian currency and units are used, it is considered that the lowest price at which a seringuero can continue producing is 2$600 in Para. The total expense of shipping a kilo of rubber from the upper Acre to Para and selling it can be taken as 500 reis. This includes freight, duties, transfer charges, warehousing, insurance, and commission of 1 per cent on the gross selling price. This leaves, therefore, 2$100 per kilo at the seringal as the lowest price at which the seringuero could produce rubber, or 953 reis ($0.099 U. S.) per pound.

A communication received from business men and the military authorities at Riberalta stated that at the time it was written, October 27, 1923, it was possible to produce "fine" rubber at 8 bolivianos per arroba ($0.097 U. S. per pound). This presumably means, however, "under existing conditions," whereby the seringuero is paid in goods on which a high profit is exacted. Assuming this merchandise profit to be 75 per cent, the seringuero would actually receive the value of 4.57 bolivianos for his arroba, equivalent to only $0.055 U. S. per pound.

From a consideration of the above figures it will be seen how impossible it is to arrive at the true physical cost of production by the seringuero, the actual producer, expressed in terms of United States currency, especially when the exchange rate varies. However, it appears that the cost may be made very low, according to locality—somewhere between 6 and 12 cents a pound, with a probable average of 8 to 10 cents.

COST ESTIMATES

From the time the rubber leaves the seringuero's hand the costs are accurately known, and they begin to mount rapidly. Due to the system in vogue there are chances for great losses, and in fact such do occur. In order to carry on the business at all and to cover losses the proprietor is obliged to make abnormal gross profits. But this does not at all mean that his net profits are large; the general appearance and condition of the country show they are low or nonexistent.

There are given below, from the records of two properties operated by one of the most successful firms in Bolivia, the profit and loss statement showing how costs are derived:

TABLE 54.—COST OF PRODUCTION OF "FINE" RUBBER, PROPERTY NO. 1

Production items	Amount	Value	Profit and loss items	Loss	Gain
1919–20			1919–20		
	Pounds	*Bolivianos*		*Bolivianos*	*Bolivianos*
Production	[1] 65,394	50,699	General merchandise		11,575
Overweight	2,953		Cattle	348	
			Farm products		1,560
			Miscellaneous work		1,514
			General expenses	28,082	
			Interest	2,590	
			Depreciation on buildings, etc.	1,059	
			Tools and furniture	137	
Total	68,347	50,699	Total	32,216	14,649
Net loss		17,567	Net loss	17,567	
Total f. o. b. cost		68,266			
Cost per pound		1.00			
1920–21			1920–21		
Production	[2] 71,482	51,414	General merchandise		19,355
Overweight	5,766		Cattle	3,791	
			Farm products	4,743	
			Miscellaneous work		2,834
			General expenses	36,315	
			Interest	6,757	
			Depreciation on buildings, etc.	4,639	
			Tools and furniture	1,127	
Total	77,248	51,414	Total	57,372	22,189
Net loss		35,183	Net loss	35,183	
Total f. o. b. cost		86,597			
Cost per pound		1.12			
1921–22			1921–22		
Production	[3] 72,810	32,022	General merchandise		16,047
Overweight	5,078		Cattle	4,246	
			Farm products		948
			Miscellaneous work		1,187
			General expenses	22,608	
			Interest	6,313	
			Depreciation on buildings, etc.	2,474	
			Tools and furniture	1,150	
Total	77,888	32,022	Total	36,791	18,182
Net loss		18,609	Net loss	18,609	
Total f. o. b. cost		50,631			
Cost per pound		0.65			
1922–23			1922–23		
Production	[3] 68,097	29,901	General merchandise		8,929
Overweight	6,515		Cattle	1,649	
			Farm products		1,468
			Miscellaneous work		704
			General expenses	17,771	
			Interest	4,333	
			Depreciation on buildings, etc.	2,606	
			Tools and furniture	744	
Total	74,612	29,901	Total	27,103	11,101
Net loss		16,002	Net loss	16,002	
Total f. o. b. cost		45,903			
Cost per pound		0.62			

[1] At 18 to 20 bolivianos per arroba of 11½ kilos (approximately 25 pounds).
[2] At 18 bolivianos per arroba.
[3] At 11 bolivianos per arroba.

TABLE 55.—COST OF PRODUCTION OF "FINE" RUBBER, PROPERTY NO. 2

Production items	Amount	Value	Profit and loss items	Loss	Gain
1921-22			1921-22		
	Pounds	*Bolivianos*		*Bolivianos*	*Bolivianos*
Production	[1] 52,232	23,095	General merchandise		15,000
Overweight	1,307		Cattle		1,154
			Farm products	475	
			Miscellaneous work		4,496
			General expenses	19,096	
			Interest	6,000	
			Depreciation on buildings, etc.	4,000	
			Tools and furniture	962	
Total	53,539	23,095	Total	30,533	20,650
Net loss		9,883	Net loss	9,883	
Total f. o. b. cost		32,978			
Cost per pound		0.62			
1922-23			1922-23		
Production	[1] 82,962	36,701	General merchandise		19,500
Overweight	7,038		Cattle		2,322
			Farm products	2,586	
			Miscellaneous work		2,489
			General expenses	25,357	
			Interest	6,000	
			Depreciation on buildings, etc.	7,000	
			Tools and furniture	1,021	
Total	90,000	36,701	Total	41,964	24,311
Net loss		17,653	Net loss	17,653	
Total f. o. b. cost		54,354			
Cost per pound		0.60			

[1] At 11 bolivianos per arroba of 11½ kilos (approximately 25 pounds).

PROFITS ON RUBBER AND MERCHANDISE

The proprietor, if he is a merchant, rarely makes less than a gross profit of 100 per cent on the goods he exchanges for the rubber. Usually this is the only profit he makes. If he has to pay cash for the rubber, he buys it at a price that nets him this same profit.

The following figures were furnished by one of the large proprietors on the lower Abuna as showing the gross profits made by him on merchandise and on rubber:

TABLE 56.—GROSS PROFITS ON MERCHANDISE AND RUBBER

Items	Fine	Sernamby	Caucho ball
RUBBER PAID FOR IN MERCHANDISE	*Milreis*	*Milreis*	*Milreis*
Cost per kilo in merchandise	3$000	1$200	2$000
Profit on merchandise	1$500	$600	1$000
Net cost in merchandise	1$500	$600	1$000
Freight to Manaos	$700	$600	$680
Gross cost per kilo	2$200	1$200	1$680
Selling price per kilo	4$950	3$960	4$650
Gross profit per kilo	2$750	2$760	2$970
RUBBER PAID FOR IN CASH			
Cost per kilo in cash	2$000	$800	1$500
Freight to Manaos	$700	$600	$680
Gross cost per kilo	2$700	1$400	2$180
Selling price per kilo	4$950	3$960	4$650
Gross profit per kilo	2$250	2$560	2$470

Transportation Costs and Expenses of Rubber from Points in Northeast Bolivia

	Milreis
1. From Manoa, at mouth of the Abuna River, to Manaos (per kilo):	
Transport from seringal to Manoa	0$100
Customs duties and expenses at Manoa	$010
Railroad freight (to Porto Velho)	$430
Steamer freight (Amazon River Co.) to Manaos	$087
Contingent expenses	$073
Total per kilo	$700

Equivalent at exchange of $0.103 to $0.033 U. S. per pound. (The corresponding cost for sernamby is 600 reis per kilo, and for caucho ball 680 reis; this difference caused by the railroad tariff, which is based on ad valorem values.)

	Bolivianos
2. From Riberalta to Manaos (per metric ton):	
Expenses at Riberalta	20.00
River freight, Riberalta to Villa Murtinho (Brazil)	88.00
Expenses at Villa Bella (Bolivia)	41.10
Total	149.10
	Milreis
Equivalent in Brazilian currency (at 0.35)	426$000
Expenses at Porto Velho	450$730
Dispatching	37$600
Expenses in Manaos	264$000
Total per metric ton	1,178$330

Equivalent at exchange of $0.103 to $0.055 U. S. per pound.

3. From Bolivia, via Acre River at Xapury, to Para (per kilo):	
Freight to river	0$100
Freight to Para	$300
Customhouse fees, Para and Manaos	$000
Receiving and packing	$018
Insurance and stamps, etc	$050
Port of Para taxes and warehouse and export broker	$084
Total per kilo	$558

Equivalent at exchange of $0.103 to $0.026 U. S. per pound.

Expenses of Shipping a Ton of Rubber from Riberalta to London September 1, 1923

	Bolivianos	Bolivianos
Expenses in Riberalta:		
Marking, etc	10.00	
Cartage to port	10.00	20.00
River freight Riberalta at Villa Murtinho		88.00
Expenses at Villa Bella:		
Manifests and stamps	10.00	
Bills of lading "parciales"	1.60	
Insurance, printed blanks, and stamps	16.00	
Declaration of origin	10.00	
Customs clearance and minor expenses	3.50	41.10
	Milreis	
Expenses at Porto Velho:		
Railway freight, official rubber quotation 4$800	434$730	
Incline plane	16$000	
	450$730	
Warehousing and statistical tax	6$400	
Gratifications	20$000	
Dispatch stamps	5$000	
Customhouse dispatch ⅛ per cent	6$200	
	37$600	

Expenses in Manaos:	Milreis	
River freight	84$000	
Bill of lading stamps	6$000	
Unloading	3$000	
Cases and nails	43$400	
Cutting and boxing, approximately	18$000	
Cartage to warehouse	1$800	
Boat and tips	20$000	
Translation of Bolivian "guia"	15$000	
Stamps and printed blanks in customs	9$000	
Warehousing, 1 per cent official value	49$000	
Statistical tax	2$500	
Transportation, Madeira-Mamore	6$500	
Stamps on maritime bill of lading	1$800	
Agency commission, 3 reis per kilo	3$000	
	264$000	
Total	752$330	Bolivianos
Equivalent at exchange of 0.35		263.32

Freight and expenses in London:	£.	s.	d.	
Freight, 280s. per ton	14	0	0	
Master porterage, 1s. 10d. per ton plus 200 per cent		4	6	
Inward dues, 3d. per cwt. plus 75 per cent		9	2	
Cartage to store, 6s. 3d. per ton		6	3	
Receiving and housing, 3s. per ton		3	0	
Cutting, selecting, packing, weighing, per ton	1	8	7	
New cases, at 3s		18	0	
Rent, 7½d. per ton a week plus 10 per cent			8¼	
Rent, 6 cases approximately a week			10	
Opening for inspection		1	1	
Taring and weighing, 10s. per ton		10	0	
Fire insurance, 11d. per cent		1	2	
Total	18	3	3	
Equivalent at exchange of 16½d				264.18
Brokerage, one-half of 1 per cent		13	6	
Commission, one-half of 1 per cent		13	6	
London commission	2	18	6	
Total	4	5	6	
Equivalent at exchange of 16½d				62.18
Grand total expenses per ton				738.78

Expenses per arroba 8.48 bolivianos, or, at exchange of $0.303, $0.10 U. S. per pound.

Recapitulation

RUBBER

	Bolivianos
Expenses from Riberalta to Villa Murtinho	108.00
Expenses at Villa Bella	41.10
Railway freight, 450$730	157.75
Expenses at Porto Velho and Manaos, 301$600	105.57
Freight and expenses, London, £18 3s. 3d	264.18
Commission, etc., London £4 5s. 6d	62.18
Total expenses per ton	738.78

Equivalent to $0.10 U. S. per pound.

CAUCHO

	Bolivianos
Expenses from Riberalta to Villa Murtinho	108.00
Expenses at Villa Bella	41.10
Railway freight, 357$100; incline plane, 16$000; total, 373$100	130.58
Expenses at Porto Velho and Manaos, 301$600	105.57
Freight and expenses, London	264.18
Commission, etc., London	62.18
Total expenses per ton	711.61

Equivalent to $0.099 U. S. per pound.

OTHER INDUSTRIES AND RESOURCES

AGRICULTURE

Due to the difficulty of transportation in this vast area, to the distance from large centers of population, and to the sparsely settled condition of the country itself, there has been no agricultural census taken for many years, and figures are not available to indicate the acreage of the crops actually grown. All the staple products common to tropical and subtropical countries, such as sugar cane, mandioca (yuca), corn, bananas, pineapples, oranges, rice, beans, coffee, cacao, and tobacco, are raised, but usually in small patches. With only a few exceptions, as noted below, there are no farms or plantations as these are known in the United States.

Some of the larger proprietors are beginning to experiment with other crops on a commercial scale, particularly cotton, in order not to be dependent on the one product, rubber. Seiler & Co., of Riberalta, have 500 acres of Moco cotton planted at Conquista, the seed coming from Parahyba, Brazil. A worm destroyed a large part of the 1923 crop. They also have an equal area planted to cotton on their property "Victoria" on the Rio Orton, which has given good results. Alfredo Barber & Co. also are growing cotton.

Suarez Hermanos, the largest operators in the rubber districts of Bolivia, have started growing cotton in an experimental way. This firm also produces on its "Ivon" property on the Beni River about 80 tons of sugar and 9,500 gallons of alcohol yearly, and on its various properties about 230 tons of rice.

TIMBER

At present there is very little local demand for lumber. The many falls and rapids of the Beni, Mamore, and Madeira, with the consequent high freight rates, makes the exportation of sawn lumber out of the question. The hard timber will not float, and the soft timber can not compete with that on the more accessible lower rivers. It appears, therefore, that it will be far in the future before the extraction of timber or lumber will be a remunerative business.

The forests of the Beni, Orton, and Abuna Rivers are slightly heavier than those of the Mamore, Ouro Preto, and Pacanova.

The forests contain a mixture of species. In no place do pure stands of merchantable-size timber occur. The number of trees that reach a size of 18 inches and over in diameter is comparatively small. Rough estimates of both lowlands and tierra firme show that the number of such will not average over 20 to 25 per acre.

TRANSPORTATION AND COMMUNICATION

RIVER

A fine network of rivers forms the principal means of communication and transportation in these regions. With one exception—the Acre River, which flows into the Purus—all these streams belong to the Madeira system. They comprise the Beni, Madre de Dios, Orton, and Abuna, with their more important tributaries, as follows:

Acre.
Madeira.
Abuna.
Negro.
Pacahuaras.
Mamu.
Beni.
Madeira—Continued.
Orton.
Tahuamanu.
Manuripe.
Buyuyumanu.
Madre de Dios.
Heath.
Madidi.

The navigability of these streams is conditional on the season of the year, and in some cases their courses are obstructed at all times by rapids which form perpetual barriers to navigation. The rivers generally begin to rise in late September or early October, though the annual rise is frequently delayed until the middle of November. In fact, the latter is the accepted period in certain rivers for the resumption of launch navigation, as in the Tahuamanu. Others, which draw on the snows of the Andes for part of their water, as does the Madre de Dios, begin to rise earlier. Thus during the first week of October, 1923, there was experienced a rise of about 10 feet in this river, at a time when the waters of the Mamore were still free from the discoloration that accompanies these rises.

Sometimes the first rises are in the nature of temporary freshets, the river falling as quickly as it rises and only attaining a steady level of high water in December or January. December to March is the season of heaviest rainfall, and it is at the end of this period or early April that the rivers reach their maximum height. The Madeira is generally at its height about the middle of April, after which it begins to fall, reaching its extreme low water in June or July. It then maintains the same general level until early October. The other rivers of this fluvial system follow more or less the same general schedule of rise and fall, though these different stages in the upper rivers precede those in the Madeira by a couple of weeks or more.

SEASONAL DIFFERENCE IN WATER LEVEL

The difference in level between lowest and highest water in the larger streams varies between 25 and 50 feet and in their navigable tributaries between 10 and 25 feet. Thus, during the season of high water, that is, between the middle of November and the middle of May, at least a dozen rivers in the territory may be freely navigated throughout most of their course by boats drawing 5 to 6 feet of water. However, during the season of low water the navigable extent of these rivers decreases greatly and even the larger streams have to be navigated with care by steamers drawing 3 to 4 feet of water,

the standard type of river craft in this region. At this time the smaller streams are navigable only for launches drawing 1½ to 2 feet of water, while those ordinarily navigable by launches may accommodate only canoes or rafts.

During the season of low water the channels of some rivers are strewn with snags—trees too heavy to float, which fall into the current at the time of high water and remain in the channel, a menace to navigation, throughout the period of low water. Floating trunks of lighter trees are also dangerous to river craft during high water. Steamers travel at night only when the water is high enough to insure a safe channel, or when there is a full moon. The Abuna and Tahuamanu are examples of streams whose navigability is greatly limited by these circumstances. Other obstacles to navigation are the shallow stretches formed by bars at times of low water and hidden rocks that obstruct the channel of some rivers at certain points.

LIMIT OF NAVIGATION

The limits of navigation in these rivers are generally fixed, as in the Brazilian affluents of the Amazon, by cachuelas, or rapids. Sometimes these rapids disappear at high water, but others can never be passed by boats. Thus, the Beni is navigable only between Cachuela Esperanza in its lower course and the rapids of Altamirani, a few miles below Rurrenabaque, where the river encounters the first spurs of the Andes. At Cachuela Esperanza, where the Suarez headquarters are located, all cargo has to be transshipped around the rapids to the lower river, which is navigable in turn to its mouth at Villa Bella. At Cachuela Esperanza goods are carried up the bank from the boat and are then transported on push cars, which run over about half a mile of track, to the point where they are removed to be loaded onto another boat. Suarez collects 10 centavos per kilo at this point for transshipment of merchandise belonging to second parties.

The Cachuela Fortaleza near the mouth of the Abuna obstructs the passage of boats at all times, making transshipment obligatory at this point. In the season of low water rapids at Camacho serve as the limit of navigation on the Madre de Dios, although navigation is otherwise free to the confluence with the Heath at the Peruvian border.

Conditions of navigation of the different rivers of the Territory of Colonias may be demonstrated by the following table, navigability being understood as the ability of boats drawing 3 to 4 feet of water to navigate at all seasons of the year, unless otherwise specified:

TABLE 57.—NAVIGABILITY OF RIVERS OF COLONIAS TERRITORY

Name of river	Length within Colonias Territory, miles	Navigability
Acre	91.1	Navigable for small launches.
Madeira	51.8	Not navigable on account of rapids.
Abuna	302.2	Navigable from Cachuela Fortaleza to Santa Rosa.
Negro	164.0	Navigable by launch (1½–2 feet), 123 miles.
Pacahuaras	104.8	Navigable by launch 47 miles.
Mamu	128.9	Navigable by launch 40 miles.
Beni	268.3	Navigable below Cachuela Esperanza to mouth; above to mouth of Madidi. (Navigable beyond limits of territory to Altamirani.)
Orton	163.1	Navigable for entire length.
Tahuamanu	174.3	Navigable by launch.
Manuripe	180.6	Navigable by launch 115 miles.
Buyuyumanu	94.9	Navigable by canoes.
Madre de Dios	258.8	Navigable to confluence of the Heath.
Heath	156.2	Navigable for 110 miles.
Madidi	344.9	Navigable for 227 miles.

The Mamore is navigable from the terminal of the railway at Guajara-Mirim to Trinidad for boats drawing 3½ to 4 feet of water; above it is navigable for launches to its confluence with the Sara, which is in turn navigable to Puerto Velarde or to Cuatro Ojos. The Itenez is navigable for steamers drawing 3 or 4 feet for about three months of the year to Villa Bella de Matto Grosso, but during the greater part of the year is navigable only to a short distance below Forte do Principe da Beira.

TYPES OF BOLIVIAN RIVER CRAFT

The river craft of this part of Bolivia may be classed by their local names, also general in Brazil, as follows:

Monteria.—A small narrow canoe, 10 to 12 feet long, generally of the dugout type, made from the trunk of the cedro or wood of similar weight. The monteria is seldom used for carrying cargo, except the personal effects of the one or two occupants.

Canoa.—A larger canoe, with cargo capacity of one-half to 1½ tons. It is employed widely for gathering rubber up small streams and collecting it at a central shipping point. Some canoas are found with capacity of 2 to even 9 tons.

Batelon.—Probably the most typical craft of the larger rivers; a cargo lighter with capacity ranging between 10 and 18 tons, and in instances up to 25 tons. The batelon is built of wood, preferably of itauba, the best being imported from Santarem on the lower Amazon.

Alvarenga.—A lighter built of iron and floored over, thus providing a hold where cargo may be stored. (This term is used less commonly in Bolivia than in Brazil.)

Balsa.—A small raft, generally made of about seven trunks of the very light palo de balsa lashed together.

