Annals of the Association of American Geographers, 45(1):36-63.1955

THE MISKITO PINE SAVANNA OF NICARAGUA AND HONDURAS*

JAMES J. PARSONS
University of California, Berkeley

THE genus *Pinus,* the most widely distributed and most valuable member of the temperate zone forests of the Northern Hemisphere, extends well into tropical latitudes both in the Old World and in the New World. Natural stands of *P. merkusii* form a part of the man-induced highland savanna association which reaches to within a few miles of the equator in northern Sumatra. This pine has an even more extensive distribution on the Shan Plateau of Burma and Siam, in Indo-China, and on the islands of Luzon and Mindoro in the Philippines. Related species (*P. khaysa, P. insularis*) occupy somewhat higher elevations both on the mainland and in the Benguet hill country of northern Luzon.

The most extensive stands of pines within the tropics, however, are found in Middle America. At least a dozen distinct species are represented among the highland pines which cover much of the more arid portions of interior southern Mexico, Guatemala, Honduras, and northernmost Nicaragua. There are three species of pines on Cuba and Hispaniola. One of these, *P. caribaea,* also occurs extensively in open stands with grass and sedge on the low sand and gravel plains of the rainy British Honduras coast and again on the Miskito (Mosquito) Coast of Nicaragua and Honduras, separated from the highland pine forests by a belt of broadleaf high tropical forest.[1]

THE EXTENT OF THE SAVANNA

The pine savanna of eastern Nicaragua and Honduras seems never before to have been mapped and its very existence has been unknown to many geographers. Interspersed with saw palmettos and scrub hardwoods such as are found along the Gulf Coast and South Atlantic seaboard of the United States, it covers an extensive area of deeply weathered quartz gravels stretching southward from Cape Camarón, Honduras, for some 300 miles to a point a few miles north of Bluefields, Nicaragua, where the southernmost natural stand of pine trees in the New World occurs (Fig. 1). Commercial exploitation of the softwood lumber resource of this coast has only recently been initiated. The designation "Miskito pine savanna" seems appro-

* The field reconnaissance for this study, carried out in Central America during the spring of 1953, was supported by the Geography Branch, Office of Naval Research.

[1] This three-needled Caribbean pine, which also is found on the Bay Islands (Guanaja), the Isle of Pines, in western Cuba, the Bahamas, and in the Petén district of Guatemala, has only recently been recognized by foresters as botanically distinct from the larger-coned slash pine of the southeastern United States. The latter has now been restored to *P. elliottii* as Engelmann originally distinguished it from *P. caribaea* from the Isle of Pines type locality in 1880. Elbert L. Little, Jr. and Keith W. Dorman, "Slash Pine (Pinus Caribaea), Its Nomenclature and Varieties," *Journal of Forestry,* XC (December, 1952) : 918–23.