Callapo.—A larger raft, usually formed by joining two or three balsas together. Callapos are built with cargo capacity up to 3½ tons. They are widely used for carrying rubber down the upper rivers during the dry season, when these streams are inaccessible to launches. Rubber is also often transported long distances by

making a raft of the balls themselves, supported by a framework of balsa wood. These rafts are propelled by poles or allowed to drift with the current.

Motor.—A launch with an explosion type of engine, using gasoline or kerosene as fuel, and a screw propeller. Gasoline launches are frequently fitted up by installing a motogodille at the stern of a batelon. The use of these easily adjustable motors has become increasingly popular, and they are now seen on all the rivers of the Amazon Valley, supplying motive power for large canoes or batelones, which have been floored and roofed over. The motogodille has the advantages of being relatively cheap, of being easily attached or removed, and of requiring little depth of water for its propeller.

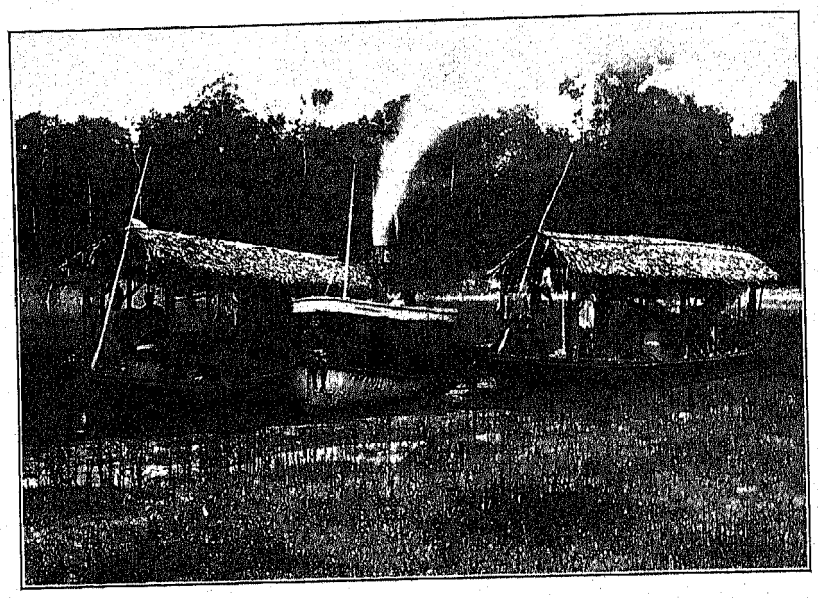


FIG. 43.—Steam launch and barges, Abuna River

Lancha.—Wood-burning steamers, usually paddle-wheelers, 50 to 70 feet long. Customarily they have two decks or a half deck above and are without cabins, travelers sleeping in hammocks on deck. There is a shallow hold for cargo, the draft ranging between 3 and 4 feet. In addition to having a cargo capacity of 30 to 50 tons, these small steamers generally tow one or more batelones with cargo.

FREIGHT AND PASSENGER SERVICE

All of the important rubber-producing interests operate boats for their own account. These include especially Suarez, Seiler, Barber, Zeller-Villinger, and Picollet in the Abuna, the last named, however, only operating gasoline motors, with lighters. In addition to these the Madeira-Mamore Railway Co. conducts a regular freight and passenger service between Riberalta and Villa Murtinho, opposite the mouth of the Beni. For this purpose motor launches with batelones are used on the lower Beni and sternwheelers between Cachuela Esperanza and Riberalta.

The Madeira-Mamore Railway Co., through a subsidiary, the Madeira-Mamore Trading Co., operates directly a line of boats between the terminus of the railway at Guajara-Mirim and the head of navigation on the Mamore and the Itenez. A regular service is maintained between Guajara-Mirim and Trinidad on the Mamore, from which point launches continue to Cuatro Ojos. From the head of navigation cargo and passengers reach Santa Cruz in about three days by mule or oxcart. The same company runs an intermittent service as far as Villa Bella de Matto Grosso on the Itenez during high water, by which route the Anglo-Bolivian Rubber Estates take out most of their production.

The Bolivian Government maintains a small fleet of boats on the rivers of the Beni system. Though these boats serve primarily for

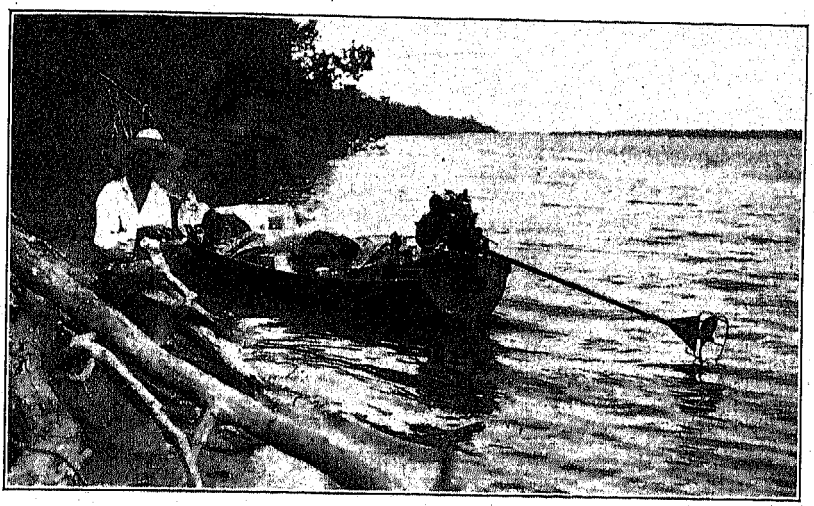


FIG. 44.—Canoe equipped with small motor (motogodille) for navigating shallow rivers and creeks

transporting mails, official dispatches, and soldiers, they also carry passengers. They run up the Beni to the head of navigation below Rurrenabaque and, when depth of water permits, to Porvenir on the Tahuamanu, from where there is overland communication with Cobija on the Acre. These boats are under the jurisdiction of the Delegacion Militar, or chief military authority of the Territory. They are under the immediate direction of a competent engineer, the son of an American long resident in Santa Cruz, who also is in charge of the Astillero Nacional, or Government repair shops, at Riberalta. Suarez Hermanos have well-equipped shops at Cachuela Esperanza, where repairs can be made. There are facilities for minor repair work at Abuna or Presidente Marques on the Madeira and at Guajara-Mirim on the Mamore.

STEAMERS PLYING ON BENI AND MAMORE RIVERS

The following is a list of the steamers in service on the Beni and Mamore and their tributaries:

TABLE 58.—STEAMERS PLYING ON BENI AND MAMORE RIVERS

Owners and names of vessels	Horse-power	Tons	Type of craft
RIO BENI			
Suarez Hermanos Sucesores:			
Campa	80	40	Sternwheeler.
Illimani	50	30	Do.
Herta	65	30	Do.
II de Octubre	80	-------	Towing screw boat.
Manuripe	80	-------	Do.
Esperanza	40	-------	Do.
Madidi	35	-------	Do.
Several motor launches.			
Seller & Co.:			
Helvetia	65	40	Sternwheeler.
Maravillas	50	25	Do.
Francia	100	-------	Towing screw boat.
Madeira-Mamore Ry. Co. (Seccion Fluvial):			
Bolivar	100	40	Sternwheeler.
Presidente Villazon	100	40	Do.
Triunfo	50	-------	Towing screw boat.
Several motor launches.			
Delegacion Militar:			
Beni	65	30	Sternwheeler.
Manu	65	30	Do.
Tahuamanu	35	-------	Towing screw boat.
Orton	70	-------	Do.
Several other motor launches on the Acre, Abuna, and Beni Rivers.			
Heirs of Nicanor G. Sanvatierra:			
Madre de Dios	70	-------	Do.
Ignacio Aponte:			
Carmen	30	-------	Do.
RIO MAMORE			
Madeira-Mamore Ry. Co. (Seccion Fluvial):			
Rodolfo Arauz	-------	-------	Sternwheeler.
Felix de Lima	-------	-------	Do.
Herta Barbosa	-------	-------	Do.
Bolivar	-------	-------	Do.
San Lorenzo	-------	-------	Do.
Emilia	-------	-------	Screw boat.
Suarez Hermanos Sucesores:			
Britania	-------	-------	Sternwheeler.
A. W. Barber & Co.:			
Cochabamba	-------	-------	Do.
Ana Catarina	-------	-------	Do.
Estrella	-------	-------	Do.
Zeller, Villinger & Co.:			
Chimore	-------	-------	Do.
Cormoran	-------	-------	Do.
Guapay	-------	-------	Do.
Antonio L. Velasco:			
Trinidad	-------	-------	Screw boat.
Ciceron Chavos:			
Luisa	-------	-------	Do.

ROAD

The tapping centers on the rubber properties are usually connected with the barracon, or general headquarters, by roads sufficiently wide for oxcarts, which form the principal means of transport. Mules are also much used for carrying rubber to the barracon and, if the barracon is located inland, for transporting the rubber thence to the point of shipment on the river. These roads are made by clearing a path of the requisite width through the forest, and

their construction seldom involves any grading or filling, though low stretches are frequently corduroyed. Despite the deep ruts worn in these trails by the oxcarts during the rainy season, they are generally passable throughout the year.

Mules for this service are generally brought in from northern Argentina at a very considerable cost, and the oxen used come from the Mojos prairies between the upper Beni and Mamore. The carts are made locally. Oxen have proven not only much cheaper than mules but less subject to disease, large numbers of mules having died from mal de cadera, a spinal ailment which is usually fatal. Forage for pack animals is supplied by grass grown in clearings along the trails.

The different rivers of the rubber region are connected by an elaborate series of roads or trails that makes it possible to travel overland by several routes from the Beni to the Acre or the Abuna, crossing the Madre de Dios and the Orton, or the Mamore, over which cattle are driven to the Territory of Colonias. There is naturally a wide difference in the quality of these roads, the best being that which connects Porvenir on the Tahuamanu with Cobija, capital of Colonias Territory, on the Acre River. This road can be traveled at all times by oxcarts, and for several years a motor-truck service was operated over it. This system of roads, to which there is nothing comparable on the Brazilian side of the border, has been made possible by the Bolivian road tax, levied in the form of a poll tax of 4 bolivianos per head, which sum may be worked out—as, in fact, is generally done—at the equivalent of two days' labor for the sum in question. The custom is for the proceeds from each property to be devoted to the construction and upkeep of roads of benefit to the particular property.

TELEGRAPH AND CABLE

Telephones are installed nowhere in the rubber district of Bolivia. There are Government wireless telegraphic stations at Riberalta, Villa Bella, and Cobija. The central wireless station at Riberalta communicates directly with La Paz via Viacha, and thence connects at Arica with the Pacific cables, allowing the transmission of messages from Riberalta to foreign points. Cobija and Villa Bella communicate with La Paz through Riberalta. The equipment is of Marconi make. The rates are not excessive.

From Villa Murtinho, opposite Villa Bella, at the confluence of the Beni and the Mamore, there is connection with Porto Velho by the Brazilian Government telegraph lines, or via Cuyaba in Matto Grosso with the coast at Rio de Janeiro. From Villa Murtinho messages may be sent directly to points in foreign countries by relaying at Rio de Janeiro. Another alternative is: Riberalta–Porto Velho (radio), Porto Velho–Manaos (radio), Manaos–Para (Amazon River Telegraph Co.'s subfluvial cable, or radio), Para–foreign point of destination (Western Telegraph Co.'s oceanic cable). However, connection from Riberalta to the Pacific coast via Viacha is generally much more rapid and satisfactory than communication across Brazil.

Radio telephony could be used to advantage by the more important proprietors of the region. Both Suarez and Seiler have electric

power plants already in operation, the one at Cachuela Esperanza and the other at Riberalta, which could easily be utilized for this purpose. The problem of communicating with distant posts from the central headquarters could be greatly facilitated in this manner. With present facilities communication often requires weeks of travel.

EXPORT ROUTES FOR RUBBER

There are two alternative routes for the exportation of rubber from the Beni-Colonias region and two from the minor Itenez region of the Department of Santa Cruz. These different routes may be described as follows:

BENI-COLONIAS

1. *Via the Madeira.*—Rubber shipped from the Beni-Colonias region by the Madeira route is sent out by the Rio Beni to the mouth at Villa Bella and at Villa Murtinho, opposite the latter point, is loaded onto the Madeira-Mamore Railway for Porto Velho. At Porto Velho it is transshipped to the steamers of the Amazon River Steam Navigation Co. or of the Companhia Fluvial, a subsidiary of the railway company. The rubber is reembarked for the foreign port of destination at either Manaos or Para, with which there is direct river connection throughout the year. This route serves as outlet for the production of the Beni, Madre de Dios, Orton (lower), and Abuna Rivers. Part of the production of the Orton zone is shipped out by the Acre River. The rubber from the Abuna reaches the railway directly at Presidente Marques. (The service of the Madeira-Mamore Railway is described in greater detail under Region 5; see p. 252.)

2. *Via the Acre-Purus.*—Porvenir on the Tahuamanu to Cobija on the Acre by oxcart; thence to the Amazon by the Acre and the Purus.

The Tahuamanu, which with the Manuripe forms the Orton, is accessible for shallow-draft launches from the Beni for about nine months in the year. The usual type of sternwheeler, drawing 3 to 4 feet of water, can reach Porvenir in normal years from about the middle of November to the middle of May, though this period is often curtailed by the late rise or early fall of the river. During the height of the dry season the Tahuamanu can be traveled only in canoes, not so much for lack of sufficient depth of water as because of the frequency of snags in the channel.

PRIVATE CART ROAD TO COBIJA

The cart road which connects Porvenir with Cobija runs in a general north and south direction for 20 miles. It was built by Suarez Hermanos, who own the establishment at Porvenir, and is used almost exclusively for transporting their rubber and other merchandise, although Seiler & Co. also send some of their production by this route. The road is one of the best highways in the Amazon Valley. During the dry season it is passable for vehicles of any kind. However, during the rainy season, at which time the great

bulk of the year's output of rubber has to be moved, considerable effort is required to keep the road drained sufficiently. For the first 6 miles out of Cobija the road leads through a belt of cleared and thickly settled country, but the rest of its course is through the forest, although there are two or three large clearings along the way. It follows high ground for nearly all its length and is consequently free from bridges. Corduroying has been resorted to for many stretches where effective drainage is difficult. The road is kept cleared on each side for a width of about 15 feet, in order to admit the sunlight.

Suarez Hermanos formerly used mules for transporting rubber over this road, but most of these animals died. Later three 3-ton motor trucks were used and made the trip in two and a half hours. Though a very efficient method of transport, the motor service was discontinued after nine years, when with the falling price of rubber and the rising cost of gasoline (60 bolivianos per case at Cachuela Esperanza) it ceased to be economical. An expenditure of 25,000 to 30,000 bolivianos per year had been required to maintain the road in condition for the trucks to pass. The trucks have since been replaced by oxcarts, which are in use at present. Suarez Hermanos maintain a large herd of good oxen at Porvenir for this service. These oxen are kept free from ticks, which formerly impaired their usefulness, by means of a fine concrete bath. During the season when rubber is being moved two trains of 18 to 30 carts are sent across to Cobija each week. The trip is made at night, the carts leaving Porvenir at four o'clock in the afternoon and arriving at Cobija early the next morning. The distance can be made by horseback in five or six hours.

WATER CONNECTIONS AT COBIJA

Cobija is connected with Para and the Atlantic Ocean by the Acre, Purus, and Amazon Rivers. It is accessible for launches drawing 1 to 1½ feet of water all the year. The flat-bottomed sternwheelers of the Amazon River Co., which draw 3 to 4 feet and carry 100 to 120 tons of cargo, run intermittently to Cobija from the first of December to the middle of May. During the height of the rainy season, and especially from January to early April, steamers drawing 8 or 9 feet of water could reach Cobija without difficulty. On the other hand, during the months of lowest water, and particularly from June to early November, any quantity of rubber too large to be loaded on a small launch or in batelones must be sent down in the form of rafts. Sixty tons or more of rubber are sometimes transported in one of these rafts. In reaching the mouth of the Acre or the passage in the Purus known as the Cachoeira the raft is broken up and the rubber is loaded onto a steamer for Manaos or Para. (Further details regarding navigation on the Acre and Purus are given at pp. 281–284.)

The Acre route would be utilized to a much greater extent for the exportation of Bolivian rubber if Porvenir were accessible from the Beni for a longer period in the year, for the difficulty of navigating the Orton and the Tahuamanu during the dry season nullifies many of the advantages of this route. On the other hand the Beni is always navigable from Riberalta to the mouth, except the portage at

Cachuela Esperanza, while rubber can be sent down the Madre de Dios all the year with comparative ease to its junction with the Beni. Thus, due to the facilities of the Madeira-Mamore Railway and the uninterrupted navigability of the Madeira below Porto Velho, it is possible to ship out rubber by this route during the entire year. The removal of snags and the dredging of some shallow passages in the Orton and Tahuamanu would be necessary to provide there anything approaching the same facilities of transport that are furnished by the Madeira route. Moreover, the present cart service between Porvenir and Cobija would have to be supplied by a Decauville railroad or by some such means of transport as caterpillar tractors. The firm of Suarez has at times seriously considered improvements of this character.

Another factor which limits the practicality of this route at present is the small amount of water in the upper Acre River from June to November, during which time the only feasible means of taking out rubber in large quantities is by forming rafts of the balls. At present the Porvenir-Acre route is used for exporting rubber only in the rainy season, during which time it serves as an outlet for the region tributary to most of the Orton and to its confluents, the Manuripe and the Tahuamanu, which comprises, however, a very productive territory. The Suarez properties directly tributary to this route comprehend over 2,000,000 acres and those of Seiler & Co. over 500,000 acres.

RUBBER EXPORTS VIA PRINCIPAL RIVERS

Exports of rubber by the three principal ports of shipment in 1918 were:

	Tons
Cobija (Rio Acre)	1,473
Manoa (Rio Abuna)	1,504
Villa Bella (Rio Beni)	2,210
Total	5,187

For 1922 the figures were:

	Tons
Cobija (Rio Acre)	818
Manoa (Rio Abuna)	584
Villa Bella (Rio Beni)	766
Total	2,168

For the first three months of 1923 (these months comprising the season when the Cobija-Porvenir route is most practicable) shipments by Cobija were 555 tons, as against only 187 tons by Villa Bella consigned by way of the railroad.

THE MADEIRA-MAMORE RAILWAY

The great economy in cost of transporting rubber by this route as against the Madeira-Mamore Railway, amounting to about half, is a very strong element in its favor and should lead to its increased use. The high railway freight rates have been a constant source of complaint by the rubber exporters of Bolivia. They argue, in favor of a reduction of rates (which are now levied on a sliding scale

according to the current prices of rubber[14]), that such a reduction would more than compensate the railroad company by the increased volume of rubber that would be exported by this route. However, this is problematical, as the freight rates of the railway are partly governed by other considerations besides the probable volume of freight that might be attracted through a reduction of tariffs.

According to the treaty of Petropolis, the railway was to be extended from opposite the terminus at Guajara-Mirim on the Mamore to Riberalta, a distance of 61 miles. Surveys were actually made and the roadbed completed for a considerable distance, but the work was then suspended and has never been resumed. The treaty provided for the construction of a bridge over the Mamore at Guajara-Mirim, but the cost would be prohibitive in view of the relatively small advantages that it would bring. Though the construction of this spur would enable rubber to be embarked in railway cars at Riberalta for Porto Velho, thus omitting the double handling now necessary at Cachuela Esperanza and Villa Murtinho, there is little interest in the project in Bolivia. A much smaller amount of money spent in opening a navigable channel at Cachuela Esperanza would give greater advantages to Bolivian shippers.

The realization of projects for railways from Cochabamba or La Paz to the low country of Bolivian Amazonia is probably too remote to be considered seriously in connection with the exportation of rubber. However, there are two such schemes, the first providing for the completion of the Yungas Railway from La Paz to the head of navigation on the Beni and the other the construction of a line from Cochabamba into Santa Cruz. The construction of the first is proceeding very slowly for lack of funds. The second is still in the project stage, and its terminus would, moreover, be too far from the center of the rubber industry to make it a practicable route for the exportation of rubber. By the Yungas route rubber could be landed in Arica in 12 to 15 days from Riberalta, or a little more than the actual traveling time between Riberalta and Para. However, it would have to pay freight rates required to raise it nearly 16,000 feet over the Andes.

TRANSPORT PROBLEM OF THE ABUNA ZONE

At present the entire production of the important Abuna zone, except for part of the output of the Rapirran and Chipamanu, goes out by the Madeira, some of the rubber from these two small rivers being carried overland to the Acre for shipment. In an effort to free themselves from dependence on the railroad a number of proprietors attempted a few years ago to restore navigation in the "cachoeira" section of the Madeira. Several launches with barges were put on the different navigable stretches of the river between the worst of the rapids, around which cargo was laboriously portaged, as before the building of the railroad. Unforeseen costs and the difficulty of administering such a cooperative enterprise early

[14] During 1923 the rate on "fine" rubber from Presidente Marques (Abuna) to Porto Velho, a distance of 137 miles, was 450 reis per kilo when the official quotation in Manaos for rubber was 5$000. This rate decreased by 8.4 or 9.4 reis for each drop of 100 reis in the official rubber quotation, until at a price of 1$500 for rubber the freight rate was 127 reis per kilo. For prices above 5$000 the freight was graduated at a rate proportionately higher.

caused its failure. However, at the time the field party was in the Abuna the reestablishment of this service was being discussed by the leading rubber shippers.

A more feasible solution of the transportation problem of the Abuna would be the opening of improved connections overland to the Acre River. This could either follow the present route of the pack road from the rubber barracon of Sao Luis to Nova Olinda on the Acre or leave the Abuna at some other convenient point. Sao Luis is about 225 miles from the mouth of the Abuna. The road to Nova Olinda is about 57 miles long and leads across a rolling country that offers few difficulties to road construction. This road is now used only by pack mules, but with the expenditure of $40,000 to $50,000 could be put in condition to permit the use of motor transport, either trucks or tractors. Another alternative is a Decauville railroad. An Italian engineer, who is director of public works of the Acre Territory, has surveyed the route for a railway line between the Abuna and the Acre Rivers. Nova Olinda is located about 20 miles below Rio Branco (the capital of the Acre Territory), and from either of these points there is launch navigation throughout the year and steamer navigation from November to May.

ITENEZ

The small production of the Itenez zone is nearly all shipped out by the Madeira. It was formerly sent overland a long distance to the Rio Paraguay for reshipment at Corumba, from where there is free navigation all the year to Buenos Aires. Though one or two producers still use this route, the Anglo-Bolivian Rubber Estates (Ltd.), whose headquarters are located at the distant village of Concepcion de Chiquitos, now send out their rubber to Para by the Itenez and the railway. The construction of the much-discussed road between Santa Cruz and the Paraguay at Puerto Suarez or the Laguna de Caiba might give a certain impulse to the rubber industry in the Velasco region, which is now stagnant because of difficulties of transportation.

OWNERSHIP OF LAND AND LAND LAWS

A discussion of the subject of land ownership may be prefaced by quoting from Bolivia: A Commercial and Industrial Handbook,[15] the section relating to concessions and titles of rubber lands, as follows:

> Bolivian legislation in regard to rubber lands is based on the Ley de Gomas of December 12, 1895, put into effect by decree of June 30, 1896, and modified in important respects by a series of subsequent laws. The law of 1895 fixed the "estrada" of 150 rubber trees as the unit of concessions of land, and authorized the delegate of the Territory of Colonias and the prefects of departments in which rubber trees existed to grant up to a maximum of 500 estradas to individuals and 1,000 estradas to legally constituted companies. The privilege of making larger grants was reserved to the National Congress. These provisions were not to affect the titles to properties already constituted which contained more than the maximum number of estradas permitted by the law. The concessionaires were to pay for each estrada 15 bolivianos in 15 yearly installments, though they might consolidate their title by paying the

[15] Special Agents Series No. 208, issued by the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

entire sum at once. All properties granted were to be surveyed and their limits clearly marked off.

The custom of measuring grants by "estradas" gave rise to such great abuses that a law of October 26, 1905, was issued declaring "the unit of measurement for all acquisitions is the hectare, the granting of lands by 'estradas' being prohibited henceforth." According to this law, any native of the Republic or foreigner capable of assuming the obligations of the civil law might acquire by purchase from the Government a maximum of 20,000 hectares (49,420 acres) at the price of 1 boliviano per hectare. A special act of Congress was required for grants of land exceeding 20,000 hectares. Those who were in possession of State lands to which they had not confirmed their titles were given a period of two years in which they might consolidate their rights to those properties in conformance with the requirements of this law. In the event of failure to satisfy the provisions of the law the lands in question were to revert to the State. This law was put into execution by a decree dated June 20, 1907. Purchasers of lands under this law were obligated to colonize the land at the rate of one family for each 1,000 hectares.

The further sale of public lands was suspended by a law of September 11, 1915, and those who had occupied public lands in accordance with the law of 1905 were allowed until the end of 1920 in which to perfect their titles. Further petitions for land were to be reserved for the exclusive consideration of the National Congress. A law of September 26, 1917, provided for a tax of one-half centavo per hectare on all lands secured under the provisions of these laws, the proceeds to go toward a fund for the construction of a railway from Cochabamba to Santa Cruz.

The relation between the estrada and hectare, which had been left undetermined by the law of 1905, was fixed at 75 hectares (185.3 acres) for each estrada by a law of November 8, 1917. All grantees of lands under the previous law who had not perfected their titles at this time were required to accept this proportion in determining the extent of their properties. In case the land actually occupied exceeded the maximum provided for in accordance with this ratio, the holder of the land might either renounce the excess or retain it by the payment of 20 centavos for each hectare of excess.

Practically all the rubber-bearing lands in Bolivia are now included in grants to which the titles have either been perfected or are the subject of negotiations with the Government.

INTERPRETATION OF DECREE OF NOVEMBER, 1917

The scope of the decree of November, 1917, was defined early in 1923 by a decision of the Supreme Court of the Republic in which it took occasion to interpret the two fundamental laws governing the cession of lands containing rubber trees. In the statements of the Government's case made by the Ministry of War and Colonization and by the Supreme Court it is emphasized throughout that concessions granted under these laws do not carry titles to land but to a stated number of estradas of rubber trees, the extent of land comprehended in each grant being strictly limited to the 75 hectares per estrada as provided by the law of 1917. The Minister of War and Colonization in a formal opinion dated January 2, 1923, declared as follows: "La propriedad es unicamente gomera y los titulos expedidos por las prefecturas y delegaciones no pueden ni deben referirse sino a los arboles gomeros."

Since the publication of the law of 1917 most of the concessionaires have taken steps to secure the "consolidation," or definite registration, of their concessions. However, at the beginning of 1923 there were still unconsolidated in the Territory of Colonias 83 concessions aggregating 11,332 estradas and covering 3,869,118 hectares (9,560,760 acres). For the excess of lands contained therein over the area permitted by the legal ratio of 75 hectares to one estrada, there is owed to the National Treasury a total of 618,140 bolivianos or

$200,000. It is probable that part of these lands will lapse to the State. At the beginning of 1923 a total of 66 concessions with an aggregate area of 5,327,493 hectares (13,164,470 acres) had been consolidated. In the region between the Beni, Madre de Dios, and Madidi Rivers 38 concessions still lacked the necessary surveys for securing definitive titles.

Although the requirements of the law as regards the proportion of estradas to hectares have been met in the majority of cases, the finality of some titles might be questioned on other grounds, especially on the fulfillment of the requirement regarding colonization of public-land concessions. The regulation which calls for the settlement of one family for each thousand hectares of land has not been complied with in many instances.

LIST OF PRINCIPAL RUBBER CONCESSIONS

A list of the principal concessions of rubber lands in the Territory of Colonias and the adjacent zone of the Department of El Beni follows. The location of the concessions is shown on the map of the Territory, figure 41, facing page 288.

Territory of Colonias

Acre:
1. San Miguel.
2. San Vicente.
3. Buenos Aires.
4. Espiritu Santo.
5. Santa Cruz.
6. Eco de los Andes.
7. Choqueyapu.
8. Gironda y Murillo.
9. Pacahuaras.
10. Bella Flor Nueva Paz.
11. Junin Bolivar.
12. Triunfo.
13. Gironda y Murillo.
14. Santa Lourdes.
15. Costa Rica.
16. Filadelphia.
17. Illampu.
18. El Carmen.

Orton and Abuna:
19. Buena Vista.
20. Rapirran.
21. Buen Jardin.
22. Montevideo.
23. Villa Rica.
24. Perpetuo Soccorro.
25. San Juan.
26. Nueva California.
27. Mamu and Quita Calzon.
28. Tacna.
29. Arica.
30. Saucini, Muyurina, Calacala.
31. Ingavi.
32. Diana.
33. America.
34. Concepcion.
35. Magallanes.

Orton and Abuna—Continued.
36. Tarasconia.
37. El Marco.
38. Gran Cruz.
39. Nueva Suiza.
40. Cachuela Esperanza.
41. Perseverancia.
42. Pando y Revolucion.
43. Campero.
44. Montezuma.
45. La Lorena.
46. Orton Segundo Grupo.
47. Nuevo Mundo.
48. Palestina.
49. Abuna Chico.
50. Santa Rosa.
51. Puerto Rico.

Madre de Dios:
52. Valparaiso.
53. Alto y Bajo San Pablo.
54. San Miguel.
55. Genechiquia.
56. Maravillas.
57. Victoria.
58. Purgatorio.
59. Conquista.
60. Medio Rio.
61. Peninsula.
62. Contra Avaricia.
63. Florencia.
64. Camacho.

Beni:
65. Agua Dulce Victoria.
66. Alto y Bajo San Pablo.
67. Portachuelo.
68. Rosario.
69. Santa Elena y Bella Brisa.

Beni—Continued.
70. Exaltacion.
71. Capacabana.
72. Mamorebey y Biata.
73. Blanca Flor.
74. San Lorenzo.
75. Ethea.
76. Vitumbo.
77. Fortaleza.
78. Maco.
79. San Antonio.
80. Todos Santos.
81. Ballivan.
82. Sena y Canada.
83. Triunfo.
84. Constanza y Esperanza.
85. Madidi.
86. Guarayos.
87. Causeco.
88. Granada.
89. Cuba.

Beni—Continued.
90. Amberes.
91. Santa Cruz.
92. Cochabamba.
93. Asuncion.
94. Suiza.
95. Potosi.
96. Tarija.
97. La Paz.
98. Chuquisaca.
99. Oruro.
100. Evangelina.
101. Isabel.
102. Julia.
103. San Roque.
104. Ramona.
105. Carmen.
106. Talisman.
107. Bengala.
108. Venus.
109. Regada.

Department of El Beni

110. Cachuela Esperanza.
111. El Yata.
112. Orton Tercera Grupo.
113. El Prado.
114. Ivon.
115. Portachuelo.
116. Genesguaya.
117. Genesguaya.
118. Concepcion y Genesguaya.
119. San Miguel.
120. Mamorebey y Biata.
121. Jenejoya.
122. Esperanza.
123. California.
124. Carnavales.
125. San Juan.
126. Los Angeles.
127. Natividad.
128. Carmen Alto.

There are many smaller and less important properties not included in the list.

RESERVATIONS

There have been reserved for purposes of colonization 227,400 hectares (561,900 acres) in the zone comprehended between the Negro, Abuna, and Madeira Rivers. This is a district rich in rubber trees. The Government has also reserved for agricultural settlement the following areas adjacent to the principal river ports:

Reservations	Hectares	Acres
Porvenir (Rio Tahuamanu)	7,854	19,408
Puerto Rico (Rio Orton)	7,854	19,408
Heath (Rio Madre de Dios)	5,105	12,615
Cobija (Rio Acre)	3,075	7,598
Bolpebra (Rio Acre)	158	390
Santa Rosa (Rio Abuna)	4,581	11,320
Fortaleza (Rio Abuna)	1,140	2,832
Manoa (Rio Abuna)	1,283	3,170

EXPORT DUTIES

By decree of January 21, 1924, export duties on Bolivian rubber have been increased. This replaces the law of November 18, 1913. The following table compares the rates of duty under the two laws:

TABLE 59.—BOLIVIAN EXPORT DUTY ON RUBBER, LAWS OF NOVEMBER 18, 1913, AND JANUARY 21, 1924

Quotation	Former duty, per kilo (ad valorem)	Present duty, per kilo (ad valorem)	Quotation	Former duty, per kilo (ad valorem)	Present duty, per kilo (ad valorem)
	Per cent	*Per cent*		*Per cent*	*Per cent*
Not exceeding 15d	Free.	2	From 36d. to 40d	4	9
From 16d. to 20d	Free.	3	From 37d. to 40d	4	10
From 21d. to 25d	Free.	6	From 41d. to 45d	4	12
From 26d. to 30d	2	7	From 46d. to 50d	4	
From 31d. to 35d		8	From 46d. to 48d	6	
From 31d. to 36d	2		49d. upward		

The official value of fine rubber is fixed at 70 per cent of the London value, which is reported semimonthly by the Bolivian consul in London. A further reduction of 30 per cent is made for the "common" grades, that is, sernamby and Mollendo.

Thus, if rubber is the equivalent of 15d. ($0.304 U. S. at par) or less, 70 per cent of this, or $0.213 per pound, is taken as the fixed valuation in Bolivia for fine, and less 30 per cent of this, or $0.149, for common. At 2 per cent this would amount to $0.00426 and $0.00298 per pound, respectively.

9. PERU—ECUADOR—COLOMBIA

LOCATION AND AREA

Region 9 comprises the upper and non-Brazilian part of the Amazon Basin, excluding also Bolivian Amazonia. It extends from approximately 3° north latitude to 13° south latitude, and is roughly bounded on the west side by the line which marks the highest limit at which Hevea is found. This altitude is generally 1,500 to 2,000 feet, but is reported in some places to reach 5,000 feet.

The territory under discussion lies within the Republics of Peru, Ecuador, and Colombia, and may be divided into three sections. The first of these comprises the upper basin of the Rio Negro, or the confluents Guainia and Uaupes, and the valleys of the Caqueta and Putumayo. The Guainia and Uaupes lie within the boundaries of Colombia, but part of the drainage basin of the Caqueta and more especially the Putumayo is claimed by both Colombia and Peru. The second area covered by this report comprehends the basin of the Maranon, as the Amazon is generally known after entering Peru. It includes the territory immediately tributary to the main river, the basin of such north-bank tributaries as the Napo, Tigre, Pastasa, and Morona, and the great southern affluents, Ucayali and Huallaga. The Peruvian side of the Javary, or Yavary, may also be included in this area. The left-bank rivers listed above lie

within the area claimed by both Peru and Ecuador. The third and southernmost section comprises the Peruvian territory about the headwaters of the Jurua, Purus, and Madre de Dios, including the upper reaches of the Acre River, which finds its outlet through the Purus.

For the purposes of this survey detailed consideration will be given only to the second of these areas; that is, to the country contiguous to the Amazon-Maranon and the lower courses of its tribu-

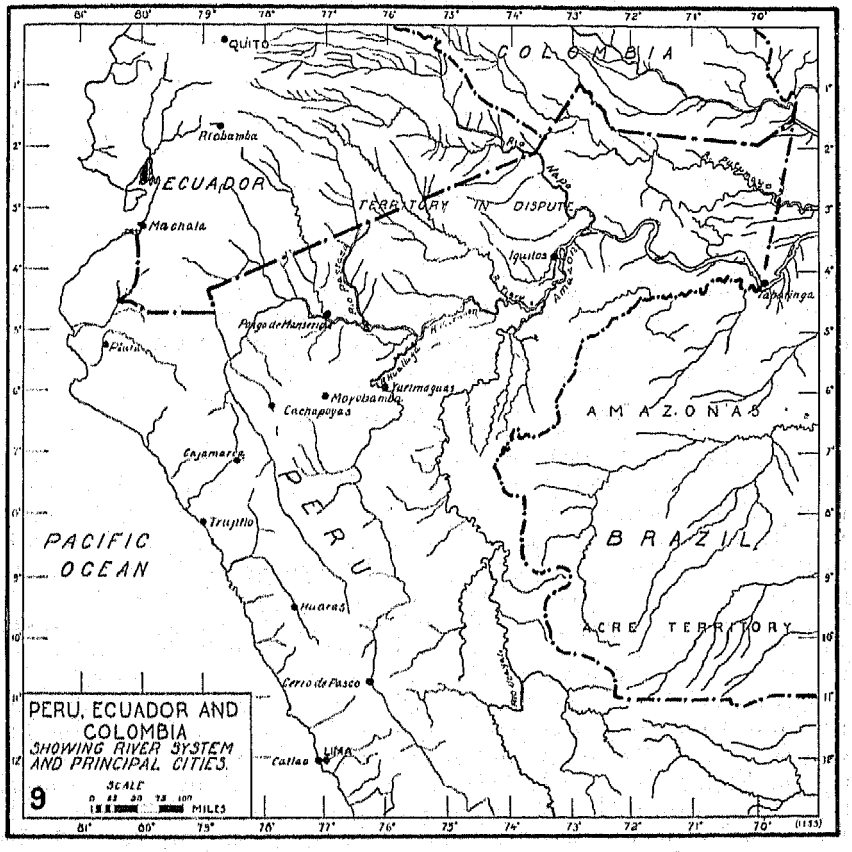


FIG. 45

taries. With this must be included the Putumayo region, which is known to share most of the same natural conditions. The extreme northern and southern sections must be eliminated for the present as impracticable by reason of their inaccessibility, and they are discussed briefly herein merely to give greater completeness to the treatment of the area comprehended in Region 9. These include the Colombian section of the Rio Negro Basin, the valley of the Caqueta, and, in the south, the upper basins of the Jurua, Purus, and Madre de Dios, where rubber can be worked profitably only under the most favorable conditions of price.

SECTIONS VISITED BY FIELD PARTY

The territory actually examined by the field party comprised (1) the lands bordering the Amazon-Maranon from the Brazilian border through the Pongo de Manseriche to the mouth of the Rio Santiago; (2) the Huallaga to about half a day above Yurimaguas; (3) the country between the Huallaga and the Ucayali in the basins of the Yanayaco and Chambira; and (4) the Ucayali from the mouth of the Pucacaro to the junction with the Maranon.

Information regarding areas which were not personally examined by the field party was obtained from persons in Iquitos and elsewhere who were familiar through actual experience with those regions. In this connection particular effort was made to obtain data on the Napo and the Putumayo, the two most important rivers not visited by the field party. With the information thus obtained it is believed that a fairly accurate estimate was secured of conditions as they exist in the valleys of those two rivers.

PHYSICAL FEATURES

The montana of eastern Peru differs little from the forest lands of its neighbors, Brazil and Bolivia. The Amazon Basin, especially along the axis of the main river, continues its monotonous uniformity to the very foothills of the Andes.

FLOOD PLAINS AND TIERRA FIRME

Along the rivers, until within a short distance of the mountains, the conditions are the same as in Brazil. The rivers occupy wide flood plains, in which they follow circuitous courses until they empty into other streams; and these larger streams follow the same rule until all become merged in the Amazon. Along the lower stretches of all the important rivers there is much swampy land; but at certain places, as in other parts of the valley, the rivers may flow along the extreme edge of their drainage basins, and in such places there is more or less high land to be seen.

Between the outer margins of the river valleys there exist the high lands not subject to inundation and which are known in this area as tierras altas or simply as tierra firme. Some of these areas are fairly level to gently rolling; others are cut by small watercourses into hills of low elevation and rather steep sides. Such lands might be considered too hilly for rubber planting, in view of the large amount of level land available in other sections, but thousands of acres of rubber are planted on more hilly land in Ceylon and the Federated Malay States.

LOMA LANDS

The general elevation of the land becomes higher as the mountain ranges are approached, and consequently the rivers empty themselves more quickly than in the lower part of the basin. A great deal of the valley land, therefore, is inundated only in times of extraordinarily high water, usually once in four or five years. Such areas, known locally as loma, make excellent agricultural lands, producing various crops, of which the most important now seems to be sugar cane.

They are, however, but narrow strips, and usually within 300 or 400 yards either a lagoon or a branch of the river is encountered or else a low, swampy area, and these conditions exist until the margin of the valley is reached. Such areas are, therefore, not adapted to rubber planting except on a very small scale, primarily because of their small lateral extent and the high water table on the swampy parts. Due to the periodic rise and fall of the water in the rivers, drainage of such areas would be difficult and ineffective for such a deep-rooted tree as Hevea.

The loma lands (corresponding to the restinga lands of Brazil) in the aggregate cover a large area in eastern Peru and, due to the natural fertilization of the occasional overflows, should in the future, when the country is made more accessible by railways, prove a source of great agricultural wealth in rice, beans, corn, mandioca, and general foodstuffs.

AMAZON RIVER

Below are given notes on the topography of the areas examined by the field party. To avoid confusion it should be borne in mind that the Peruvians give the name "Amazon" to the main stream from its junction with the Ucayali, and above that call it the Maranon; that is, on their maps the Amazon is formed by the Maranon and the Ucayali. One the Brazilian maps the "Amazon" begins at the mouth of the Rio Negro; between that point and the Peruvian border it is called the Solimoes. In this regional report the Peruvian nomenclature is used.