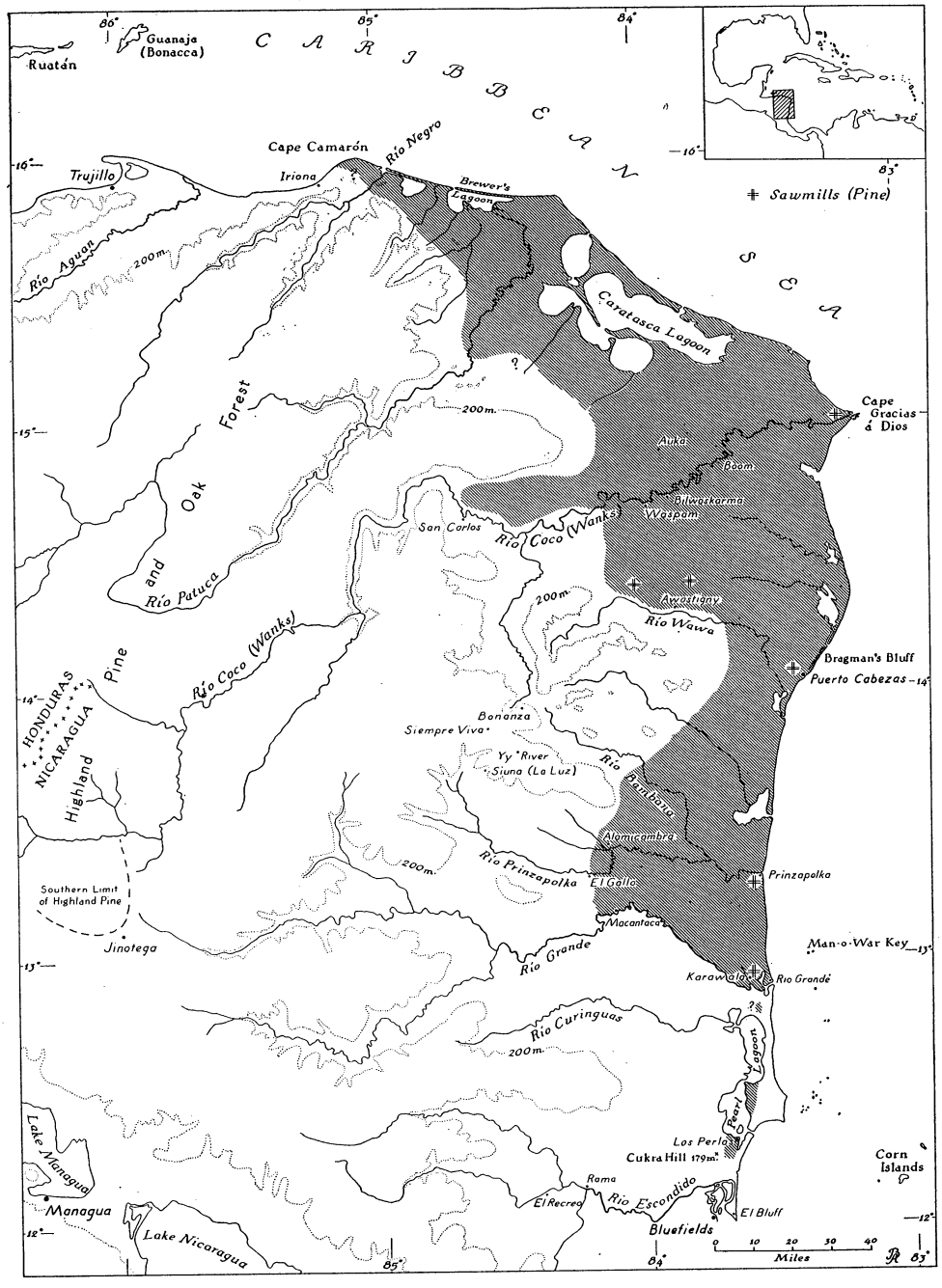

FIG. 1. The extent of the "Miskito savanna" (shaded). Pines are more conspicuous towards the inner margin of the savanna; palmetto and mangrove, toward the beach. Coastal swamp forests and the gallery forests have not been differentiated for the savanna north of the Río Grande. The limits of the savanna north of the Río Patuca is from data supplied by Fred H. Vogel of STICA, Tegucigalpa. (Map drawn by Dr. Brigham Arnold)

priate for this particular plant association as its limits approximate closely those of the territory originally occupied by the Miskito Indians.[2] Their descendants, with a generous admixture of Negro and White blood, are still the most numerous inhabitants of this thinly-settled coast of Central America where both the English and the Miskito languages are more commonly heard than Spanish.

At its most westerly extension on the north bank of the Río Coco (Río Wanks) the Miskito pine savanna reaches more than 100 miles inland from the coast, but its average width is closer to 30 miles. Gallery forests mark the courses of each of the several rivers which cut across the savanna in slightly entrenched channels of which the larger, the Río Patuca, Río Coco, Río Prinzapolca, and Río Grande, are all navigable deep into the interior. Pines occur chiefly on the higher, better drained surfaces interspersed with palmettos and scrub hardwoods which often occur as islands in the savanna. Extensive tracts of seasonally inundated land along the coasts, as behind Cape Gracias á Dios, are treeless marshes. Mangroves and freshwater swamp trees fringe the coastal lagoons and estuaries. Even toward the interior, where pine-covered gravel ridges reach elevations of 500 feet or more, there are fairly extensive, ill-drained flats of grey-blue clay soils supporting only sedges and palmettos.[3] The total area mapped as savanna south of the Río Coco in Nicaragua approximates 2.5 million acres, but of this nearly one-third may be "hardwood islands," gallery, and swamp forests. An area almost as large lies to the north, most of which is within the so-called "disputed territory" which is claimed by both Nicaragua and Honduras, but, except for the immediate banks of the Río Coco, actually administered by the latter.[4]

The northern and southern limits of the coastal Miskito savanna are clearly edaphically conditioned. On the north, beyond low-lying Cape Camarón, the rugged Sierra de Esperanza comes down to the sea to pinch out the gravel shelf. These

[2] Eduard Conzemius, "Ethnographical Survey of the Miskito and Sumu Indians of Honduras and Nicaragua," *Bureau of American Ethnology Bulletin 106* (Washington, 1932). "Mosquito" (Mosquito Coast, Mosquito Territory) has been the spelling generally adopted by the English, originally under the erroneous assumption that the name owed its origin to the insects. I have here adopted the alternative spelling "Miskito" which avoids that confusion. The Spaniards called the Indians "Moscos" and the area "Mosquitia" or "Costa de Mosquita." In general mosquitos are neither particularly numerous nor bothersome in this area today.

[3] There is an early recognition of the association of pines with better drained savanna soils in the remarkable report by a German commission appointed by Prince Carl of Prussia and the Duke of Shoenburg-Waldenburg to investigate the colonization possibilities of the Miskito Coast. A. Fellechner, Dr. Muller, and C. L. C. Hesse, *Bericht Über die im hochsten Auftrage. . . . bewirkte Untersuchung einiger Theile des Mosquitolandes.* Berlin, 1845.

[4] Although the Río Coco was made the boundary under the King of Spain's 1906 arbitration award it was never accepted by Nicaragua. In 1953 Nicaragua police exercised jurisdiction for a few miles north of the Río Coco and there were Nicaraguan schools on both sides of the river. However the only Nicaraguan military post north of the river was at Cape Gracias á Dios, a Nicaraguan settlement which was moved from the mouth of the river to a site upstream on the north bank following the hurricane of 1941. The nearest point clearly under Honduras was Auka, 18 miles from the Río Coco, where there was a Honduras mayor, Honduras money, and people who considered themselves Hondureños.

gravels are not to be found on Bonacca (Guanaja) Island, 60 miles northwest of the cape, where there is a small stand of Caribbean pine. To the south (Fig. 2), high forest replaces the pine beyond Pearl Lagoon as the quartz sands and gravels give way to the striking red, friable clays of the Cukra Hill mafic igneous complex and the basalt flow at El Bluff (elevation 200 feet) which protects the entrance to Bluefields Bay.