In the rivers examined by the field party the fall is too low to permit the generation of electric power. One exception to this might be the Pongo de Manseriche, where the Maranon is restricted to a narrow gorge, in places not over 150 feet wide, between precipitous rock walls. However, as this is an unsettled, practically unexplored area, with no towns near by to which power might be economically transmitted, its utilization lies a long way in the future.

From the Peruvian border to Iquitos, a distance of 286 miles, most of the land in sight along the Amazon is low valley subject to inundation. At several points, however, high land well above possible inundation was observed, the most noticeable being at San Francisco, Chimboto, San Pablo, Libertad, San Tomas, and Pebas.

A few hours east of Iquitos there is a long stretch of tierra firme. At San Pablo, which is approximately half way from Iquitos to the border, on the south side, there is a large area of high, well-drained land which extends inland toward the Javary for many miles. This land is rolling, being made up of low hills (more or less 50 feet high) and narrow valleys.

MARANON RIVER

The first stretch of upland above Iquitos was observed near the establishment Factoria Puritania, 63 miles from Iquitos. High land is in sight on both banks for a considerable distance before reaching this point and many habitations were noticed. At Puritania the land is gently undulating and extends to the north for a considerable distance, according to local information.

Hacienda Payorate.—This place, on the north side of the river, opposite the mouth of the Ucayali (80 miles from Iquitos), is on valley land. The tierra firme is about 1½ miles from the river. The water level on the loma land is only 4 or 5 feet below the surface of the ground. The uplands are rather hilly in character.

Nauta.—Eight or ten miles above Payorate is the village of Nauta. Between the two places the land is all high—well above inundation—though too hilly for rubber. The land around Nauta is very hilly, but according to local information becomes swampy a short distance to the north. From this place up the river for several days' travel no tierra firme of any consequence is to be seen. The loma, or alluvial, land, however, gradually rises and should be good agricultural land. At Pardinai a considerable area has been cleared. The manager of the property said that in his 14 years' experience the land had never been flooded; the highest the water had come was within 18 inches of the top of the banks.

Bristol and San Lorenzo.—These two places, located close together on the north side of the Maranon, are 25 or 30 feet above high water. The banks are red in color, and the land as far as could be seen rather level. The proprietor at San Lorenzo said that inland the surface was slightly broken and rolling, and that the topography on the south side of the river here, within a mile of the bank, was of the same general character.

Aripau.—This is a short distance above the last-named two places, but on the south side of the river. For 1 or 2 miles there are high, steep bluffs, more or less 30 feet above the water. The land as seen from the river has much the appearance of that of the Acre. The captain of our steamer stated that land of the same character extended inland all the way to Yurimaguas on the Huallaga River.

Barranca.—This village is located on a high bluff overlooking the river. The land is hilly, but not too much for rubber planting. This is the last point at which high lands are adjacent to the river until near the Pongo de Manseriche, where the Maranon comes through the last range of the Andes.

Puerto Limon.—This is the limit of navigation for small steamers and is one of the suggested termini for a railroad proposed to be built from the west coast. It is located on high loma land which is not subject to inundation. The real tierra firme is half a day's journey inland.

Pongo de Manseriche.—This region has little interest from the standpoint of rubber planting at this time, due to its isolated position and the hilly character of the land. On the north bank a few miles from the river a low range of hills projects into the plain. The Pongo de Manseriche is 509 miles from Iquitos.

HUALLAGA RIVER

The lands close to the Huallaga River along its lower course are level and while subject to overflow are fairly well settled, with many small fields in cultivation. The valley is very wide, and no high land of any considerable extent is noticed until La Laguna is reached.

La Laguna.—This small village is located on the right side of the Huallaga, and tierra firme extends up and down the river for a

considerable distance. In the interior the land is level for about 10 miles, when the lowlands of the Rio Samiria are reached. This latter is a small stream which flows between the Huallaga and the Ucayali and empties into the Maranon. This upland, which is well above high water, extends to beyond Yurimaguas, the largest town along this stretch of the Huallaga.

Providencia and Santa Maria.—The tierra firme mentioned above approaches the river edge along these places on the east side and is also noticed on the west bank. It is high, well drained, and rolling.

Oromina.—This hacienda, located a few miles below Yurimaguas, is situated on nearly level tierra firme, and the owner of the property said land of the same character existed for many miles to the east, or toward the Ucayali River.

Yurimaguas.—This town, located on the west side of the Huallaga River, is 138 miles from the mouth of the river and 350 miles from Iquitos. The immediate vicinity is much broken, the hills being from 100 to 150 feet in height and formed by small creeks and ravines. It resembles somewhat the country around Cobija in Bolivia but is more hilly.

About 80 miles above Yurimaguas the Huallaga emerges into the Amazon plain through a gorge in the Cordillera Oriental, the most eastern range of the Andes.

Area between Huallaga and Ucayali Rivers.—The field party ascended the Huallaga about 40 miles above Yurimaguas to the mouth of the Yanayaco. This was ascended two days in canoes, followed by three days of walking overland, and then three days on foot and by canoe to reach the Ucayali. The distance is estimated to be about 100 miles.

All this distance the land is above inundation, except marginal strips along the small rivers and a strip of 6 or 8 miles along the Ucayali and its arm, the Rio Pacaya. On the Huallaga side the land for the first 10 or 15 miles is rather level and low, but except possibly in unusually high rises is not inundated and then only in spots. Beyond that the land becomes more hilly, being cut by small ravines, and some of the hillsides are too steep for rubber planting.

LOWER UCAYALI RIVER

From Saman, the point near which the field party emerged on the Ucayali (455 miles from Iquitos), to the mouth of the river practically all of the country is low and subject to inundation. At a few places tierra firme is in evidence. On the east side at Requena (178 miles from Iquitos) high land is seen along the river for some distance. It is, however, very hilly, and this same characteristic is said to mark the land clear to the Javary River.

From what has been stated it can be seen that there exists in the triangle between the Huallaga and the Ucayali and within a short distance of Iquitos a rather large body of high land above any possibility of inundation. The area is intersected by many small streams, some of which are navigable by launches. We have no means of estimating its total area. Victor Solaini, the representative of the Peruvian Government, said he calculated it at 3,000,000 acres, but only an extended survey could determine this with exactness.

Area between Maranon and Huallaga Rivers.—It appears also that in the triangle formed by the Huallaga and Maranon Rivers there is a large area not subject to inundation. Near Yurimaguas for 5 or 6 miles the land is very hilly, but after that it is claimed to be level and undulating. An American engineer who has lived in this region for 30 years stated that he had been over much of it, and that in the vicinity of Jeveros, about half way between the two rivers, the lands are good for agricultural purposes, the best he knew in the immediate vicinity. Mr. Solaini calculated this area at 5,000,000 acres.

The hill towns of Lamas and Tarapoto, both of which are said to enjoy a very fine climate, are easily accessible from this region by way of Balsapuerta, thus affording places where those in need of temporary relief from the climate of the lowlands might find an invigorating change. Moreover, in the event of the construction of a railway between the lower Huallaga or the upper Maranon and the Pacific this region would be admirably situated in the matter of transportation.

UPPER UCAYALI RIVER

The consensus of opinion in Iquitos is that the best lands in the montana section of Peru, for both rubber planting and general agriculture, are on the upper Ucayali. Unfortunately lack of time prevented the field party from visiting this region.

The area lies along the Pachitea and upper Ucayali as far as the junction of the Tambo and the Urubamba (which form the Ucayali), and the extreme southern end is embraced in the area known as the Gran Pajonal. It is reported to be a very healthful district, there being few mosquitoes or insect pests, and not unsuited to settlement by Europeans. The land is said to be rather level, becoming hilly and broken on its eastern extremity near the foothills of the mountains. It is heavily forested, and good estradas of "weak" rubber are reputed to exist and to have been worked in years past. Efforts have been made to colonize parts of it, with poor results, owing not only to bad management but also to the district's isolation and lack of marketing facilities. The land produces good cotton, coffee, rice, corn, beans, and general tropical agricultural products.

Unfortunately its remote and isolated position at present does not render it attractive from the standpoint of large-scale rubber planting, but all reliable accounts are to the effect that topographically and meteorologically conditions are excellent for that purpose, and the district has, besides, the advantage of being close to the mountains, with their cool climate, to which Europeans could resort periodically for recuperation.

ELEVATION

Elevations can be given only approximately. In the list below the towns of Moyobamba, Tarapoto, and Lamas are without the main Amazon Basin, being located in the valleys formed by the last ranges of the mountains. They are important centers for the cultivation of cotton, tobacco, sugar, and other agricultural products, and their commercial relations are entirely with Iquitos. Elevations are given under the names of the authorities from which they have been taken:

TABLE 60.—ELEVATION OF PRINCIPAL TOWNS

Towns	James Orton	Ministerio de Fomento[1]	F. A. Mitchell	Juan Pablo Quine[2]
	Feet	*Feet*	*Feet*	*Feet*
Iquitos	295	347	383	
Yurimaguas		597	597	
Tarapoto		1,227	1,397	1,227
Lamas			2,532	2,739
Moyobamba		2,821		
Shapaja				882

[1] Extracto Estadistico por 1918. Ministerio de Fomento, Lima, 1919.
[2] Del Pacifico a la Montana, Juan Pablo Quine, Iquitos, 1918.

Shapaja, a proposed terminus for a railroad, is on the Huallaga River, 112 miles above Yurimaguas and 18 miles from Tarapoto.

Dr. Harry Bassler, an American engineer, uses as a base Iquitos, 100 meters (328 feet), and gives other localities as follows: Mouth of the Ucayali River, 344 feet; Requena, 360; upper end of Puinahua Canal, 410; Orellana, 449; Cantamana, 478; mouth of Utoquinea River, 492; mouth of Pachitea River, 551.

From the above it will be seen that the regions centering about Iquitos and the lower stretches of the rivers, although more than 2,000 miles from the Atlantic Ocean, have relatively very low altitudes. Elevations do not exceed 600 feet until close to the mountains.

CLIMATE

It was not possible to obtain meteorological records over consecutive years in Iquitos. The information given below is taken from various sources and is of a fragmentary character, but will give a fairly good idea of climatic conditions in Region 9.

TEMPERATURE

Except in the upper rivers, with their higher altitude, we were not able to note any difference in the daytime temperature from other sections of the Amazon Valley. The action of the sun seemed more intense at times than lower down the Amazon, but the nights were delightfully cool, and, on the rivers especially, heavier covering was required at times for comfort.

Dr. George W. Converse, an American physician employed by the Government in 1913 in sanitary work in Iquitos, makes the following statement in his report to the director of the Public Health Service for that year:

> In general the temperature of Iquitos is 86° for the day and 71.6° for the night.
>
> From March 9, 1913, to December 31, 1913, the rainfall was 94 inches for the nine and one-half months, or at the rate of 119 inches per year. It rained 182 days out of 305, or 60 per cent of the days were rainy.

The alcalde (mayor) of Iquitos, Engineer Samuel Young, in a note to the field party gave the following data:

> Maximum temperature, 100.4° F.; minimum temperature, 62.6°; ordinary temperature, 80°.

Neither do we have anything concrete relative to the rainfall in each month of the year. We can only say that the time of heaviest rainfall is from October to April, although at times 15 days in January and February may pass without rain.

James Orton, one of the first Americans to make extended studies in this part of South America, in his book, The Andes and the Amazon, gives the following abstract of a register of weather kept in Iquitos for the months named in 1871:

TABLE 61.—METEOROLOGICAL DATA, IQUITOS, 1871

	April	May	June	July	August	September	October
Average of thermometer ° F.	79.1	78.9	78.4	76.8	78.9	79.1	80.0
Average of wet bulb per cent	76.7	75.9	75.2	73.4	74.4	75.8	75.2
Direction of winds	NE.	NE.	NE.	S. and E.	N.	NW.	NW.
Direction of storms	N.	NE.	NE.	SE.	SE.	SE.	NE.
Highest day average of thermometer ° F.	81.5	82.2	82.5	82.5	82.9	85.2	83.6
Highest record average of thermometer do	84.7	86.3	84.9	85.1	86.7	90.3	87.8
Lowest record average of thermometer do	74.4	72.8	70.1	65.8	67.2	70.5	74.8
Rainy days number	17	13	16	11	10	8	14
Rainfall inches			3.1	4.3	3.9	9.3	7.6

The following data were furnished for Iquitos by Booth & Co. and for Yurimaguas by Mr. Mitchell from personal records. The figures represent averages.

TABLE 62.—MONTHLY MEAN TEMPERATURE, IQUITOS AND YURIMAGUAS

Months	Iquitos [1]			Yurimaguas, 1917		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
	° F.	° F.	° F.	° F.	° F.	° F.
January	78.0	71.9	75.0	86.0	70.5	80.0
February	75.9	69.8	72.8	85.1	75.2	80.6
March	75.2	71.2	73.2	83.4	73.5	78.9
April	74.3	70.8	72.8	84.2	73.9	79.5
May	74.1	71.6	72.8	82.4	69.9	77.1
June	73.7	68.7	71.2	83.4	72.3	78.8
July	74.1	66.9	70.5	83.6	70.1	77.3
August	74.1	66.5	70.3	85.8	71.6	79.1
September	74.1	69.8	71.9	87.2	72.5	80.2
October	74.8	70.5	72.6	84.7	74.3	80.0
November	75.0	70.8	73.4	84.2	75.0	80.4
December	75.5	71.2	73.4	84.9	71.7	78.9

[1] Date not stated.

While these figures may not possess a high degree of accuracy, they have their use in giving a fairly good idea of the average temperature.

RAINFALL

It would appear from what information we could gather that this area has a heavier and better-distributed rainfall than the lower Amazon country. People in Iquitos and in the country stated that it usually rains every month; that it was a rare occurrence for a month to pass without rain. This must be taken with some reserva-

tion, since it is well known that this section is a very good cotton-producing country and cotton growing requires some months of dry weather.

During the rainy season (at the same time augmented by the melting snows of the mountains) the rivers rise and in the dry season fall. However, due to a smaller drainage basin and a higher elevation, the rivers discharge their flood waters more quickly, and there is not so much damage done as in the lower Amazon. During the floods a large area of lowland along the rivers and inland lakes is inundated, but as the higher stretches of the rivers are approached an increasing amount of valley land is encountered which is not covered except in the very highest floods. The seasonal rains occur most frequently in the afternoon and night. At times rain may fall uninterruptedly for several days.

The rainfall for the season 1923–24 was very erratic, not only in Peru but in the lower Amazon as well. On the overland trip (see p. 330) between the Huallaga and the Ucayali Rivers, taken in what is ordinarily the rainy season, we found ravines and small rivulets perfectly dry and even fair-sized streams with very little water. Brown and parched grass was observed in cleared spaces around houses. This matter was commented on many times by the inhabitants of the region, and we were informed that the main rivers were lower at that time (March) than they had been for many years.

POPULATION

Even a relatively distant approximation to the true population of Region 9 is impossible; its boundaries are not strictly defined, and it does not correspond to any administrative division. Moreover, in the present state of development anything approaching a scientific census is out of the question.

The Department of Loreto, Peru, which is the most important administrative unit under consideration, was estimated by the Geographical Society of Lima in 1896 to have a population of 100,000. Since that time only arbitrary personal estimates have been made. The average of such estimates is probably about 60,000 for the entire department, exclusive of uncivilized Indians, whose numbers are given at 60,000 to 100,000. These estimates include the population of the territory disputed between Peru, Ecuador, and Colombia, whose extent is ill defined. Most of the white and mixed population is concentrated in a narrow belt along the Amazon-Maranon from Iquitos to the mouth of the Huallaga, along the Huallaga from its mouth to the vicinity of Chasuta, and in the zone bordering the Ucayali. The Tarapoto and Moyobamba districts of the Department of San Martin are also relatively well populated. The Indian population is densest in the region to the north of the main river.

To the south there are probably about 25,000 people in those parts of the Departments of Cuzco and Madre de Dios in which rubber is found.

The latest Ecuadorian statistics give the population of the Province of Oriente as 100,000. The most recent Colombian figures put the population of the districts of Caqueta, Putumayo, and Uaupes at, respectively, 74,254, 40,770, and 5,000, but these totals are un-

doubtedly in excess of the actual population of those sparsely settled regions.

It may be very roughly estimated that the total population of those parts of the three countries in which rubber is found or is capable of being grown is between 200,000 and 250,000.

CITY OF IQUITOS

Iquitos, capital of the vast Peruvian Department of Loreto and commercial center of eastern Peru, is situated on high land about 30 feet above flood level of the Amazon and at an altitude of 306 feet above sea level. It is distant 2,032 miles from Para, 286 miles from the Brazilian border, and 509 miles from the first ridges of the Andes at the Pongo de Manseriche.

It is the seat of the prefect or governor of the Department, of the subprefect of the Province of Bajo Amazonas, and of a superior court, and constitutes a municipality governed by an alcalde and council. A garrison, consisting of one full regiment, is stationed here. It is also the base of a small flotilla of river gunboats. There are British, Brazilian, and Colombian consuls, and honorary consuls representing the interests of several other nationalities.

The population of the city is around 10,000, but was considerably greater during the rubber boom. The town is surprisingly well built, some very substantial buildings dating from more prosperous times. Among these are several business houses and a hotel whose exterior is the most attractive in Peru. The two principal business streets are paved with brick for part of their length, but the rest are unpaved. There is no sewage or water system, and ditches running down the center of the streets are used for drainage. Drinking water is obtained from wells and springs. The town is lighted by electricity. There is a Decauville steam road for hauling freight and passengers the length of the city.

Among local industries are sawmills, brick and tile works, small cigarette factories, balata-washing plants, cotton gins, and an ice factory. The only bank is a branch of the Commercial Bank of Spanish America (Ltd.), which is affiliated with the Anglo-South American Bank. There is considerable interest in public education, and the city appears well supplied with schools. There are three daily newspapers.

OTHER TOWNS OF THE REGION

The other towns of the region are small places that serve as local distributing and collecting centers. Of these the most important is Yurimaguas on the Huallaga, with a population of about 2,500. Contamana, a village of about 600, is a place of some importance on the Ucayali.

Other towns over the first ranges from Yurimaguas and which have close commercial relations with Iquitos are Moyobamba, Tarapoto, and Lamas. The first of these is a place of considerable importance. Smaller towns, such as Nauta on the Maranon, which flourished in the days of the rubber boom, have lost most of their population and are now in complete decay. Many places that loom up in large type on maps of the region are only collections of a few houses.

LABOR

The ruling and directing class of this region is white Peruvian, Ecuadorian, or Colombian, or persons of these nationalities with a certain admixture of Indian blood. The mass of the population is mixed blood, with the Indian element predominating, at least outside the larger towns. There are also large numbers of "domesticated" Indians of varying degrees of civilization, engaged in agriculture or gathering balata, who constitute the chief labor force on the rivers to the north of the Amazon, such as the Napo and Putumayo. For example, on the Arana properties in the Putumayo zone there are over 10,000 such Indians, of whom 3,000 may be considered as actual or potential laborers.

A considerable number of still savage Indians remain in the remoter districts. These include such tribes as the Aguarunas and Wambizos in the upper Maranon country, the warlike Caschipos in the region of the Pachitea, and less important groups on some of the northern tributaries of the Maranon.

Many of the seringueros on the Peruvian side of the Javary and in the Peruvian part of the Jurua and Purus basins are Brazilians.

The foreign element in this area is entirely negligible, and is limited to a few European merchants in Iquitos, to the Chinese shopkeepers in the towns, to a handful of agricultural colonists on the Pachitea, and some Japanese in the upper Madre de Dios country.

POSSIBLE SOURCES OF ADDITIONAL LABOR

The recruiting of additional laborers for an enterprise of moderate size in eastern Peru does not offer a serious problem. The natural increase of the present population is extremely high, families being as a rule large and the rate of mortality by no means excessive. Also the valleys among the near-by foothills of the Andes could probably be drawn upon for a few thousand workmen. This includes not only localities like the Moyobamba district of the Department of San Martin and the Chachapoyas district of the Department of Amazonas but such remote places as the valley of Cajamarca. The completion of a railway between the eastern plains country and the Pacific would, of course, greatly facilitate the introduction of laborers from the mountain and coast regions. However, under present conditions it should not be difficult to obtain 4,000 or 5,000 laborers for a plantation undertaking.

The so-called savage Indians offer another possible source of labor. Tribes long considered intractable and even cannibalistic have not only permitted balata gatherers to work on their lands, but have in many cases engaged in the same work for white employers. With good treatment and proper consideration for his rights, the Indian of these regions is generally amenable to domestication and in spite of his inherent defects can be made a valuable laboring element. He is physically strong and capable of prolonged effort, but it requires considerable training before he is willing to work regularly day after day. His needs are few, and it is difficult to arouse in him the activity necessary to do more that satisfy these elementary wants.

IMMIGRANT LABOR

White immigration as material for the labor supply of a plantation enterprise would be highly impracticable and is wholly inadvisable. Even immigrants from countries where standards of living are very low would not be satisfied with the conditions of employment that would be necessary or with the general circumstances of life in these tropical regions. During the past few years one British and two American agricultural colonies in eastern Peru have ended in disaster.

Public sentiment in Peru is opposed to the importation of oriental labor. As the result of this feeling, the Peruvian Government, after allowing the entrance of considerable numbers, has passed an exclusion law against Chinese and Japanese. The agitation for this legislation grew out of the inability of the native Peruvian tradesmen to compete with the Chinese shopkeepers, who have almost monopolized retail business in the necessities of life. Nearly all these Chinese are Cantonese, who have preferred trading to agriculture. However, it is possible that the Government of Peru might permit the admission of Chinese coolies as plantation laborers and under certain restrictions as to residence. Here, as throughout the Amazon Valley, there is a widespread belief that the contact of any considerable numbers of Chinese would result in the deterioration of the native stock. However ill-founded such a feeling may be, it can not be ignored in considering the possibility of oriental labor.

QUALITY OF LABOR

Though generally of slight stature, the laborers of this region are as a class robust and muscular and capable of very considerable physical effort. As carriers the Peruvian Indians probably have no equal in South America, and as woodmen and rivermen they are famous throughout the Amazon Valley, in nearly all of which they are well known as gatherers of caucho. These latter qualities are also shared by the Ecuadorians and Colombians of the upper Napo, Putumayo, and other northern rivers.

As a laborer the Peruvian Indian, or cholo, is more docile and easily directed than the Brazilian caboclo. Much depends on the personal element in directing this class of labor, and any calculations of efficient management as applied to white labor or even to native labor of certain other races are likely to fall under the circumstances prevailing in these regions.

The Indian in particular stands in greater awe of the white, to whom he is capable of genuine attachment when humanely treated. He becomes rebellious or defiant only on extreme provocation and when his courage is fortified by strong liquor. However, if offended beyond endurance his tendency is to decamp quietly from the locality rather than resist. There would appear to be very little ill treatment of labor in these regions, and the stories of former "atrocities" are now greatly discounted by the calmer and more unprejudiced judgment of those who were actually familiar with conditions.

EFFECT OF HEREDITY

According to Temperate Zone standards the worker of these regions may be called indolent. However, his tendency to idle is only his heritage from the Indian's philosophy of the futility of any superfluous effort beyond what is necessary to supply his few elementary needs. Add to this the debilitating effects of hookworm and the climate, and his reluctance to do regular and rapid work is comprehensible. Yet when understandingly directed, these defects of the laborer of these regions can be largely overcome.

The Peruvian laborer is not so voluble as the Brazilian, his loquacity being in direct proportion to the percentage of white blood in him. However, his relative taciturnity is seldom associated with sullenness, and a smile can easily be won from him. He is not given to brawls, even when under the influence of the native cane rum, and crimes of violence are rarer than among the more high-strung Brazilian caboclo.

LITERACY AND LANGUAGE

Illiteracy is the rule among the rural inhabitants, in spite of the efforts of the Peruvian Government to establish schools wherever there is a small nucleus of population. The Peruvian of predominant Indian blood is probably inferior in intelligence to the quicker-witted Cearense type of laborer of Brazil. However, he is sufficiently intelligent for the satisfactory performance of whatever tasks might be required of him in connection with the work of a plantation. Moreover, with training he can be made a very good mechanic.

Spanish is the language of the upper class and is spoken by those of mixed blood as well. However, a knowledge of Quechua is almost universal except among the more isolated and distant Indian tribes and is widely spoken.

LIVING CONDITIONS

(*a*) *Housing.*—The type of dwelling used in the rubber country of Peru, Ecuador, and Colombia is similar to that of the Brazilian and Bolivian parts of the Amazon Valley. Houses are built in the same fashion and of the same materials. The most striking difference is the higher gable of the Peruvian house and the more frequent use of bamboo as material for walls. Materials for better constructions are supplied by cedro lumber sawed in local mills and by brick and tile made in Iquitos.

(*b*) *Food.*—The staple articles of food in these regions are bananas or plantains, yuca (mandioca), corn, rice, red beans, and dried fish. Papayas, oranges, and a large variety of other fruits are grown in considerable quantity. Nearly every house has a flock of chickens, but hogs are less common than in Brazil. Neither are fish or game as important articles of diet as in Brazil, though there would appear to be no lack of either in Peru. Small herds of cattle are found along the lower rivers, but the principal source of such beef as is consumed in the towns is large clearings on the upper Huallaga and, to a less extent, on the Ucayali and Maranon. Most of the rice eaten is brought down from the Napo. Sugar is produced

in a number of small local mills. Considerable quantities of good coffee are brought out from the Tarapoto district. Salt is found along the Huallaga, but the State monopoly in that article has prevented the utilization of these deposits for local needs. Except for certain imports from Brazil, Region 9 is now nearly self-sufficient in the matter of ordinary foodstuffs.

HEALTH AND SANITATION

Health conditions in the area investigated in Peru are undoubtedly better than in most of the Brazilian part of the Amazon Valley. In fact, with the exception of certain restricted localities, we were impressed by the general aspect of robustness of the population. Part of this is due to the heritage of good physique received from the Indian side of their ancestry and part of it can be accounted for by the circumstance that many of the inhabitants of the Department of Loreto originally came from the cooler and very healthful districts to the west. However, the climate of the lower lands is not in itself unhealthful, though sharing in the heat common to their tropical position. The nights are nearly always comfortably cool.

The total deaths registered in Iquitos during the 26-year period 1895–1920 amounted to 10,900. Of these 5,936 were outsiders, who had come to Iquitos from other points in the interior, usually ill at the time of their arrival. Of the total, 2,546 were infants less than a year old and 2,300 children between 1 and 7 years. On the basis of a population of 12,500 this represents an average death rate for the period of 33.84 per thousand.

Against these deaths must be credited 22,253 births for the same period, or an annual average of 68.64 per thousand on the basis of a population of 12,500. The balance in favor of births was 17,289.

DISEASES

To all outward appearance hookworm is not so prevalent as in Brazil, though it is widespread in some parts, and no measures have been taken to eradicate it.

Little malaria was observed or reported along the main rivers, but it exists in greater or less virulency on some of the smaller streams, as we had occasion to observe in a few malignant cases contracted in the interior. Probably no river in the Amazon Valley is more infested with mosquitoes than the lower Ucayali, where they make life almost unendurable for one not hardened to their incessant and voracious attacks, but these mosquitoes are fortunately of the culex and not of the anopheles variety. In the upper Ucayali there are said to be few mosquitoes, and they are not found in excessive numbers on the Maranon. Higher places like Moyobamba and Tarapoto are said to be comparatively free from insect plagues of any kind. In Iquitos between the years 1895 and 1911 the annual mortality from malaria ranged from 37 to 109, but for the years 1912–1920 the average was only 11.6.

Yellow fever, which was extinguished in Iquitos several years ago by an American sanitary commission, has not reappeared. In 1911

76 deaths were reported and in 1912 43 deaths. The last death from this cause occurred in 1915. This is also true of beriberi, which has apparently disappeared with more rational alimentation. However, intestinal and pulmonary diseases account for a considerable share of the deaths in Iquitos.

Leprosy occurs in several localities, but efforts are being made by the authorities to bring the lepers to Iquitos for isolation in a leprosarium located outside the city.

MEDICAL FACILITIES

There is nothing in this part of Peru comparable to the excellent service maintained in the Brazilian section of the Amazon Basin by the Prophylaxia Rural, a branch of the Federal Public Health Service. In fact, there are no authorities in Peru charged with regard for sanitary conditions, and whatever is done is accomplished by private initiative.

Certified physicians reside in Iquitos, but no hospital exists in the entire region. Clinics have been maintained at times by certain philanthropic associations in Iquitos, but these are not equipped to handle either surgical cases or serious illnesses.

Good drug stores are to be found in the city, and proprietary medicines are everywhere sold in considerable quantity. In the interior many empirical remedies are used, which are prepared from local plants.

VEGETATION

The territory examined by the field party is virgin forest, except those small areas which have been cleared for cultivation and for pasturage. The latter form, however, a very small proportion.

The large zone between the Huallaga and Ucayali Rivers, which appears on maps as the Pampas de Sacramento, is not a region of open plains, as might be assumed from the name, but is the usual virgin forest common to the whole area under study. In fact, the only district that was reported to us as approaching in character the campos regions of Brazil is the so-called Gran Pajonal of the Pachitea country. However, this land has been little explored.

In general the forests differ little in appearance from the Madeira or Acre forests. In a few cases fairly heavy jungle is met. On the uplands between the Huallaga and the Ucayali stretches of jungle were encountered, particularly along the ravines and lower slopes of the hills, which resemble the heaviest Malaya or Sumatra jungle, but such are small in extent.

TREES OF THE PERUVIAN FOREST

On the next page are listed the names of the principal trees observed. An attempt has been made to give also the corresponding Brazilian name and the probable scientific classification.[16]

[16] Too much reliance should not be placed on this comparison. The scientific names of Brazilian woods are better known than those of Peru, but very much work is necessary before a correct classification can be made.

Peruvian name	Brazilian name	Scientific name
Canela muena	Casca preciosa	Aniba canelilla.
Caoba-aguano		
Caprona	Pau mulatto	Calycophyllum spruceanum.
Cedro	Cedro	Cedrela spp.
Andiroba	Andiroba	Carapa guianensis.
Cordoncillo	Limaoruna	Chlorophora tinctoria.
Cumaseba		
Muena mala	Louro fetido	
Hoja santa	Abacaterana	
Quillo bordon	Pao marfim	Agonandra sp.
Muena negra	Louro chumbo	Nectandra sp.
Mauba	Mauhuba amarella	Acrodiclidium sp.
Pucuna caspi	Ucuuba preta	Virola sp.
Remo caspi	Carapanauba	
Itauba	Itauba	Silvia itauba.
Huito	Genipapo	Genipa americana.
Estornaque	Macacauba	Platymiscium sp.
Incira	Muirataua	Apuleia molaris.
Huacapu	Acaricuara	Minquartia guianensis.
Quinilla colorada	Massaranduba	Mimusops sp.
Quillo muena	Louro inamuhy	
Huimba-topo	Pau de balsa	Ochroma sp.
Louro puchury	Puchury	Nectandra puchury.
Guariuba	Guariuba	Clarisia racemosa.
Quinilla amarella	Caramury	
Marupa	Marupa	Simaruba amara.
Muena blanca	Louro tamanco	Ocotea guyanensis.
Palo de sangre	Muirapiranga	Brosimum paraense.
Lagarto caspi	Jacareuba	Calophyllum brasiliense.
Chonta quira	Acaourana	
Pijuayo caspi	Sapupira preta	Bowdichia sp.
Huacapurana	Acapurana	Campsiandra laurifolia.
Pucaquiro	Araruba	
Urco tangarana	Tachyzeiro preto	Tachigalia sp.
Pisho	Gomavel	Astronium lecointei.
Huacamayo caspi	Pau roxo	Peltogyne densiflora.
Yana muena	Macacauba	Platymiscium duckei.
Quinilla rosada	Maparajuba	Mimusops sp.
Muena amarilla	Louro rosa	
Muirapinima	Muirapinima	Piratinera guianensis.
Tahuary	Pao d'arco	Tecoma sp.

WILD RUBBER

To within comparatively recent times the collection of wild rubber was the main industry of the montana section. At present its production has greatly diminished and is now of only minor importance. Reminders of the boom days are to be seen in the many handsome edifices in Iquitos built from profits derived from wild rubber.

When it was realized that the profitable extraction of rubber was over (except possibly for some working under extraordinarily favorable conditions), the leading spirits of the country wisely adopted the policy of fostering new industries and exploiting other products indigenous to the area or adaptable to it. Much progress has been made in this direction, and the inhabitants are slowly making their economic recovery from the debacle which overwhelmed them. Judging from what was seen it may be said they are taking more advantage of exploiting and developing other natural resources than are their neighbors in Brazil.

CAUCHO AND HEVEA

The first rubber produced in Peru (caucho negro) was Castilla. Production began in a small way in 1882 and gradually increased, with the result that at the present time most of the Castilla trees have been destroyed. Some still exist, but in districts difficult of access or else inhabited by Indians more or less antagonistic to the encroachments of the rubber gatherers.

Hevea exists over a large area in eastern Peru and over a wide variation of terrain. Reliable information is to the effect that it occurs from the alluvial lands of the lower rivers to an elevation of 5,000 feet in the mountains, this latter having been observed in the area south of the Rio Madre de Dios near the Brazilian frontier. The rubber coming from Peru is classified in Iquitos in two general categories—jebe fina ("fine") and jebe debil ("weak fine"). The jebe fina, or the rubber commonly spoken of as "hard fine Para," is derived from the *Hevea brasiliensis* and jebe debil from another single species or a mixture of various species. The main source of jebe debil is the *Hevea guyanensis*, which seems to be the most widely distributed tree over the area. The different species are localized in their distribution; that is to say, "fine" rubber comes from certain localities and "weak" from others. It may happen that in the "fine" areas some trees producing "weak fine" are present, and vice versa.

DISTRIBUTION OF WILD RUBBER

The broad, general distribution of the rubber-bearing areas is as follows:

WEAK FINE

1. The area south of the Caqueta (or Japura) River to the Maranon-Amazon and the triangle between the Huallaga and Maranon. This includes practically all of the Department of Loreto north of the Amazon and Maranon. The rubber from the Putumayo region, marketed as "Putumayo block," is considered to be the same as the other rubber north of the Amazon.

2. In the area between the lower and upper Ucayali and west to the mountains. This extends from above 6° south latitude to near the junction of the Tambo and Urubamba Rivers, about 10° 30′ south latitude.

3. The Peruvian section of the Madre de Dios Basin.

FINE (HEVEA BRASILIENSIS)

4. The south half of the area between the Huallaga-Maranon and the lower Ucayali. This area extends from about 6° 30′ south latitude to the mouth of the Ucayali and embraces all the triangle near the junction of the Ucayali and Maranon.

5. The area between the Maranon and Javary, south of the above (4) district.

6. An irregular strip along the Javary south of the above (5) district and along the Peruvian boundary to the Madre de Dios River. This region, one of the largest areas in Peru containing *Hevea brasiliensis*, embraces the headwaters of the Jurua, Purus, and Madre de Dios, with their many small tributaries. In this area, therefore, rise three of the main rivers which are noted for their rubber production in the neighboring Republics of Brazil and Bolivia.

In the area south of the Amazon and Maranon Rivers, a "fine" rubber may be encountered in varying quantities in the areas indicated as "weak," but it is always in relatively small amounts.

SIZE AND CONDITION OF WILD TREES

There is no appreciable difference in the size and appearance of the Hevea in Peru and in the best rubber-producing districts of Brazil or Bolivia. Trees inspected which had been tapped in the past with the machadinho were badly mutilated and at the time of suspension of work must have been very poor producers. On the other hand, in the areas of the jebe debil, or guyanensis, where exploitation started late, many trees were observed which had been tapped very little and have been but slightly injured.

Since the gathering of rubber has been declining for some years and is now virtually suspended the older trees have had time to recuperate from the drastic treatment of the past and to renew their bark. Were conditions to arise whereby it would be profitable to tap such trees again the yields would undoubtedly be higher and more consistent than when tapping was stopped.

On the lower lands tapped trees of *Hevea brasiliensis* were measured which varied in girth from 4 feet to around 9 feet at 3 feet from the ground. The general average was about 6 feet. On the high and more broken land the average size of the trees was larger. Many trees were encountered which measured 10 and 11 feet in circumference and occasionally as much as 12 feet; none exceeding 12 feet were observed. The larger trees were usually near the lower ends of the hill slopes or near the ravines in the valleys between the hills.

The average size of the guyanensis seemed to be around 5 to 5½ feet at 3 feet from the ground.

AVERAGE PRODUCTION PER MAN AND PER ESTRADA

On the lowlands the gathering season, called arreacion, was six months. On the uplands the year was divided into two arreaciones of six months each.

The average estrada consisted of about 120 trees, and one man worked two estradas. The yields appeared to be very low—300 to 400 kilos (660 to 880 pounds) on the average for the whole year of two arreaciones. The region of the Javary, according to local information, is the best producing region, some estradas yielding from 8 to 10 frascos, equivalent roughly to 16 to 20 pounds, per tapping. The other regions were said to give only 3 to 4 frascos, or 6 to 8 pounds, per tapping.

One explanation offered for the low yields was that the seringuero had only two estradas, and these he tapped year after year. However, since the trees have now had several years' rest, they would probably yield as well as the average of the remainder of the Amazon Basin. With a rational system of tapping, using a specially constructed knife in place of the machadinho, the average production could be considerably increased with less damage to the tree.

COLLECTION AND PREPARATION

As stated above, the production of rubber in the area tributary to Iquitos has almost ceased. The larger properties have only a few men to keep the estradas open. These still produce a small amount of rubber, and in other cases some is produced in intervals between other work.

The methods of gathering the rubber, both the Hevea and the Castilla, are essentially the same as described on pages 22 and 23. In the case of the Heveas the machadinho is universally used, with the same disastrous results to the tree. In the case of caucho the tree is cut down and destroyed. The method of preparation of the rubber is likewise the same, except for Putumayo block.

MARKET GRADES

The different grades of rubber which came out of Peru in the past, and which are now produced only on an insignificant scale, are from the same species as are exploited in the rest of the Amazon Valley, namely, Hevea and Castilla. The classification by the buyers in Iquitos is:

Hevea:
- (*a*) Fine.
- (*b*) Entre fine (medium).
- (*c*) Weak fine.
- (*d*) Sernamby of fine (coarse).
- (*e*) Sernamby of weak fine (coarse).
- (*f*) Putumayo block.

Caucho (Castilla):
- (*a*) Slab (caucho muerto, or dead caucho).
- (*b*) Peruvian ball (caucho ball).

The "fine" produced in the region around the headwaters of the Purus, Madre de Dios, and Javary is considered to be on a par with the best rubber produced in the Amazon Valley. The difference in quality of the "fine" and "weak fine" is reflected in the prices they bring on the market. Thus for shipments from Iquitos for 1923 the average valuation per kilo for customhouse purposes was 1.025 soles for "fine" and 0.715 sol for "weak."

"Putumayo block" is a "weak fine" rubber produced by the Indians on the Putumayo River. The rubber is allowed to coagulate naturally, and then, together with the sernamby, or scrap, is washed in hot water and worked to remove bark, dirt, and impurities. It is then pressed into blocks and shipped in this form. The rubber is claimed to be about equal to thin brown plantation crêpe. According to a report made by Frederick J. Maywald, consulting chemist, in 1921, the following were some of its properties:

Shrinkage, 29 per cent.
Washed and dried rubber had an acetone extract of 2.05 per cent.
A standard compound cured for 75 minutes at 297° F. had a stretch of 1 to 9.3, a tensile strength of 1,430 pounds, and a permanent set of $\frac{1}{16}$ inch. Cured for 90 minutes at 297° F. it had a stretch of 1 to 9.5 inches and tensile strength of 1,915 pounds, and a permanent set of $\frac{1}{16}$ inch. Cured 105 minutes at 297° F. gave an overcure.

PRODUCTION

For Region 9 as for the other districts embraced in this survey no figures of actual production exist. Export records provide the only statistics available. However, as there is no local consumption, the movement of rubber through the port of Iquitos is a fair measure of the rubber production of the territory.

Exports of rubber (Hevea and caucho) via Iquitos, by grades during the years 1912–1923, and by river of origin during 1919 were as follows (quantities in metric tons of 2,204.6 pounds):

TABLE 63.—PRODUCTION (EXPORTS) OF HEVEA AND CAUCHO, REGION 9, 1912–1923 [1]

Years	Hevea						Caucho			Grand total
	Fine	Medium	Weak [2]	Coarse [3]	Putumayo block	Total	White and slab	Ball	Total	
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1912	1,210	18	269	248	145	1,890	49	988	1,037	2,927
1913	617	10	248	227	346	1,448	28	827	855	2,303
1914 [4]						932			605	1,537
1915 [4]						1,861			679	2,540
1916	597	46	308	209	453	1,613	14	425	439	2,052
1917	667	51	479	308	369	1,874	23	667	690	2,564
1918	361	13	251	101	231	957	11	320	331	1,288
1919	563	41	572	341	763	2,280	13	403	416	2,696
1920	237	9	213	108	109	676	7	335	342	1,018
1921	49	1	53	12	31	146		62	62	208
1922	102	2	102	36	110	352	1	151	152	504
1923	51	1	35	16	320	423	1	71	72	495

[1] Figures represent exports through the port of Iquitos, Peru.
[2] "Weak fine."
[3] Sernamby.
[4] Grade details not at hand for 1914 and 1915.