The interior boundary or "bush line" (Fig. 3) between pine savanna and high evergreen forest (a dense tropical *monte* as much as 120 feet tall) is almost everywhere sharp. Silicious sand and gravel soils, often containing a mottled, imper-

FIG. 2. Southernmost extremity of the Miskito pine savanna between Pearl Lagoon and Cukra Hill. The surface soil, a sugary quartz sand, is bared in foreground by ruts of old logging road. Mangrove swamp in background.

vious subsoil with iron concretions, characteristically support a savanna vegetation; the high forest occurs on the crumb-structured humic clays of superior water-holding capacities which are found towards the interior.[5] The "bush line" seems not to be related to topography (save possibly near Cape Camarón) and it is some distance inland from it that the land rises above the 700-foot contour. *P. caribaea* stops abruptly with the savanna at the margin of the high broadleaf forest, but is said to recur locally in the arid hill lands of interior Honduras. There, however, the *ocote*

[5] This relationship seems to have been first noted by Hugh Bennett, "The Soils of Central America and Northern South America," *American Soil Survey Association Bulletin,* I, No. 6 (1925) : 69–81. Karl Sapper also recognized the soil as the factor determining the boundary of pine savanna and high forest on the Miskito Coast in "Klimakunde von Mittelamerika," *Handbuch der Klimatologie,* IIH, W. Köppen and R. Geiger, eds. Berlin, 1932. p. 58.

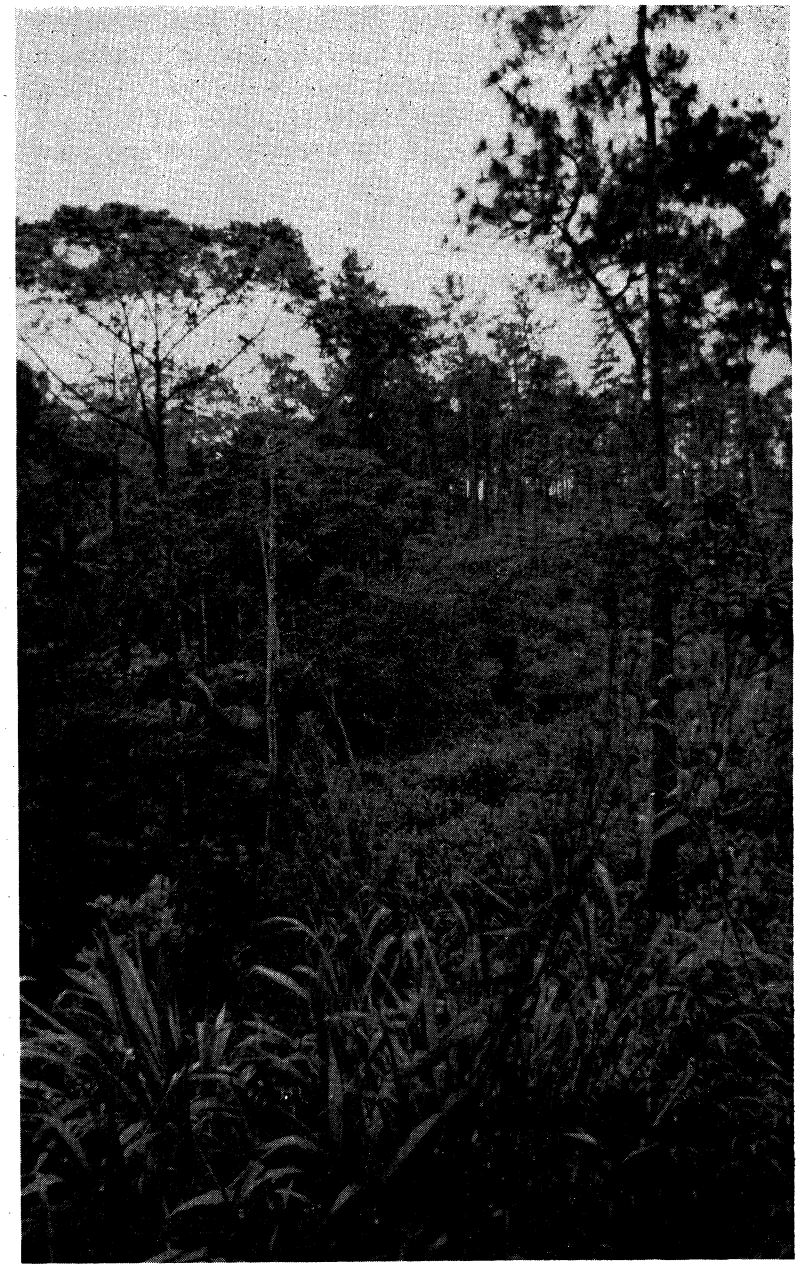

FIG. 3. The "bush line" near Awastigny showing dense growth of tall grasses of sort never found further out on the savanna.

pine (*P. oocarpa*) is the dominant conifer.[6] In British Honduras, too, the Caribbean pine occurs not only on the coastal "pine ridges," but also at elevations of more than 3,000 feet on Mountain Pine Ridge along the Guatemala frontier.[7]

THE ORIGIN AND NATURE OF THE GRAVELS

The origin of the extensive, low-lying gravel surfaces, which petroleum geologists have termed the Puerto Cabezas beds, has puzzled observers. They appear to have been laid down during periods of higher sea level by torrential rivers originating in the much deformed Cretaceous-Tertiary gneissic and igneous highlands at the headwaters of the Río Coco and Río Patuca in northern Nicaragua and southeastern Honduras. Limestone occurs extensively within these forested mountains, and there are thick sections of argillites and quartzites, together with quartz-rich sandstone conglomerates.[8] The absence of softer igneous materials and the preponderance of water-worn quartz gravels and sands suggested to Hershey[9] nearly 40 years ago that the gravels had been reworked by marine action on one or more occasions with the consequent separation of the softer materials from the harder quartz. The virtual absence of bedding planes within the gravels may support this hypothesis. Rapid tropical weathering has obliterated the fossil evidence, but it seems probable that some marine deposits are incorporated within the Puerto Cabezas beds. From the air dendritic gully erosion is here and there conspicuous, especially in the hilly areas of savanna as are found inland from Bragman's Bluff.

There appear to be no persistent terrace levels preserved which can be correlated readily with higher stands of the sea in the past, for their dissection is far advanced. Moreover, late Pleistocene warping and faulting is demonstrable. Remnants of at least two well-marked river terraces associated with the general rejuvenation which led to the entrenchment of the savanna rivers are, however, recognizable in some areas. At Bragman's Bluff, a much-dissected 150-foot wave-cut beach cliff, is one of the few places where pines come down to the sea. At the

[6] Paul J. Shank, "Forest Resources of Honduras," *Proceedings of the Inter-American Conference on the Conservation of Renewable Resources, Denver, 1948.* Washington, 1949. pp. 559–63. Frederick H. Vogel, *Forestry in Honduras.* Institute of Inter-American Affairs, Washington, 1952. 18 pp. The taxonomy of the pines of Honduras remains to be worked out. There is a possibility that there is more than one species on the Miskito savanna. Francisco Altschul, "Informe sobre Territorio de la Mosquitia," *Revista del Archivo y Bibliografía Nacional* (Tegucigalpa), XV (1927) : 576–79, 657–60 mentions two distinct types of pines on the Honduras savannas along the lower Río Patuca, one the "common Baltimore pine," the other "a Rosemary or shortleaf pine" which branches closer to the ground (p. 658). This may refer, however, only to the often-observed correlation between needle length and growing site.

[7] A. F. A. Lamb, "Pine Forests of British Honduras," *Empire Forestry Review,* September, 1950: 219–26. E. E. M. Loock, "The Pines of Mexico and British Honduras," *Union of South Africa Department of Forestry Bulletin 35,* Pretoria, 1950.

[8] Letter from Dr. Roy A. Wilson, Department of Geology and Geography, Rollins College, Winter Park, Florida, July 22, 1953. Dr. Wilson was formerly Geologist with the Gulf Oil Corporation in Nicaragua.

[9] Oscar H. Hershey, "Geological Reconnaissance in Northeastern Nicaragua," *Geological Society of America Bulletin,* XXIII (1912) : 493–516.

Puerto Cabezas pier, four miles to the south, the cliff is perhaps 40 feet high, disappearing entirely toward the mouth of the Río Wawa. The tilted strata exposed at Bragman's Bluff indicate fairly extensive warping of the Pleistocene gravel beds which here have a thickness of at least 75 feet. They are underlain by vari-colored clays and gravel lenses of more consolidated marine deposits (the Bragman's Bluff beds) which are probably of Pliocene age.[10] The lowest visible member of this series is a well-cemented and resistant sandstone which forms a wave-washed ledge several feet wide just above high tide.

In the vicinity of Brewer's Lagoon in Honduras, von Hagen[11] reports old pine stumps standing in depths of water up to 20 feet, evidence that the relationship between land and sea has been undergoing rapid change in the recent past.

Curiously, the size of the water-worn quartz gravels decreases from the Río Coco southward along the coast. At Puerto Cabezas they are marble-sized and larger; at Karawala, they are a pea-gravel; and at Pearl Lagoon, a fine quartz sand. This gradation in size southward is much more conspicuous than any decrease in size from the interior toward the sea and would seem to indicate either that the gravels were laid down by streams quite unrelated to present-day drainage patterns or that sorting by the southward setting shore current was active during periods of marine transgression.

CLIMATE

The Miskito Coast is drenched with rain throughout most of the year. Average annual rainfall probably exceeds 100 inches everywhere within the pine-grassland area, reaching 150 inches to the south in the neighborhood of Bluefields (Table I). Average daily temperatures range narrowly between 76° F. (January–February) and 81° F. (May–June) with sensible temperatures being lowest during the spring months when Trade Winds blow most steadily. Despite the high annual rainfall there is a marked dry season which usually sets in about mid-February and continues into the first week of May. March and April are the driest months, but protracted drought is rare. At Bluefields, for example, over a 21-year period there has never been a rainless month. The average two-month precipitation for March and April at Puerto Cabezas is 4.38 inches; for Bluefields, 5.79 inches; for Iriona, at the northern margin of the savanna in Honduras, 2.44 inches. Critical levels of soil moisture are reached, however, in these months when the herbaceous cover withers and dies and low fires smoulder the length and breadth of the savanna. The occasional showers that fall during March and April, together with the heavy dews, are usually sufficient to induce sprouting in the recently burned savanna grasses and sedges, the roots of which are undamaged by the light burns.