TABLE 64.—EXPORTS OF RUBBER THROUGH IQUITOS, BY RIVERS OF ORIGIN, 1919

Grades	Javary	Putumayo	Other	Total
	Tons	*Tons*	*Tons*	*Tons*
Fine	211		352	563
Medium	2		39	41
Weak	9	3	560	572
Sernamby:				
Fine	130		165	295
Weak		1	46	47
Caucho:				
White			4	4
Slabs			9	9
Balls	112	33	257	402
Putumayo block		763		763
Total	464	800	1,431	2,696

COST ESTIMATES

At the prices which have prevailed the past few years the Peruvian producer finds the business of extracting and preparing rubber unprofitable and has devoted his energies to other things.

Some of the factors which enter into the cost of production and make it impossible for the seringuero to produce cheaply are:

(*a*) Import taxes on primary necessities for his work.

(*b*) High freight rates on articles brought into the country.

(*c*) High expense of interior navigation on the rivers, which makes the articles of consumption for his sustenance during the season reach an exorbitant price. Therefore, at a low price he gets further in debt each year, and finally abandons the work.

(*d*) Low average yields.

Under present conditions it is considered that rubber will not be produced below a price for "fine" of 22 soles per arroba of 15 kilos, or approximately $0.17 U. S. per pound (at exchange of $0.25 to the sol), f. o. b. Iquitos.

The expense of shipment from Iquitos to New York is shown in the following copy of an account sales of a shipment of Putumayo block rubber in 1923:

Cost of shipment from Iquitos to New York, January, 1923

	Kilos, gross	Kilos, net
Shipping weight	55,787	48,322
Less 8 per cent. The produce was weighed and cased some months before shipment was effected. It was not reweighed on shipment, but an average shrinkage of 8 per cent was estimated, and shipping weights declared on this estimate	4,463	3,866
	51,324	44,456

16 cases, 7,839—1,093=6,746 pounds at $0.23	$1,551.58	
184 cases, 90,326—12,711=77,615 pounds at $0.225	17,463.38	
27 cases, 13,342—1,849=11,493 pounds at $0.215	2,471.00	
		$21,485.96
Expenses to New York:		
Ocean freight at $0.65 per cubic foot plus $0.82 per ton of 40 cubic feet	1,750.33	
Cartage	54.07	
Warehousage and labor charges	106.43	
War tax	1.50	
Customhouse charges	3.50	
Marine insurance from Iquitos to New York on $23,700 at ⅛ per cent	79.00	
War risk on $23,700 at 0.025 per cent	5.93	
Fire insurance	1.21	
Weighing and calculating shrinkage	204.30	
Brokerage, 1 per cent	214.86	
Interest	20.02	
Postage and minor charges	8.00	
Commission and guaranty charges, 2.5 per cent	537.15	
		2,986.30
		18,499.66

Expenses in Iquitos:	£	s.	d.	
Packing, casing, etc., and labor	113	5	0	
Warehousage (for Government)	5	1	32	
Manifests, Brazilian customs documents, consular invoice, stamps, customs, commission, etc	3	4	30	
Transport from warehouse to dock	15	3	97	
Total	137	4	59	
Equivalent at exchange of $4 to the pound sterling				549.86
Net proceeds				17,949.80

OTHER INDUSTRIES AND RESOURCES

AGRICULTURE

The principal agricultural products of the area are cotton, sugar cane, and tobacco.

FOODSTUFFS

Sugar cane is grown in several places and small mills exist which make crude and semirefined sugars. All is used for local consumption, none being exported. The mills make alcohol from the residues and waste liquors, which besides being used as a beverage is beginning to find a use as fuel in internal-combustion engines. No estimate is available as to the area planted in sugar cane, but it is small and of minor consequence.

Tobacco is produced in a few places, Tarapoto within the mountains being the largest producer. This tobacco finds a ready sale all over the eastern part of Peru and is shipped to the west coast of Peru via the Amazon and Panama Canal.

Other crops, such as rice, corn, coffee, beans, mandioca, and general food crops, yield well, but they are grown for local consumption mainly and no record as to acreage is available. In the last few years small quantities of some of these, particularly beans, have been shipped to Brazil.

COTTON

Cotton has taken the place of rubber as an economic resource, and due to good yields and prices the past few years it has been the main crop in holding up the economic structure of the region. It is stated there were 10,000 acres of cotton under cultivation in 1923; in 1924 an increase of 40 per cent in planting was anticipated. The main centers of production are the upper Huallaga and Ucayali Rivers, with some in the lower Ucayali and small amounts in other scattered places.

The variety most in favor in this locality is the "rinon," a native long-staple cotton, which is found in its wild state on the Putumayo. Iquitos cotton is classified on the markets as semirough, and in February, 1924, was quoted in Liverpool at about 20d. a pound; in January, 1924, lots were sold in New York which realized $0.35¾ a pound. The cotton is ginned in Iquitos on saw gins, being brought down on rafts and in steamers. The average production per acre is given as around 340 pounds of lint cotton.

The seed is shipped to the Continent and England. A project is on foot for the erection of a cottonseed-oil mill at Iquitos to handle this product there.

OILSEEDS AND NUTS

The forests of Peru possess many trees, vines, and palms which produce articles of present or future commercial value. The most characteristic tree along the river banks and islands is the Cecropia (imbauba) and in the upper reaches the pau mulatto (*Calycophyllum spruceanum*), with a large sprinkling of Sapium and the kapok-producing tree (Ceiba), called here huimba. The Brazil-nut tree was not seen in eastern Peru. In a way its place is taken commercially by the palm called yarina or tagua (Phytelephas), which produces the tagua nut or vegetable ivory from which buttons and like articles are made. Some of the other more important are:

Peruvian name [1]	Brazilian name [1]	Scientific name
OIL-BEARING PALMS		
Huicungo	Murumuru	Astrocaryum murumuru.
Chapaja	Urucuri	Attalea excelsa.
Inchaui	Inaja	Maximiliana regia.
Chambira	Tucuma	Astrocaryum sp.
Huiririma	Jauary	Astrocaryum jauary.
Hunguragua	Pataua	Oenocarpus pataua.
Nhegiba	Maraja	Bactris maraja.
Cinami	Bacaba	Oenocarpus bacaba.
Aguaje	Mirity	Mauritia flexuosa.
Catirina	Curuana	Attalea monocarpa.
Pijuayo	Pupunha	Guilielma speciosa.
Uasahy	Assahy	Euterpe sp.
Conta	Babassu	Orbignia speciosa.
Shebon	Curua-assu	Attalea sp.
OIL-BEARING NUTS OF TREES AND VINES		
Cumala	Ucuuba	Virola spp.
Andiroba	Andiroba	Carapa guianensis.
Cacaoillo	Jaboty	Erisma sp.
Avilla	Fel de paca	
Macambo		

[1] See footnote No. 16, p. 343.

FIBERS

Besides cotton, which is indigenous, the forests of eastern Peru contain many fiber-yielding plants, palms, and trees which have present or potential commercial applications. Some of the most important of these, with their sources and uses, are listed below:

Chambira (Brazilian name, tucuma).—A strong fiber from the leaves of the chambira palm. Used for making cords, ropes, hammocks, and clothing.

Caballo uso (Brazilian name, malva).—Made from the bark of a shrub (*Malva spicata*). A strong fiber for making cords and ropes, and could be used in place of jute.

Penca or cabuya (family of Bromeliaceae).—A sisal, not indigenous, but planted extensively. Used for making ropes.

Buena Maria (Brazilian name, matamata).—A fiber from the rough bark of a tree (fam. Lecythidaceae). Used for making cords, ropes, and such products.

Icaja blanca (Brazilian name, marmarana).—A rough fiber from the bark of a tree. Used in making ropes.

Torourco (Brazilian name, piry-piry grande).—A fiber from a small sedge. Used for making brushes for painting, whitewashing, calcimining, etc.

Yana huasca.—A fiber from a tree of the same name. Used for making cords and rope.

Anallo caspi.—A fiber from a large tree bearing this name. Good for cords and rope.

Ava huma (Brazilian name, castanha de macaco).—From the bark of a tree (*Couroupita guianensis*). Used for making cords and rope.

Espitana.—A rough fiber from the bark of a tree of this name. Used for rope, etc.

Piassava.—Derived from the palm piassava (*Leopoldinia piassava*). Used for making brushes, brooms, and ropes, and cables in marine work.

Llanchana.—The inside bark of a large tree of this name. Is a very strong, silky, soft fiber. Used by the Indians to make clothes and blankets. Could be used to make cords and sacks.

Bombomaje (Brazilian name, jipijapa).—This is the so-called panama-hat palm (*Carludovica palmata*). The fibers are used in making fine hats.

Flor de punga.—A brown kapok from the tree called punga (Brazilian name, sumaumeira).

Flor de balsa.—A brown kapoklike fiber from the balsa tree (*Ochroma* sp.), with the properties of brown kapok.

Huimba (Brazilian name, sumauma branca).—A white kapok with long fibers of a silky luster which might be utilized as vegetable silk.

TIMBER

The forests of Peru contain a wide variety of hard and soft woods of present and potential value. The exploitation of certain timbers, while not of large magnitude, is progressing; and in this respect the Peruvians, though more isolated and burdened with higher freight rates, are doing more to develop this industry than their neighbors in the State of Amazonas, Brazil.

It is said that heavy timber grows on the eastern slopes of the Andes up to 4,000 feet, and that above this, in places, some black walnut occurs. At the present time only three kinds of woods are exported—(*a*) red cedar (cedro), (*b*) caoba aguano, used as a substitute for mahogany in furniture and veneering, and (*c*) huito, a white hardwood.

BEST TIMBER LOCATIONS

The best timber areas are localized; that is, some areas have more of one particular kind than another. It is for this reason, with the demand as it is for only a few kinds, that it is not possible to organize a large-scale production of a single species in a fixed locality. It is only profitable now to secure trees close to rivers and streams on which to float the logs to the mills or shipping points.

The rivers considered the best for timber exploitation are those on the north side of the Amazon-Maranon, this superiority seeming to be mainly a question of better transportation at this time. These rivers are: Morona (and Acuamari), Pastasa, Nucuray, Urituyaco, Chambira, Tigre (and Corrientes), Itaya, Nanay, Napo (and Curaray and Tamboryaco), Ambiyaco, Atacuary, Loreto yaco, and Putumayo (and Cotuhe, Yagas, Algodon, Cara-Parana, Igara-Parana). The area embraced in this district is estimated by Israel & Co., of Iquitos, to be approximately 162,000 square miles.

The rivers on the south side, especially in their upper or higher reaches, also contain the same timbers, and most of the present supply comes from them. These rivers are the Maranon proper, the Huallaga, the Ucayali, and their tributaries.

LOGGING METHODS

The method of obtaining logs is as follows: The trees are felled by Indians on the banks of sloughs and creeks. When the rains come the logs are then floated out to the rivers. There is always a heavy loss, since borers frequently enter the log before it can be floated. The logs, the standard size of which is about 2 feet in diameter and 16 feet in length, are made into rafts of 100 logs, with four men to the raft to direct it. From the upper Ucayali it requires about 20 days for a raft to reach Iquitos.

There are several sawmills in this part of Peru which cut lumber and logs for local use and for export. The most important of these mills, and their locations are: Puritan, Rio Amazonas; Independencia, Rio Nanay; Cantamana, Rio Ucayali; San Mateo, Rio Amazonas; San Pablo, Rio Amazonas; Santa Teresa, Rio Ucayali; Puerto Prado, Rio Amazonas; Sanango, Rio Huallaga.

PRICE OF TIMBER

There are given below the prices paid for different kinds of timber by a firm in Iquitos in 1923. These are f. o. b. prices in Iquitos.

TABLE 65.—PRICE OF CEDRO AND MISCELLANEOUS TIMBERS [1] 16.4 FEET LONG

Diameter, Cedro	Price each	Diameter, miscellaneous timbers [1]	Price each
	Soles		*Soles*
19.6 to 23.5 inches	6.00	17.3 to 19.5 inches	8.00
23.6 to 27.4 inches	8.00	19.6 to 21.5 inches	10.00
27.5 to 31.4 inches	12.00	21.6 to 23.5 inches	12.00
31.5 to 35.3 inches	15.00	23.6 to 25.8 inches	14.00
35.4 to 39.2 inches	20.00	25.9 to 27.4 inches	16.00
Over 39.3 inches	25.00	27.5 to 30.2 inches	18.00
		30.3 to 31.4 inches	20.00
		Over 31.5 inches	22.00

[1] Comprising the following: Caoba aguano; quinilla colorada; huacapurana; marapina; alfaro; capirona; palo de cruz; huarihuba; tahuari (papelillo caspi); mahuba; mulna; mucha; huito; huacapu; quillo bordon; palo de rosa; itauba; palo de sangre; and chonta quira.

For all trunks measuring 8.2, 9.8, 13.1 feet, or more than 16.4 feet long and more than 3.2 feet in diameter proportional rates.

For the following hardwoods, 2 soles was offered for such logs of 11.8 inches in diameter and 4 feet long (for sizes of large diameter a proportional price was to be given): Palo de sangre, chonta quira, tahuari, estoraque, tortuga, itauba, espitana, almendro, huarihuba, canela muena, muena negra, hineira caspi, arusi caspi, and lagarto caspi.

At that time the same firm was offering for andiroba of minimum dimensions 23.6 inches in diameter by 15 feet long and over, 20 soles per cubic meter.

TRANSPORTATION AND COMMUNICATION

OCEAN

Iquitos has regular monthly connections with Manaos and Para by steamers of the Amazon River Steam Navigation Co. Vessels of 600 tons are used in the service here. These boats reach Iquitos from Para in 19 to 20 days and make the trip downstream in 12. The time between Manaos and Iquitos is respectively 12 and 7 days. At either place connections are made with ships of the Booth Line or Lamport & Holt Line for foreign ports. Other more or less regular connections with Manaos or Para are furnished by boats of Monteiro da Silva & Co. and Augusto D. Lobato, both of Para.

Until 1917 Iquitos had direct connections with Liverpool by ships of the Booth Steamship Co., but this service, suspended on account of the war, has not since been reestablished.

A Lima firm has for some time operated two boats between Callao and Iquitos via the Panama Canal. These vessels, which are wooden ships of some 2,500 tons purchased from the United States Emergency Fleet Corporation after the war, make the voyage in about two months, although they have encountered much difficulty in

navigating the Maranon at low water. The principal cargo from Iquitos has been cedar lumber. (The *Presidente Leguia*, of this line, was burned in January, 1924, while tied up in Callao harbor.)

RIVER

The river system of this area may be illustrated by the following diagram:

Amazon-Maranon.
- Negro.[17]
  - Guainia.
  - Uaupes.
- Caqueta.
  - Apaporis.
- Putumayo.
  - Igaraparana.
  - Caraparana.
- Napo.
  - Curaray.
  - Aguarico.
  - Coca.
- Tigre.
  - Corrientes.
- Pastasa.
- Morona.
- Santiago.
- Javary.
- Ucayali.
  - Blanco.
  - Tapiche.
  - Pacaya.

Amazon-Maranon—Continued.
- Ucayali—Continued.
  - Tamaya.
  - Pachitea.
  - Tambo.
  - Urubamba.
    - Mishagua.
- Huallaga.
- Jurua.
- Purus.
  - Acre.
- Madeira.[17]
  - Beni.[17]
    - Orton.
      - Tahuamanu.
      - Manuripe.
    - Madre de Dios.
      - Piedras.
      - Heath.
      - Tambopata.
      - Inambari.
      - Manu.

NAVIGABILITY OF RIVERS

The level of the rivers of this area, as throughout the Amazon Valley, varies greatly between the wet and dry seasons. In this respect the seasonal variations of the northern tributaries of the Amazon is the exact reverse of those that reach it from the south. The Ucayali and Huallaga begin to rise about the end of October, though this may happen earlier or later. In January these rivers are in full flood and generally reach their highest mark in April. In May they begin to fall again and are at their lowest in August and September, sometimes as late as October. On the other hand, the left-bank tributaries, such as the Napo and Putumayo, are at their highest during precisely the period of low water in the right-bank affluents, that is, from May to September, and their season of low water is from November to April.

Outside of the purely Andean section of their course, these rivers are little interrupted by rapids, La Chorera in the Igaraparana (Putumayo) and Araraquara in the Caqueta being the outstanding exceptions. The principal obstacles to navigation are sand bars. However, the navigability of all of these rivers varies greatly between the rainy and dry seasons, the annual rise amounting to from 8 to 25 feet according to the particular river.

Amazon-Maranon.—The main river flows east for nearly 800 miles through this territory, from the Pongo de Manseriche to the

[17] Does not flow through Region 9.

Brazilian border. As already explained, to the mouth of the Ucayali it is known to the Peruvians as the Maranon and below that as the Amazon, though the Brazilians are accustomed to refer to the river beyond their frontier as the Maranon and thence downstream to the mouth of the Negro as the Solimoes. In its upper course the Maranon is a swift stream, flowing between two chains of the Andes and unnavigable because of its rocky channel and torrential current. Some distance before the Maranon reaches the Pongo de Manseriche the valley widens considerably, but at the Pongo the river breaks through the last chain of the Andes in a gorge about 50 yards wide. During high water it is impossible to pass the Pongo from below because of the force of the current, and it is extremely dangerous to do so at low water, when craft run the risk of being dashed against exposed rocks. However, when the river is at medium height it is possible to get through, though it costs considerable effort and has been accomplished a very few times.

Below the Pongo de Manseriche the Maranon enters the great Amazonian plain, but there are a few bad passages until Puerto Limon is reached. However, with careful pilotage, steamers drawing 5 feet of water can reach the foot of the Pongo all the year, and those drawing 8 or 9 feet could reach it during about five months of highest water. Boats of this draft can reach Puerto Limon at all times. At high water steamers of 20-foot draft could reach the mouth of the Huallaga, but at low water could not get above the mouth of the Ucayali. For about 10 months of the year ocean-going steamers drawing 20 to 22 feet can ascend the Amazon to Iquitos, 2,037 miles from Para. During the two months of lowest water, July and August, Iquitos is accessible to vessels of 14-foot draft. Only a pilot thoroughly familiar with the channel can take a deep-draft steamer as far as Iquitos, except at high water. After receiving the Ucayali the Amazon is a very wide river and below the mouth of the Napo it is over a mile from shore to shore.

Guainia and Vaupes.—Conditions of navigation in these important streams are described in regional report No. 4, page 229.

Caqueta.—In the Brazilian section of its course, a distance of about 500 miles, the Caqueta, known in Brazil as the Japura, is a very wide but shallow stream. At high water it can be navigated by steamers of 4 or 5 foot draft as far as the rapids of Sihare, 44 miles beyond the Colombian frontier. However, during most of the year this part of the river is navigable only in light-draft launches which can follow the tortuous channel among the sand bars that spread out over the bed of the river for long distances. Above the rapids of Sihare there is another stretch of 315 miles with much the same conditions of navigation to the Falls of Araraquara. Higher up the Caqueta can be traveled at high water by launches of very shallow draft several hundred miles to the place near the Andean foothills known as Puerto Limon. However, during most of the year this section can be reached only by canoes.

Putumayo.—This river offers excellent conditions of navigation for shallow-draft vessels. A steamer drawing 7 feet of water makes regular trips during eight or nine months of the year from Iquitos to La Chorera, the principal establishment of the Arana properties, situated on the Igaraparana, the main branch of the Putumayo.

During approximately the same period a boat of this draft could ascend the Putumayo itself to the mouth of the Juvento, and during extreme high water could go even farther. During the months of low water navigation is limited to launches or flat-bottomed steamers drawing 3 or 4 feet. There are no rapids in the river, but the course at low water is strewn with sand bars, among which the channel is devious and given to shifting, though always negotiable with an experienced pilot. For three or four months during the rainy season launches drawing 3 feet can ascend the Putumayo to Puerto Asis, near the mouth of the Guames and close to the Andes in about latitude 0° 30′ N. Very light draft launches can reach this point during most of the year, and it is always accessible for large canoes.