Precipitation values at Puerto Cabezas, on the coast, are remarkably similar to those recorded at the gold mining camps inland 60 to 70 miles within the high

[10] One of the two exploratory wells drilled in 1947–48 near Puerto Cabezas by the Gulf Oil Corporation reached basement at 6,235 feet.

[11] V. Wolfgang von Hagen, "The Mosquito Coast of Honduras and its Inhabitants," *Geographical Review*, XXX (1940): 238–59.

evergreen forest. The annual average for Puerto Cabezas is 129.15 inches; for Siempre Viva Gauging Station (elevation 1,050 feet), 116.22 inches; for Bonanza (elevation 760 feet), 117.13 inches; for Yy River Power House (elevation 900 feet), 130.60 inches; for El Gallo (elevation 100 feet), 123.32 inches. All of these are from records of 10 to 19 years length. A rain-shadow location probably explains the lower figure of 80.56 inches for the 16-year record at Siuna (elevation 575 feet) although there is a suggestion that the rainfall values in the southern interior foothills are somewhat lower than those along the immediate coast. At the El Recreo Agricultural Experiment Station the five-year average is 122 inches or 30 inches less than either Bluefields or Cukra Hill for the same period, both of which lie due east near the coast. On the other hand, recent 12-month records from Karawala

TABLE I

AVERAGE MONTHLY RAINFALL, EASTERN NICARAGUA
(In Inches)

	Bluefields (*1921–26; 38–52*)	Siuna (*1936–52*)	Siempre Viva (*1939–52*)	El Gallo (*1927; 1931–39*)	Bonanza (*1939–52*)	Puerto Cabezas (*1927–50*)
Jan.	10.33	3.27	7.91	7.32	5.76	7.92
Feb.	5.05	1.83	4.43	2.74	3.69	3.37
March	3.34	1.05	1.91	1.67	2.27	2.41
April	2.45	1.21	1.81	1.19	2.55	1.97
May	10.54	7.97	10.13	6.85	11.03	8.04
June	21.19	15.53	15.62	16.98	19.86	18.03
July	26.03	10.68	17.25	20.93	16.57	17.42
August	21.07	9.58	13.63	17.94	13.27	15.41
Sept.	12.48	11.65	13.13	14.83	12.78	15.81
Oct.	12.42	9.56	10.07	14.52	11.69	14.73
Nov.	14.54	4.65	9.20	8.08	8.62	13.53
Dec.	15.77	3.63	10.28	10.17	9.04	11.09
Year	155.21	80.56	116.22	123.32	117.13	129.73

(135.46 inches) and Macantaca (144.97 inches) show somewhat higher precipitation for the more interior location.[12]

Throughout the length of the coast precipitation is highly local in character and a wet year in one section may be a dry year elsewhere. The driest year in the Puerto Cabezas record (1931, 94.81 inches) was followed by a record-breaking 184.93 inches in 1932. In the longer record for Bluefields, extremes of 60.19 inches (1935) and 200.11 inches (1927) have been recorded, the former figure being less than half that for the next driest year, 1939, with 126.40 inches. Extremes at

[12] Rainfall data cited have been obtained from the following sources: Standard Fruit & Steamship Co. and U. S. Weather Bureau (Puerto Cabezas); Neptune Gold Mining Co. (Bonanza, Siempre Viva); La Luz Mines, Ltd. (Siuna, Yy River); Empresas Nolen, S. A. (Karawala, Macantaca); Cukra Development Co. (Bluefields, El Gallo); U.S.D.A. (Cukra Hill, El Recreo); Koppen-Geiger, *Handbuch der Klimatologie,* II H (Iriona).

Bonanza have been 95.32 inches and 141.50 inches; at Siuna, 57.51 inches and 101.53 inches. In general, annual rainfall increases southward along the coast, a fact which must contribute to the more rapid growth of pines and wider spacing of tree rings in the southern extremity of the savanna. A three-year record for Iriona, Honduras, averages 98.78 inches, which compares with 129 inches for Puerto Cabezas and 155 inches for Bluefields. South of Bluefields, where the mountains come down to the sea, the annual precipitation is even greater, exceeding 250 inches at San Juan del Norte on the Costa Rican frontier.

A single precipitation maximum which usually occurs in July (at Bonanza and Siuna in June) is characteristic throughout the savanna. In contrast, on the "banana coast" of Honduras beyond Iriona, pronounced November maximums are registered at all stations.

Although hurricanes occur with much less frequency than in the Antilles, they are nevertheless a conspicuous climatological feature of the Miskito Coast. Most tropical disturbances occur in late September and October, at the end of the Caribbean hurricane season. Occasionally one strikes at the beginning of the season, in late May or early June. From mid-June to mid-September hurricane development centers much further eastward in the Atlantic Ocean and the tracks of those storms which enter the Caribbean area lie well to the north of Cape Gracias á Dios.