Napo.—This river enjoys much the same favorable conditions of navigation as the Putumayo. Steamers drawing 6 or 7 feet can ascend to the mouth of the Aguarico, a distance of over 600 miles, during nearly all the year and to the mouth of the Coca during high water. At the height of the rainy season boats of this draft can reach a point known as Embarcadero, about 12 miles east of the village of Napo and very near the Andes. Above that point navigation is restricted to canoes, but a launch drawing 1½ or 2 feet could reach the Embarcadero throughout the year. Both the Aguarico and the Curaray are navigable for long distances by launch, the latter to a point called San Antonio del Curaray.

Tigre.—The Tigre, the first important stream emptying into the Amazon above Iquitos, is navigable all the year to the mouth of the Corrientes for steamers of 6-foot draft and to the mouth of the Cunanibo for launches drawing 2 to 3 feet. The Corrientes and another tributary, the Pucacaro, are also navigable for considerable distances for small launches.

Pastasa.—This river, which is characterized by its tortuous course and frequent sand bars, is navigable at high water to the mouth of the Huasaga for steamers of 6-foot draft, but during most of the year this point is accessible only for launches drawing 3 feet. Smaller launches can ascend much higher to Andoas, except at extreme low water.

Morona.—The Morona could be navigated by boats drawing 5 to 6 feet at extreme high water as far as the old Peruvian frontier army post of Puerto Pardo, but navigation is usually confined to launches drawing 2 to 3 feet.

Santiago.—This stream, which enters the Maranon immediately above the Pongo de Manseriche, is navigable for very light draft launches and canoes.

Javary.—This river, which forms the boundary between Peru and Brazil to the south of the Amazon, is always navigable for steamers of 6-foot draft to the mouth of the Curuca, and thence upriver only by launches.

Ucayali.—This, the greatest of the Peruvian rivers, is easily navigable all the year to the confluence of the Tambo and the Urubamba for steamers drawing 4 or 5 feet. This distance is ordinarily covered in 10 to 12 days. During the rainy season navigation is possible up the Urubamba to the mouth of the Mishagua, four days higher. At this time small launches can ascend the Mishagua to the so-called

Isthmus of Fitzcarrald, where there is a portage of about a mile to a similarly accessible point on the Manu of the Madre de Dios system.

The Tambo quickly becomes a typical mountain stream traveled only by canoes. Many of the tributaries of the Ucayali are freely navigable by launches for a considerable distance; these include the Blanco, Tapiche, and Tamaya on the right side and Pacaya on the left, all of which flow for most of their length through the low alluvial plain across which the Ucayali works its way in great curves. The Pachitea is navigable by launches at time of high water and normally by canoes, which go as far as Puerto Bermudez.

Huallaga.—Yurimaguas is the usual limit of navigation on the Huallaga and can be reached by 8-foot-draft steamers all the year. Steamers can ascend the river to Chipeza, but above this navigation is interrupted by a series of rocky passages. However, the Iquitos firm of Israel & Co. plans to remove some of these obstacles by dynamiting in order that its boats may be able to reach Chapaja, from which point it is planning to build an automobile road to Tarapoto, the center of a rich agricultural district. No craft of any kind can pass up the narrow gorge in the Huallaga known as the Pongo de Aguirre, which is the limit of navigation.

Jurua and Purus.—These rivers both rise in Peru, and the Purus in particular flows for a long way in Peruvian territory before entering Brazil. Between January and March launches can ascend it almost to latitude 10° 3′ S., but for most of the year navigation on the Peruvian sections of these rivers is restricted to canoes. This is also true of the Acre, and of the Tahuamanu and Manuripe, the confluents of the Orton, which finds its outlet through the Beni to the Madeira. Travel in these streams is generally hindered by both bars and snags, which litter their courses at low water.

Madre de Dios.—During the season of high water launches drawing 2 to 3 feet can ascend the Madre de Dios for about 150 miles inside the Peruvian border. At this time they can go up the Inambari for about 50 miles and up the Tambopata for approximately the same distance to the point known as Astillero. On the Manu they can reach the Isthmus of Fitzcarrald, where there is a short portage to navigation on the Mishagua of the Ucayali system. However, during most of the year navigation on these streams is reduced to canoes. Normally the limit of launch navigation on the Madre de Dios is the point known as Puerto Maldonado.

TYPES OF PERUVIAN RIVER CRAFT

Canoes are widely used on all the rivers of this region for carrying both passengers and merchandise. These canoes are usually hewed out of a cedar log and many are from 25 to 30 feet long. These large canoes (or ubadas, as they are commonly called in Peru) are built with great skill and make excellent craft for their purpose.

Another typical craft of the Peruvian rivers, particularly of the Ucayali and Huallaga, is the balsa, or raft. Not only are logs floated downstream in this way, but these rafts are constructed for carrying upriver products to Iquitos or Yurimaguas. Thus during the stay of the field party at the latter town a veritable fleet of rafts arrived

laden with cotton. Platforms with palm-thatched huts are built upon them, and entire families, with chickens, pigs, and even cattle, will travel for weeks with the current on these craft. During 1922 one enormous raft from the Peruvian section of the Purus reached Manaos with 17 families living on board in as many houses and accompanied by considerable livestock.

The type of steamer or launch used on these rivers does not differ materially from that used in Brazil except that the flat sternwheeler steamboat of shallow draft known in Brazil as "chata" is not found in Peru.

FREIGHT AND PASSENGER SERVICE

All of the important rivers of the Department of Loreto are covered by regular navigation services. These are largely operated by the trading firms of Iquitos and are primarily devoted to the commercial interests of their owners, though they also do a general freight and passenger business. Some of these have accommodations for passengers, the *Alberto*, which runs between Iquitos and Yurimaguas, being the equal in this respect of the best Brazilian steamers on the Brazilian rivers. For freight business launches towing cargo lighters are widely used.

About 75 per cent of all the navigation of this area is in the hands of Israel & Co., who operate boats on the Maranon, Huallaga, Ucayali, Napo, Tigre, Pastasa, Morona, and Javary. Their fleet consists of the following steamers: *Alberto*, 304 tons; *Beatriz*, 96; *Loreto*, 85; *Melita*, 54; *San Pablo*, 49; *Tarapoto*, 39; 8 launches of 3 to 16 tons.

Other operators and their respective boats are: The Peruvian Amazon Co. (Ltd.) (Julio Arana & Co.), *Liberal*, 100 tons; Adolfo Morey, *Estelita*, 30 tons; *Esploradora*, 27 tons; Luis F. Morey, *Clavero*, 52 tons; Pinto Hermanos, *Luz II*, 69 tons; Cia. Nacional de Navegacion, *Adolfo*, 123 tons; Kahn & Co., *Elisa*, 48 tons; Frederico Voglert, *Ucayali*, 49 tons; C. Hernandez e Hijos, *San Miguel*, 32 tons; Barcia Hermanos, *Maruja*, 28 tons.

In addition to these there are a number of smaller launches employed in service on the rivers of this region.

ROAD

As mules are little used outside Iquitos, except in the Putumayo and upper Napo regions, the roads in this area are only pack trails for human carriers known as varaderos. There are many such trails connecting nearly all the rivers. These include at least two between the Huallaga and the Ucayali, one of about 5 days' travel between the Ucayali and Jurua, another between the Ucayali system and the Purus at about the eleventh parallel of south latitude, and the short portage between the Mishagua and the Manu connecting the basins of the Ucayali and Madre de Dios across the neck of land known as the Isthmus of Fitzcarrald.

To the north of the Amazon all the rivers are linked up by trails. Thus it is possible to reach the Putumayo from Iquitos by utilizing the trail which leads across to the Napo, from a branch of which there is a trail to the Putumayo. Another trail connects the Tam-

boryaco, a branch of the Napo, and the Juveneto, a tributary of the Putumayo. There are other roads between the Napo, Tigre, Pastasa, and Morona, and far to the northeast a trail connects the Putumayo with the Caqueta.

TELEGRAPH AND CABLE

The Peruvian Government maintains a chain of wireless-telegraph stations at different points in this territory. The central station is located at Iquitos, which communicates directly with Lima. Other stations are situated at Leticia, on the Amazon, at the Brazilian border; El Encanto, on the Putumayo; Masisea, on the Ucayali, and Puerto Maldonado, on the Madre de Dios. The rate between Iquitos and Lima is 12 centavos per word, or 1 sol for the first 10 words and 10 centavos for each additional word. Words in code or foreign languages pay double rates. At Lima connection is made with the oceanic cables, over which messages may be sent direct to any foreign point. The service is quite satisfactory. Wireless communication between Iquitos and the Brazilian station at Manaos is slow.

The Peruvian wire lines from Lima reach to Yurimaguas on the lower Huallaga.

CONNECTION WITH THE PACIFIC COAST

The present trans-Andean routes in this region are used only for passenger travel and for carrying mails between eastern Peru and the Pacific coast country. None of them have an actual economic importance, and the entire commercial movement of the region is by way of the Amazon to the Atlantic Ocean. The present routes require from 25 to 35 days between Iquitos and Lima, and for much of the way even the most elementary conveniences for travelers are wanting. Facilities for transporting cargo are entirely lacking, and as a consequence the commercial sphere of attraction of Lima extends only to the Chanchamayo Valley, a comparatively short distance from the Oroya Railway, which connects the Cerro de Pasco mining district with the capital. Beyond that there lies an extremely mountainous zone in which travel under any circumstances is attended with great difficulties.

PRESENT ROUTES

The most-traveled route between Iquitos and Lima is by way of the Pichis trail, which follows the Ucayali, Pachitea, and Pichis Rivers well into the sierra country. The Pachitea is reached by the regular Ucayali steamers from Iquitos, thence by canoe for several days, and about nine days by mule or on foot to La Merced. From La Merced to Tarma in the Chanchamayo Valley and on to Oroya on the railway there is an automobile service over narrow mountain roads. The distance from Oroya to Lima (about 140 miles) is covered in a day.

Another route from Iquitos is via the Ucayali, Tambo, and Pangoa Rivers, which requires arduous canoe work for about 10 days and then a 6-day mule trip to Matahuasi on the Huancayo line of the Central of Peru, where there is railway connection with Lima via Oroya. An alternative is to enter the Perene from the Tambo.

A third route is from Yurimaguas on the Huallaga to Pacasmayo on the Pacific coast. From Yurimaguas to Moyobamba there is a choice of three routes—(*a*) via Balsapuerta, (*b*) via Lamas, (*c*) via Chapaja—all of which require long stretches over the mountains to Chachopoyas on a branch of the upper Maranon. From Chachopoyas travel over the western ranges of the Andes to Cajamarca is by muleback. Pacasmayo is reached from Cajamarca with comparative ease by another mule journey.

Quito or Ambato, on the Guayaquil Railway, in Ecuador, can be reached from the Amazon via the Napo. For the last part of this route there is choice of a trail from navigation at the village of Napo up to Quito or across to Ambato, or an alternative route from the limit of navigation on the Curaray by Banos to Ambato.

From Puerto Asis on the upper Putumayo to Pasto in the Colombian Andes and thence to the coast at Tumaco there is a trail by way of Mocoa. Pasto can also be reached from the Napo by way of the Aguarico and Cuyabeno, thence overland through the mountain country.

The Ecuadorian highlands are also accessible by trails from the heads of navigation on the Pastasa and the Tigre.

From the mouth of the Categuaza on the upper Caqueta a trail leads by Florencia, Guadalupe, and Neiva to Bogota. The mouth of the Categuaza can be reached at present in about 12 days.

In southern Peru there is a trail from Puerto Maldonado on the Madre de Dios and from Astillero on the Tambopata via the Santo Domingo gold mines to Tirapata on the Southern Railway of Peru, which reaches the coast at Mollendo. Part of this route is by an automobile road built by the mining company.

PROJECTED RAILWAYS

The Peruvian Government has long planned the construction of a railway between the coast and the low country to the east of the mountains, but the realization of this project has so far been delayed by a combination of circumstances—financial, political, and topographical. However, renewed interest is being shown in the undertaking, though no definite program has yet been initiated with any prospect of success.

Meanwhile the necessity of conciliating the local interests of different communities has done much to divert attention from what should be a purely engineering and financial problem. Thus the too ambitious plan of the Dunsmuir (British) concession, which recently lapsed, provided for the construction of not one but several lines into the montana and plains country, to tap the Huallaga or Maranon, the Pachitea, the Urubamba, and the Madre de Dios. A continuation of either the Central Railway into the upper part of the Ucayali drainage basin or of the Southern Railway to a navigable point on the Madre de Dios would offer little economic advantage, unless through the possible opening up of new mineral districts. Construction of the Oroya line to a navigable point on the Ucayali would be costly, due to the great extent of mountainous country to be crossed.

Moreover, the objective of a line across the Andes should by every practical consideration be either the Maranon or the Huallaga. In

this case the starting point should be Paita, Chiclayo, Pacasmayo, or some other northern point on the Pacific coast. Not only would the total distance to be traversed be considerably less than by the routes to the south, but the Andes in this latitude are much lower. An American aviator who flew from Chiclayo to Iquitos in 1923 declared that at no point did the mountains reach a height of 10,000 feet, and it is quite probable that there exist passes at below 9,000 feet. A terminus on the north Peruvian coast would have the added advantage of being nearer to American and European ports.

The construction of such a railway is vital to any possible development of rubber plantations in eastern Peru. Without such an outlet that region could not hope to compete with the lower Amazon Basin in Brazil unless costs of production could be made sufficiently low to more than compensate for the added cost of transporting rubber down the Amazon from a point in Peru. The completion of a line to the Pacific from navigation on the Maranon or Huallaga would, however, afford highly favorable and rapid transportation facilities, bringing that region to within a very few days of the Panama Canal.

TWO ROUTES CONSIDERED

Two general routes have been considered in this zone. One of these would have as terminals Pacasmayo on the coast and Yurimaguas on the Huallaga and would pass through Cajamarca, Chachapoyas, and Moyobamba. This route was lately the object of a survey by an American company. The alternate route is from the coast at Paita to a navigable point on the Maranon. Such a line would cross the Desert of Sechura from Piura and would then climb into the Andes. After descending into the wide valley of the upper Maranon it would pass through the Pongo de Manseriche, to terminate a short distance below at Puerto Limon or some other point always accessible for steamers drawing 7 or 8 feet of water.

The latter route has the advantage of shortness and greater ease of construction. However, the advocates of the other route argue in its favor that a considerable volume of local traffic could be obtained at once from the centers of population through which it would pass, whereas the Paita-Puerto Limon could depend only on the eventual development of through traffic.

It may be added, in connection with this question, that important interests in Iquitos, whose commercial life is closely linked up with the traditional route by the Amazon and Para, are opposed to th construction of a railway to the Pacific which might leave their cit off the main route of trade and divert much of its business to anothe. point.

THREE SUGGESTED ROUTES

It would appear that the most practical route from the Amazon Basin to the Pacific would be from either the Napo or the Putumayo. In this respect the route from the Napo offers great advantages. In the first place, according to all reliable information there exist in the upper valley of the Napo and near the Andes large areas of land suitable for the planting of rubber. In the Canelos district of the

Rio Curaray, for example, there are about 6,000 civilized Indians who could be employed, and additional peons could be secured from higher in the mountains. These peons are paid at the rate of about 20 sucres per month, and the Indians are accustomed to barter their services for goods.

Also, on no other river of this region is the head of navigation so near a railway in actual operation. A branch of the Guayaquil & Quito line has already been built into Pelileo, a distance of 21 miles, and the roadbed has been finished to Banos, another 9 miles. From Banos to Mera the distance is 25 miles, and thence to Embarcadero, 12 miles below Puerto Napo, an additional 36 miles, or a total of about 70 miles from the present terminus of the railway. From Embarcadero to the mouth of the Coca, from which point there is free navigation all the year for steamers, is about 60 miles.

An alternative or additional route under consideration is from Ambato to Canelos on the Curaray. From Canelos the line could be run across to navigation on the Napo at the mouth of the Coca, a distance of some 90 miles, or follow down the Curaray to San Antonio, the head of navigation for steamers of 80 to 100 tons and distant about 180 miles from Ambato.

The altitude of some of these places is: Pelileo, 8,488 feet; Mera, 3,808 feet; Napo, 1,680 feet; Canelos, 1,690 feet; mouth of the Coca, 850 feet.

A third route is offered from the head of navigation on the Putumayo at Puerto Asis via Pasto to the Pacific port of Tumaco. However, in contrast to the Ecuadorian route, nothing has been done toward the construction of a railway, though such a road would offer no serious engineering problem and would be comparatively short—probably 250 miles.

PORT OF IQUITOS

The port works of Iquitos were built and are owned by Booth & Co., who also control the docks at Manaos. Due to the great difference in the rise and fall of the river the same system of floating docks supported by a pontoon of iron caissons was adopted at Iquitos. Merchandise was raised and lowered between the dock and the level of the warehouse by means of an elevator operated by winches. However, the shifting of the channel threw the river with increased force against the point where the wharf is located and gradually undermined the foundation. During our stay in Peru the steel frame connecting the wharf with the level of the warehouses above settled so far as to threaten collapse. Preparations are being made to dismantle this framework, and meantime an incline plane is being installed to handle freight. The concession held by the Booth Co. expires in 1927.

PORT CHARGES

The following schedule of port dues has been in force at Iquitos:

Rates for loading and unloading of products at the Booth Docks, Iquitos

Loading and unloading of products from the interior and coastwise:		Soles
Volumes of 1 to 499 kilos	per ton	2.00
Volumes of 500 to 999 kilos	do	4.00
Volumes of 1,000 to 2,000 kilos	do	8.00

		Soles
Loading and unloading of foreign merchandise:		
Volumes of 1 to 499 kilos	per ton	4.00
Volumes of 500 to 999 kilos	do	8.00
Volumes of 1,000 to 2,000 kilos	do	16.00
Special:		
Cattle	per head	2.00
Sheep and goats	do	.50
Mules and horses	do	1.00

Special rates obtain for volumes weighing more than 2,000 kilos.

Plus a proportion of the extraordinary expenses which will be necessary for this service, which amount will be arranged previously between the company and the shipper.

Launches, boats, or other volumes which are not placed upon the platform or carried to the warehouse, unless they are put directly on the water: 4 soles per measured ton, with a discount of 10 per cent.

The company will collect the charges fixed in this schedule either according to weight or volume, at option of the company, and on the basis of 1,000 kilos per ton weight and 1 cubic meter per ton volume.

DEPTH OF WATER

The extreme difference in the level of the river at the Iquitos dock over a number of years was as follows:

TABLE 66.—EXTREME RIVER LEVELS AT IQUITOS DOCKS, 1913–1922

Years	Month	Maximum height	Month	Minimum height
		Ft. in.		*Ft. in.*
1913	May	78 3	September	54 3
1914	April	81 2	do	58 0
1915	do	82 9	October	45 0
1916	do	76 3	do	44 0
1917	May	75 2	September	47 2
1918	April	79 9	do	49 10
1919	do	77 10	do	48 10
1920	May	83 5	August	54 10
1921	do	83 6	October	51 1
1922	do	79 2	August	56 3

OWNERSHIP OF LAND AND LAND LAWS

The acquisition of public lands in eastern Peru is regulated by the laws of December 31, 1909, and March 11, 1910. These and supplementary decrees governing the same question are found in the publication entitled "Ley y Reglamentos de Terrenos de Montana" (Lima, 1920).

LAND TENURE

According to these laws State lands may be acquired in four different ways—sale, "denunciation," free grant (adjudicacion gratuita), and concession.

1. Lands may be purchased outright from the Government to the extent of 1,000 hectares (2,470 acres) for agricultural purposes and 30,000 hectares (74,130 acres) for the working of wild rubber. The National Congress may authorize the sale of larger areas. The price fixed by law for montana lands is 1 sol per hectare ($0.10 U. S. per acre at exchange of $0.25 to the sol).

2. The form of acquisition known as denunciation (denuncio) is actually a lease. The method of obtaining the use of lands in this form is for the person or other legal entity interested to petition the Government for the usufruct of a specified area of land. The amount of land that may be leased in this fashion can not exceed 50,000 hectares (123,550 acres). The lessee pays to the State 5 centavos per hectare every six months. Failure to pay this rental for two successive semesters results in the automatic reversion of the lands to the Government, which may then cede them to other parties.

3. Free grants of lands (adjudicacion gratuita) are made for the purpose of stimulating colonization by settlers of limited means, and provide for a maximum of 5 hectares (12 acres). No corporation may obtain lands by this means.