SAVANNA AND FOREST SOILS

The Miskito Coast is probably the rainiest area of its size in the New World with a savanna-type vegetation. For so extensive a tropical grassland, either with or without trees, to occur under an average rainfall of 100 to 150 inches with so abbreviated a dry season clearly contradicts once more the traditional concept of the "savanna climate."[13] Pines have been described from widely separated areas in the temperate latitudes as being far less demanding of nutrient values than broadleaf trees, but it is by no means certain that this holds true in the tropical pine savannas. Existence of islands of hardwoods within the Miskito savanna on sites similar to those occupied by pine and grass suggest that geology alone does not hold the key to the distribution of vegetation types here.

For the most part, the surface soils of the savanna are a light grey in color, becoming darker where drainage is poorest. Wherever gully erosion has been active, or where ant-hills or hurricane-uprooted pine trees are found, yellow-red subsoil is characteristically exposed at the surface. Neither tree roots nor percolating rainwater can easily penetrate this B horizon, a poorly aerated and mottled gravelly clay. While the quartz gravels in the top layers of the soil are little weathered, being white and hard, they become increasingly iron-stained and crummy with depth. Irregular-shaped iron concretions are sometimes found within the top four to five feet of gravels; with the quartz pebbles they frequently accumulate on the surface like "desert pavement."

[13] Carl O. Sauer, "Grassland Climax, Fire and Man," *Journal of Range Management*, III (1950) : 16–21.

The micro-climate at ground level is very distinct as between forest and savanna. The hot tropical sun gets directly to the exposed savanna soils, so raising the surface temperatures as to increase greatly the rate of evaporation, of humus combustion, and of soil development. The breakdown of silicates to clays is accelerated and the clay particles, which under forest conditions would tend to be flocculated by humus, are free to move downward and to accumulate in the subsoil, this process being most rapid in coarse textured soils.[14] With increasing impedance of soil drainage the impermeable horizon would gradually extend upward. Such colloid accumulation would be especially favored on relatively level sites where there is a marked fluctuation in the water table between wet and dry periods or where sheet erosion has clogged the original drainage channels.

While the micro-climate is not a cause, but an effect, of the vegetation cover it must have an important influence on the rate and nature of soil formation and on the perpetuation of a savanna vegetation once that has been established. The basic questions would seem to be "which came first, pine savanna or impeded soil drainage?" and, in either case, "to what extent may man and fire have been involved?"

THE CASE FOR A FIRE-SAVANNA

Where soils have been used for some time, have become depleted, and have been given up, pines are known to establish themselves where few other trees can survive. O. F. Cook long ago suggested that the pine forests of the highlands of Central America with their characteristic herbaceous understory usually are a secondary formation, the aftermath of clearing and burning of mixed montane forests by native agriculturists.[15] It seems highly improbable that the Miskito savanna surfaces were ever farmed extensively, at least in their present highly leached state. Moreover, the native Indians of the region were at best casual farmers who took their living chiefly from the sea and the hunt. Although their cultivations have probably always been restricted to the narrow strips of alluvium along the streams

[14] It would be instructive to know more about the relative fertility and composition of savanna and forest soils where found side by side. Samples of six savanna and two forest soils from the Nicaragua side were subject to laboratory analysis by Dr. Frank Harradine, Division of Soils, University of California, Berkeley. The soils were acid, but not extremely so, the pH ranging from 5.0 to 6.0 (determined by Beckman pH meter glass electrode at saturation). Organic matter (Cx 1.742 per cent) content of the surface soil was surprisingly high: in contrast to the classical relationship within the temperate zone, higher in the forest soils (5.80 and 8.35 per cent) than in the grassland soils (1.67 to 5.00 per cent). Nitrogen content of the two forest soils (0.37 and 0.57 per cent) was much higher than in samples taken a few yards away across the "bush line" within the pine savanna (0.06 and 0.07 per cent). The carbon-nitrogen (C: N) ratio was relatively high (14.5 to 21.9 on pine savanna soils; 8.4 and 9.0 on forest soils), suggesting that the decomposition of humus here may be less rapid than has commonly been supposed under tropical conditions. However, any charcoal particles in the soil would have added to the carbon values so that the evidence for organic matter accumulation is not entirely convincing.

[15] O. F. Cook, "Vegetation Affected by Agriculture in Central America," *U.S.D.A. Bureau of Plant Industry Bulletin 145,* Washington, 1909.

and behind the coastal beach ridges, it appears that they have habitually burned the savannas for as long as anyone can remember, whether to aid in hunting, to improve grazing, or simply for excitement. In more recent times foreign adventurers and lumbermen have followed their example. Such fires have not only suppressed the encroachment of broadleaf forest trees, but have also sharply restricted the regeneration of the pines themselves until, with the added pressures from the logging operations, there is a very real concern for the perpetuation of the pines as an element in the savanna association.

These coarse textured Pleistocene surfaces with their low water-holding capacity may always have supported a vegetation quite distinct from that of the primary soils developed on the tertiary rocks of the interior hill lands. Occasional clumps of scrub hardwoods standing as islands in the midst of the pine savannas are possibly remnants of what may once have been a xerophytic broadleaf forest which at one time covered the whole extent of this low and rainy coast.[16] Relative to the "fireproof" high evergreen forest, one can imagine that this lower scrub forest on the gravel surfaces might have been highly combustible. During the dry season, and especially during occasional years of prolonged spring drought, such a forest would have been extremely vulnerable to fire, which, while used by early man as a tool for both hunting and agriculture, must have been quite beyond his control.