4. Concessions of public lands may be made to individuals or companies for the purpose of colonization or in compensation for the construction of railways, roads, or works of public utility. Lands granted in this manner are divided into lots of not over 5,000 hectares (12,350 acres) each, between which there must intervene a distance of at least 3 miles. Such concessions of land are not, however, gratuitous, but are conditional on the payment of 1 sol per hectare.

A decree of May 27, 1910, fixed 200,000 hectares (494,000 acres) as the maximum area that may be comprised in any concession for the purpose of colonization. The same law also provides that such lands must be devoted to strictly agricultural development and can not be used for the extraction of rubber. Also, such lands must be settled with Peruvians and Europeans. It is worth noting that by special action the National Congress can grant extraordinary concessions superseding the provisions of the general law in particular cases. Questions pertaining to grants of public lands are handled by the Ministry of Fomento (Promotion).

OWNERS OF RUBBER LANDS

Among the largest proprietors of rubber lands in eastern Peru are:

Peruvian-Amazon Co. (Ltd.).—This company, which was organized in London by Julio Arana, now senator from the Department of Loreto, holds definitive title to 5,750,000 hectares (14,200,000 acres) of land in the Putumayo region, but extending across to the Caqueta in one direction and to the Napo in another. Much of this land lies in territory involved in the triangular boundary dispute between Peru, Colombia, and Ecuador.

Israel & Co.—This important trading firm of Iquitos possesses very large gomales on the Javary and on the Ucayali, including most of the lands bordering the Rio Pacaya, a tributary of the Ucayali.

Luis Morey.—Sr. Morey has definite titles to 132,500 hectares (327,400 acres) on the Tapiche and Blanco Rivers, affluents of the Ucayali, and incomplete titles to nearly 25,000 hectares (62,000 acres) more on the same rivers.

In the upper Madre de Dios country several large concessions have been granted for the working of rubber lands. These include grants to two British companies in the Tambopata and Inambari, both of which are now lapsed, and another, in the same general region, to an American, who owns the Santo Domingo gold mines.

BIBLIOGRAPHY

BRAZIL

Akers, C. E. Report on the Amazon Valley, Its Rubber Industry and Other Resources. London, 1912.

Akers, C. E. The Rubber Industry in Brazil and the Orient. London, 1914.

Associação Commercial do Para. A Valorisação da Borracha. Para, 1918.

Associação Commercial do Amazonas. Relatorio Annual apresentado pelo Presidente da Directoria, Joaquim Carneiro da Motta, na Sessão Ordinaria de Assemblea Geral em 12 de Março de 1923. Manaos, 1923.

Barata, Manuel. A Antiga Producção e Exportação do Para. Estudo Historico-Economico. Para, 1915.

Braga, Theodoro. Guia do Estado do Para. Para, 1916.

Brazil. Ministerio da Agricultura, Industria e Commercio. Decreto No. 10105, de 6 de Março de 1913, Approva o novo reglamento de terras devolutas da União. Rio de Janeiro, 1913.

Brazil. Delegação do Ministerio da Agricultura no Territorio do Acre. Relatorios do Delegado, Engenheiro João Alberto Maso, 1910, 1911, 1912. Rio de Janeiro, 1913.

Brazil. Ministerio da Agricultura, Industria e Commercio. A Borracha no Brazil. Rio de Janeiro, 1913.

Brazil. Ministerio da Agricultura, Industria e Commercio. Synopse do Recenseamento Realizado em 1 de Setembro de 1920, População do Brazil. Rio de Janeiro, 1922.

Brazil. Instituto Historico e Geographico Brazileiro. Diccionario Historico, Geographico e Ethnographico do Brasil. Rio de Janeiro, 1922. 2 vols.

Brazil. Brazil, the Land of Rubber (Third International Rubber and Allied Trades Exhibition). New York, 1912.

Britto Pereira, P. B. de. A Industria da Borracha na Amazonia. State of Amazonas, Diario Official, Manaos, September 7, 1922.

Cordeiro, Luiz. O Estado do Para, Seu Commercio e Industrias de 1719 a 1920. Para, 1920.

Costa, Jose Simão da. A Região Amazonica, Seu Presente, Passado e Futuro. Rio de Janeiro, 1913.

Costa, Jose Simão da. O Estado do Para e os Seus Riquezas Naturaes. Discurso proferido no Congresso de Defesa Economica da Amazonia, em 16 de Agosto de 1913. Para, 1913.

Cunha, Euclydes da. A Marjem da Historia. Rio de Janeiro.

Ducke, Adolpho. As Especies da Massaranduba. Descriptas pelo Botanico Brazileiro Francisco Freira Allemão. Vol. 2, pp. 11–16, of the Archivos do Jardim Botanico. Rio de Janeiro, 1918.

Ducke, Adolpho. Explorações Scientificas no Estado do Para. In Boletim do Museu Goeldi, Vol. 7, pp. 100–198. Para, 1913.

Gondim, Joaquim. Atraves do Amazonas. Manaos, 1922.

Herndon, Lieut. Exploration of the Valley of the Amazon. House Document No. 53, Thirty-third Congress. Washington, 1854.

Huber, Jacques. A Seringueira. Conselhos Praticos Para a Sua Cultura Racional. Para, 1907.

Huber, Jacques. Mattas e Madeiras Amazonicas. In Boletim do Museu Goeldi, Vol. 6, pp. 91–225. Para, 1909.

Huber, Jacques. Arvores de Borracha e de Balata da Região Amazonica. In Boletim do Museu Goeldi, Vol. 4, pp. 415–437. Para, 1904.

Huber, Jacques. A Hevea Benthamiana (Mull. Arg.), Como Fornecedora de Borracha ao N. do Amazonas. Boletim do Museu Goeldi, Vol. 5, pp. 242–248. Para, 1909.

Huber, Jacques. Sobre uma Nova Especie de Seringueira. Hevea collina (Hub.) e as suas affinidades no genero. Boletim do Museu Goeldi, Vol. 5, pp. 249–252. Para, 1909.

Huber, Jacques. Ensaio d'uma Synopse das Especies do Genero Hevea sob os pontos de vista systematico e geographico. Boletim do Museu Goeldi, Vol. 4, pp. 620–651. Para, 1906.
Huber, Jacques. Novas Contribuções Para o Conhecimento do Genero Hevea. Boletim do Museu Goeldi, Vol. 7, pp. 200–281. Para, 1913.
Huber, Jacques. La Vegetation de la Valle do Rio Purus. Bulletin de l'Herbier Boissier, Ser. 2., Tome VI, 1906.
Johnson, ———. The Cultivation and Preparation of Para Rubber.
Labroy, O. Culture et Exploitation du Caoutchouc au Bresil. Paris, 1913.
A Borracha no Brazil (Portuguese translation of foregoing). Rio de Janeiro, 1913.
Laforge, R. G. H. L'Industrie Extractive du Caoutchouc et la Culture de l'Arbre Gommifère. Paris, 1911.
Koegel, Ludwig. Das Urwald Phänomen Amazoniens. Eine Geographische Studie.
LeCointe, Paul. Apontamentos para a Exploração da Balata e da Gutta na Amazonia. Para, 1923.
LeCointe, Paul. L'Amazonie Brésilienne. 2 vols. Paris, 1922.
LeCointe, Paul. Exploitation et Culture des Arbres à Caoutchouc en Amazonie. Paris.
Leonardos Junior, Othon. O Rio Amazonas e Seus Tributarios de Origem Andina. Rio de Janeiro, 1923.
Lopes de Campos, Hermenegildo. Climatologia Medica do Estado do Amazonas, second edition. Manaos, 1910.
MacDowell, Samuel. O Direito de Transito da Bolivia e Outras Republicas Limitrophes e a Alfandega do Para. Para, 1923.
Manaos Harbour, Ltd. Trafego do Porto de Manaos, 1910–1923. Manaos, 1923.
Marajo, Barao de. A Amazonia, As Provincias do Para e Amazonas e o Governo Central do Brazil. Lisbon, 1883.
Medeiros Chaves, Avelino de. Necessidades Capitaes da Amazonia. Rio de Janeiro, 1918.
Medeiros Chaves, Avelino de. A Exploração da Hevea no Territorio Federal do Acre. Rio de Janeiro, 1913.
Mendes, Jose Amando. A Crise Amazonica e a Borracha. Second edition. Para, 1909.
Monteiro da Costa, Raimundo. Cultura e Exploração da Borracha no Valle do Amazonas. Manaos, 1913.
Moreira, Alberto. O Acre, Suas Possibilidades Economicas. Rio de Janeiro, 1918.
Muniz, Palma. Immigração e Colonisação, Historia e Estadistica, 1616–1916. Para, 1916.
Ourique, Jacques. O Valle do Rio Branco. Manaos, 1906.
Pearson, Henry C. The Rubber Country of the Amazon. New York, 1911.
Pereira Brasil, Raymundo. Os Sertões do Rio Tapajoz. Para, 1910.
Pereira Brasil, Raymundo. O Municipio de Itaituba. Para, 1914.
Pereira Brasil, Raymundo. O Tapajoz. Rio de Janeiro, 1913.
Pereira Lima, Archimino; and Victor Mallet Hamelin. Lei da Concessão, Descripção e Proposta de uma Estrada de Ferro o de Rodagem entre os Rios Tapajoz, São Manoel, Iriry, Curua e Jamauchim no Estado do Para. Para, 1919.
Pereira da Silva, Luciano. Defesa Economica da Borracha. Rio de Janeiro, 1913.
Pereira da Silva, Luciano. Coisas Brazileiras. Rio de Janeiro, 1920.
Plane, Auguste. L'Amazonie. Paris, 1903.
Porto, Hannibal. A Politica Economica no Problema da Borracha. Rio de Janeiro, 1921.
Porto, Hannibal. Problemas Economicas do Brazil. Rio de Janeiro, 1920.
Porto, Hannibal. Em Defesa da Amazonia. Rio de Janeiro, 1915.
Porto, Hannibal. Questões Economicas em geral, Industria Extractiva. Rio de Janeiro, 1923.
Rocha, Julio. O Acre, Documentos Para a Historia da Sua Occupação pelo Brazil. Lisbon, 1903.
Romburgh, —— Von. Les Arbres à Caoutchouc et à Gutta Percha.
Roosevelt, Theodore. Through the Brazilian Wilderness. New York, 1914.
Smith, Herbert A. Brazil, The Amazon and the Coast. New York, 1879.
Snethlage, Emilia. A Travessia Entre o Xingu e o Tapajoz. Boletim do Museu Goeldi, vol. 7, pp. 49–92. Para, 1913.

Souza Carneiro, A. J. de. Rubber in Brazil. Rio de Janeiro, 1913.
Souza, Eloy de. A Crise da Borracha. Rio de Janeiro, 1915.
Spruce, Richard. Notes of a Botanist on the Amazon and Andes. 2 vols. London, 1908.
State of Amazonas. A Cultura da Seringueira. Manaos, 1907.
State of Matto Grosso. Regulamento Consolidando as Leis e Decretos sobre Terras, Minas e Colonização do Estado de Matto Grosso. Manaos, 1913.
State of Para. Relatorio Apresentado ao Exmo. Sr. Dr. Antonino Emiliano de Souza Castro, Gobernador do Estado do Para, pelo Director Geral da Fazenda Publica e a este pelo Administrador da Recebedoria de Rendas. Exercicio de 1921 e Primeiro Semestre de 1922. Para, 1922.
State of Amazonas. Municipality of Manaos, Lei No. 1178 de 8 de Fevereiro de 1923. Orca a Receita e Fixa a Despeza para o Exercicio Financeiro de 1923. Manaos, 1923.
State of Amazonas. Municipality of Manaos, Lei No. 1180 de 20 Setembro de 1922. Orca a Receita e Fixa a Despeza do Estado do Amazonas, para o Exercicio de 1923. Manaos, 1923.
State of Amazonas. Mensagem Lida Perante a Assemblea Legislativa, na Abertura da Segunda Sessão Ordinaria da Decima Primeira Legislatura, pelo Exmo. Sr. Desembargador Cesar do Rego Monteiro, Gobernador do Estado, a 14 de Julho de 1923. Manaos, 1923.
State of Amazonas. Desenvolvimento Agricola e Industrial, Lei No. 1070 de 19 de Outobro de 1920. Manaos, 1921.
State of Amazonas. Relatorio Apresentado a Intendencia Municipal de Porto Velho pelo Exmo. Sr. Dr. Joaquim Augusto Tanajuro, Super-Intendente Municipal, por Occasião da Installação dos seus Trabalhos em 2 de Abril de 1923. Manaos, 1923.
State of Para. Mensagem Apresentada ao Congresso Legislativo em 7 de Setembro de 1922, pelo Dr. Antonino Emiliano de Souza Castro, Gobernador do Estado do Para. Para, 1922.
State of Para. Tabella dos Direitos de Exportação, Cobrados de Recebedoria de Rendas, Collectorias e Mesas de Rendas do Estado do Para, no anno de 1923. Para, 1923.
State of Para. Constituição Politica. Para, 1904.
State of Para. Regulamento de Terras e Leis, Decreto No. 3791 de 31 de Janeiro de 1921. Lei No. 1741 de 18 de Novembro de 1918; Lei No. 1947 de 11 de Novembro de 1920. Para, 1921.
State of Para. Relatorio Apresentado ao Conselho Municipal de Alta Mira pelo Intendente João Alfredo de Mendonca em sessão de 20 de Março de 1923. Para, 1923.
State of Para. Mensagem Dirigida em 7 de Setembro de 1910 ao Congresso Legislativo do Para, pelo Dr. João Antonio Luiz Coelho. Para, 1910.
State of Para. Mensagem Apresentada ao Congresso Legislativo do Estado do Para pelo Gobernador do Estado Dr. Lauro Sodre. Para, 1919.
State of Para. Mensagem Dirigida em 7 de Setembro de 1912 ao Congresso Legislativo do Para, pelo Dr. João Antonio Luiz Coelho. Para, 1912.
State of Para. Mensagem Dirigida em 7 de Setembro de 1911 ao Congresso Legislativo do Para, pelo Dr. João Antonio Luiz Coelho. Para, 1911.
State of Para. O Para em 1922, Producção do Estado, Datos e Estadisticas. Para, 1922.
Uchoa, Samuel, and others. (Departamento Nacional de Saude Publica.) Um Anno de Campanha. Para, 1922.
Veiga Simoes, ———. Darquem e Dalem Mar. Manaos, 1910.
Verissimo, Jose. Interesses da Amazonia. Rio de Janeiro, 1915.
Wallace, A. P. A Narrative of Travels on the Amazon and Rio Negro. London, 1889.
Walle, Paul. Au Pays de l'Or Noir, Para, Amazonas, Matto Grosso. Paris, 1908.
———. Guia da Amazonia. Distances between points in Amazonia. Manaos, 1917.

BOLIVIA

Akers, C. E. Report on the Amazon Valley, Its Rubber Industry and Other Resources. London, 1912.
Callivian, Adolfo. Consultos del Funcionario y Empleado en el Territorio Nacional de Colonias del Noroeste (Bolivia). Para, 1909.

Bolivia. Memoria de Guerra y Colonizacion. La Paz, 1923.
LeCointe, Paul. Apontamentos Para a Exploração da Balata e da Gutta Percha na Amazonia. Para, 1923.
Leonardos Junior, Othon. O Rio Amazonas e Seus Tributarios de Origem Andina. Rio de Janeiro, 1923.
Pearson, Henry C. The Rubber Country of the Amazon. New York, 1911.
Schurz, W. L. Bolivia, a Commercial and Industrial Handbook. Bureau of Foreign and Domestic Commerce, Special Agents Series No. 108. Washington, Government Printing Office, 1921.

COLOMBIA

Salamanca T., Demetrio. La Amazonia Colombiana. Bogota, 1916. 1st. Vol.
Pearson, Henry C. The Rubber Country of the Amazon. New York, 1911.

PERU

Akers, C. E. Report on the Amazon Valley, Its Rubber Industry and Other Resources. London, 1912.
Arana, Julio C. Las Cuestiones del Putumayo. Barcelona, 1913.
Barcia Boente, Jose. El Jebe Debil, Su Explotacion, Ventajas que reporta Recomendaciones Generales. Iquitos, 1916.
Camara de Comercio y de Agricultura del Departamento de Loreto. Memoria que Presenta el Presidente Cesante Señor Pablo Zumaeta a la Junta General, dando Cuenta de la Marcha de la Camara en el Año 1919. Iquitos, 1920.
Camara de Comercio y de Agricultura del Departamento de Loreto. Memoria que presenta el Consejo de Administracion a la Junta General correspondiente a los años 1917 y 1918. Iquitos, 1919.
Hardenburg, Walter E. The Putumayo, the Devil's Paradise. London, 1912.
Le Cointe, Paul. Apontamentos para a Exploração da Balata e da Gutta na Amazonia. Para, 1923.
Leonardos Junior, Othon. O Rio Amazonas e Seus Tributarios de Origem Andina. Rio de Janeiro, 1923.
Martin, Percy E. Peru of the XXth Century. London, 1911.
Pearson, Henry C. The Rubber Country of the Amazon. New York, 1911.
Peru. Ley y Reglamentos de Terrenos de Montana, edicion 1920. Lima, 1920.
Quine, Juan Pablo. Del Pacifico a la Montana. Breve Opusculo sobre la Ruta mas Conveniente para el Ferrocarril de Internacion. Iquitos, 1918.
Spruce, Richard. Notes of a Botanist on the Amazon and Andes. 2 vols. London, 1908.
Woodroffe, Joseph F. The Upper Reaches of the Amazon. London, 1904.
———. The Putumayo Redbook. London, 1913.
———. Revista Comercial de la Casa Israel y Cia. Iquitos. Published periodically.

GENERAL

Barbosa, Rodriques. As Seringueiras. Rio de Janeiro.
Brannt, William T. India Rubber, Gutta Percha, and Balata; occurrence, geographical distribution and cultivation of rubber plants; manner of obtaining and preparing the raw materials; modes of working and utilizing them and statistics of commerce. Philadelphia, 1900.
Brown, Harold. Rubber: Its Sources, Cultivation, and Preparation. London, 1914.
Coitinho, João Martins da Silva. Breve Noticia Sobre a Extracção da salsa e da Seringa. 1863.
Collet, M. L'Hevea Asiatique. Paris.
Cramer, P. J. S. Wild Rubber and Selection. Proceedings of International Rubber Congress, Batavia, Java. Amsterdam, 1914.
Enock, C. Reginald. The Andes and the Amazon. London, 1913.
Figart, David M. The Plantation Rubber Industry in the Middle East. Trade Promotion Series No. 2, Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, 1925. Contains complete bibliography of all phases of the rubber industry of the East.

Geer, William C. The Reign of Rubber. New York, 1922.
Johnson, ——. The Cultivation and Preparation of Para Rubber.
Jumelle, Henri. Les Plantes à Caoutchouc et à Gutta. Paris, 1903.
LeCointe, Paul. Exploitation et Culture des Arbres à Caoutchouc en Amazonie. Paris.
Leeligman. Caoutchouc et Gutta-Percha. Paris.
Miller, Leo. In the Wilds of South America. New York, 1918.
Petch, T. Diseases and Pests of the Rubber Tree. London, 1921.
Ule, E. Die Pflanzenformationen des Amazonas-Gebietes. Engler's Botanische Jahrbücher fur systematische Pflanzengeschichte und Pflanzengeographie, Vol. 35, pp. 663–678, 1905; vol. 40, pp. 114–172 and 398–443, 1908.
Ule, E. Kautschukgewinnung und Kautchukhandel am Amazonenstrome. Der Tropenpflanzer. Zeitschrift für Tropische Landwirtschaft IX 1905 Beihefte 6, 1905, pp. 1–72. (Contains a map showing the limits of distribution of all the Heveas.)
Ule, E. Kautschukgewinnung am Amazonenstrome. Beihefte zum Tropenpflanzer VI, 1, 1905, p. 71. Contains a map showing distribution of rubber trees.
Ule, E. Kautschukpflanzen der Amazonas-Expedition u. ihre Bedeutung für die Pflanzengeographie. Engler's Bot. Jahrbucher 35, pp. 663–678, 1905.
Von Romburgh, ——. Les Arbres à Caoutchouc et à Gutta-Percha.
Whitby, G. Stafford. Plantation Rubber and the Testing of Rubber. London, 1920.
Whitney, Casper. The Flowing Road. J. B. Lippincott Co., 1912.
Woodroffe, Joseph F. The Rubber Industry of the Amazon and How its Supremacy can be maintained. London, 1915.
Wright, Herbert. Hevea brasiliensis, or Para Rubber, Its Botany, Cultivation, Chemistry and Diseases. Fourth edition. London, 1912.