Hurricanes, too, must have played an important role in opening up what may have been originally a dense canopy of forest trees, thus increasing susceptibility to recurrent burning.[17] Flames spreading through wind-thrown forest trees or through a standing, but combustible, scrub forest during the dry season would have bared the surface soil and inhibited regeneration of the primary forest dominants. Repeated with sufficient frequency such fires, fanned by the steady on-shore winds of this coast, would have contributed to the eventual degradation and impoverishment of the surface soil through accelerated sheet wash, humus destruction, and leaching with consequent development of clay accumulations under a sand and gravel topsoil. These ill-drained senile soils, so characteristic of the Miskito savannas, may thus be envisoned as the product of forest removal through recurring

[16] Professor Robert L. Pendleton of The Johns Hopkins University who has visited the Miskito Coast offers another possible explanation of the origin of these interesting hardwood islands which deserves further investigation. He writes (personal communication, March 26, 1954): "These islands had been studied by a man who described them to me when I was there. They were believed to be the site of former camps of the Miskito Indians, for such sites would be protected from fire, and the soil had been enriched by wastes defecated, ashes, and other refuse. It was considered that when the growth got too dense, cutting off the breeze which was depended upon to blow the mosquitos and other insects away, the camp was moved to an open part of the savanna. There seemed to be no difference in the texture of the soil, but the color was darker in the "islands," as one would expect, and the reaction according to my informant was nearer neutral. The "island" forest is kaingined, so the soil is useful."

[17] The puzzling occurrence of extensive areas in the uninhabited rain forest behind Pearl Lagoon with single-specie dominants is tentatively attributed by Archie Carr, *High Jungle and Low*. Gainesville, Florida, 1953, to hurricane blow-downs which have opened up the forest canopy and permitted the establishment of a sun-loving secondary vegetation.

burning and subsequent acid soil hydrolysis, the breaking down of silicates to clays, and the interruption of the cycle of mineral nutrients crucial to the maintenance of tropical forest growth. As the soils became progressively degraded, fire-resistant and sun-loving grasses, sedges, and pines, probably less demanding of mineral nutrients, would have colonized the more vigorously, to the eventual exclusion of the more fire-vulnerable growth.[18]

Woodsmen familiar with the area report the existence of occasional pockets of mature pine along the margins of the savanna which are surrounded or nearly surrounded by scrub monte. This suggests to them that the hardwood forest may now be in the process of shading out pine and grass and recolonizing the savanna wherever fire is suppressed. I regret that I was unable to verify this and to observe more closely the relationship of soil to vegetation along the "bush line" during my visit to the Nicaraguan portion of the savanna. Therein undoubtedly lies the answers to many of the questions raised in these pages.

THE ROLE OF DRAINAGE IMPEDIMENT

J. S. Beard, in his general survey of the savannas of northern tropical America,[19] considers the lack of aeration, for which brilliant mottling is sure evidence, to be crucial in the differentiation between forest and savanna soils together with the alternate water-logging and dessication which this poor drainage promotes. In the rainy months water collects in the sandy surface horizon over the clay and the soil becomes saturated, whereas during the dry season the surface completely dries out and the grass and trees, having no deep roots, are subjected to severe dessication. While such drainage impediment is not found everywhere, it is at least widespread within the Miskito savanna. One of the striking characteristics of the pines on the more level sites is the apparent absence of tap roots, indicated by the great number of blow-downs as well as the radial, pad-like root system which is frequently exposed on the surface. For the development of such impervious horizons the acceleration of laterization and the downward migration of clays which the removal of an original broadleaf forest would have promoted can quite reasonably be called upon in explanation.

These impermeable clay horizons actually need not always be considered the normal product of soil weathering under high rainfall and constantly high surface

[18] A similar argument that succession here has been from evergreen forest to pine savanna is to be found in J. B. Kinloch, *Brief Review of the Forest Resources of Nicaragua,* Managua, February, 1950, an unpublished 12-page manuscript in the Library of the U. S. Department of Agriculture, Washington. See also Felix Rawitscher, "Die Erschopfung Tropischer Boden infolge die Entwaldung," *Acta Tropica* (Basle), III (1946) : 211–247. A partially analogous case may be that described by Frank E. Egler, "Southeast Saline Everglades Vegetation, Florida, and its Management," *Vegetatio* (Den Haag), III (1952) : 213–265 in which it is convincingly contended that "the herbaceous Everglades and the surrounding pinelands were born in fires; that they can survive only with fires; that they are dying today because of fires." (p. 227)

[19] J. S. Beard, "The Savanna Vegetation of Northern Tropical America," *Ecological Monographs,* XXIII (April, 1953) : 149–215. Beard, however, was not personally familiar with any of the Caribbean area pine savannas.

soil temperatures. Occasional beds of dirty white volcanic tuff (dacite-andesite pumice, degraded almost to bentonite) also occur within the gravels and where these are at or near the surface (e.g., at the Waspam airstrip) mottling and impeded drainage are frequently conspicuous.

In British Honduras Charter[20] has envisioned *P. caribaea* as a successional species which becomes established only as alluvial soils age and drainage becomes progressively impeded, but which eventually dies out with further impediment of drainage to be replaced by treeless grass and sedge savanna. The implication here seems to be that, given time, all tropical forest soils become degraded sufficiently no longer to support a high forest. This thesis seems highly questionable in view of the known antiquity of the tropical forest of the Amazon and Congo basins.[21] In any event, the Miskito pine savanna, developed on Pleistocene gravels, can scarcely have the great age which would seem to be required to support this argument. We obviously need to know much more about the time factor in tropical soil formation as well as the effect of forest removal on micro-climate and rates of soil development to speak with any assurance here. It appears well established, however, that the tropical high forest is self-perpetuating until man destroys the cycle and the forest-soil system and dissipates the nutrients.

THE PINE-SAVANNA PLANT ASSOCIATION

In general aspect the open, park-like Miskito savanna bears an extraordinary resemblance to the pine flats of Louisiana or Florida. Where pines occur they are usually widely spaced and straight boled with few low branches. Average diameters for mature trees are probably not much over 16 inches, with heights of from 60 to 100 feet. Merchantable stands average from 3,000 to 5,000 board feet to the acre, reaching maximums of 10,000.[22] On the inner margins of the savannas where fires are probably less frequent and soil conditions perhaps more favorable, stumps of up to 36 inches in diameter may be seen. However, the slow-growing timber of the poorly drained soils is more highly prized in the European export market where a knotless, high density, high tensile strength wood is required. The "four-lining" of logs measuring upwards to 20 by 20 inches by 30 feet for the overseas market rather than the sawmill operations has made operations profitable for foreign lumbermen here in the past. Only the coarser-grained wood is sawn into lumber.

[20] C. G. Charter, *Reconnaissance Survey of the Soils of British Honduras.* Port-au-Spain, Trinidad, 1941.

[21] Louis Lauvaudan represents a view widely held by European foresters when, with reference to the rain forest of central Africa, he argues that "there is no connection whatsoever between the quality of the soil and the distribution or luxuriance of the primeval forest which grows on it;" that the soil owes its fertility to the existence of the forest and disappears with it. "The Equatorial Forest of Tropical Africa: Is Past, Present and Future," *Journal of the Royal African Society,* Supplement, XXXVI, April 1937. See also P. W. Richards, *The Tropical Rain Forest; An Ecological Study,* London, 1952, and R. L. Pendleton, "Agricultural and Forestry Potentialities of the Tropics," *Agronomy Journal,* XLII (1950) : 115–123.

[22] G. R. Fahnestock and G. A. Garrett, "Nicaraguan Pine (Pinus Caribaea Mor.)," *Tropical Woods,* LV (September, 1938) : 1–16.

Most of the pines being cut commercially carry from 80 to 100 tree rings, with 125 rings being close to the maximum reported. Probably more than one ring is produced in some years. In general, the heartwood is a reddish brown, the sapwood lighter colored. Termite damage occurs in about one-third of the trees, some of the worst infected often being left to re-seed cut-over lands, as is done in mahogany operations. Some trees 60 years or more of age may still be under the minimum diameter of 12 inches, yet mature and past their prime and unlikely ever to reach legal size.

The resin content varies greatly from tree to tree, but it is generally quite high. Early English accounts indicate a greater interest in the pines as a source of pitch for the Royal Navy than as a source of lumber. Commercial turpentining ventures were inaugurated in both Honduras and Nicaragua some 30 years ago but the ventures failed, perhaps more because of labor difficulties, theft of containers, fire losses, and transport difficulties than to any lack of resin flow.[23]

In some areas the only non-herbaceous species is the pine, but for the most part the pines are mingled with a sparse orchard vegetation of large, stiff, leathery-leaved brush and low gnarled trees with thick bark, especially *Curatella americana, Micronia* spp., *Byrsonima crassifolia, Calliandra houstoniana* and, less commonly, *Quercus, Crescentia* and *Mimosa.*[24] Clumps of palmetto (*Acoelorraphe?*) may occur with them (Fig. 4), but they are most common on poorly drained soils in the flats and adjacent to the mangrove-fringed coastal lagoons.

Most of the genera of herbaceous plants found in the Nicaraguan portion of the savanna are also represented in the piney woods flora of the southeastern United States. As there, they are characteristically arranged in scattered clumps with bare soil between. *Cyperaceae* are sufficiently widespread that the designation "sedge savanna," which Beard associates with high rainfall areas, would seem to be appropriate.[25] They occur even on well-drained slopes, especially *Rhynchospora barbata* and *Bulbostylis paradoxus* (*Stenophyllus paradoxus*), the latter a peculiar little upright sedge locally called "niggerhead" whose fire-blackened aerial rhizome sheathed with old leaf bases give it something of the appearance of a shaving brush. It occurs most conspicuously on hill slopes where a white quartz pebble pavement mantles the soil surface.

Among the bunch grasses the genera most conspicuously represented are *Trachy-*

[23] According to Dr. N. T. Mirov, Plant Physiologist of the California Forest and Range Experiment Station, Berkeley, chemical analysis of pitch samples collected by me from pines at Karawala, Nicaragua, show a distinctive and much more complex set of turpenes than those found in the slash pine of the southeastern United States. The presence of substantial quantities of phellandrene, carene, and longifolene turpenes emphasizes the distinction between the Miskito Coast pine and the slash pine (cf. footnote 1).

[24] Botanical determinations of species and genera cited in this section have been made by Jason R. Swallen and Lyman Smith of the U. S. National Herbarium, Washington, D. C.

[25] Beard, *op. cit.*, p. 195, considers a sedge savanna as characteristic of swampy conditions of relatively small extent which alternate rapidly with forest and woodland. This does not fit the Miskito Coast situation well.

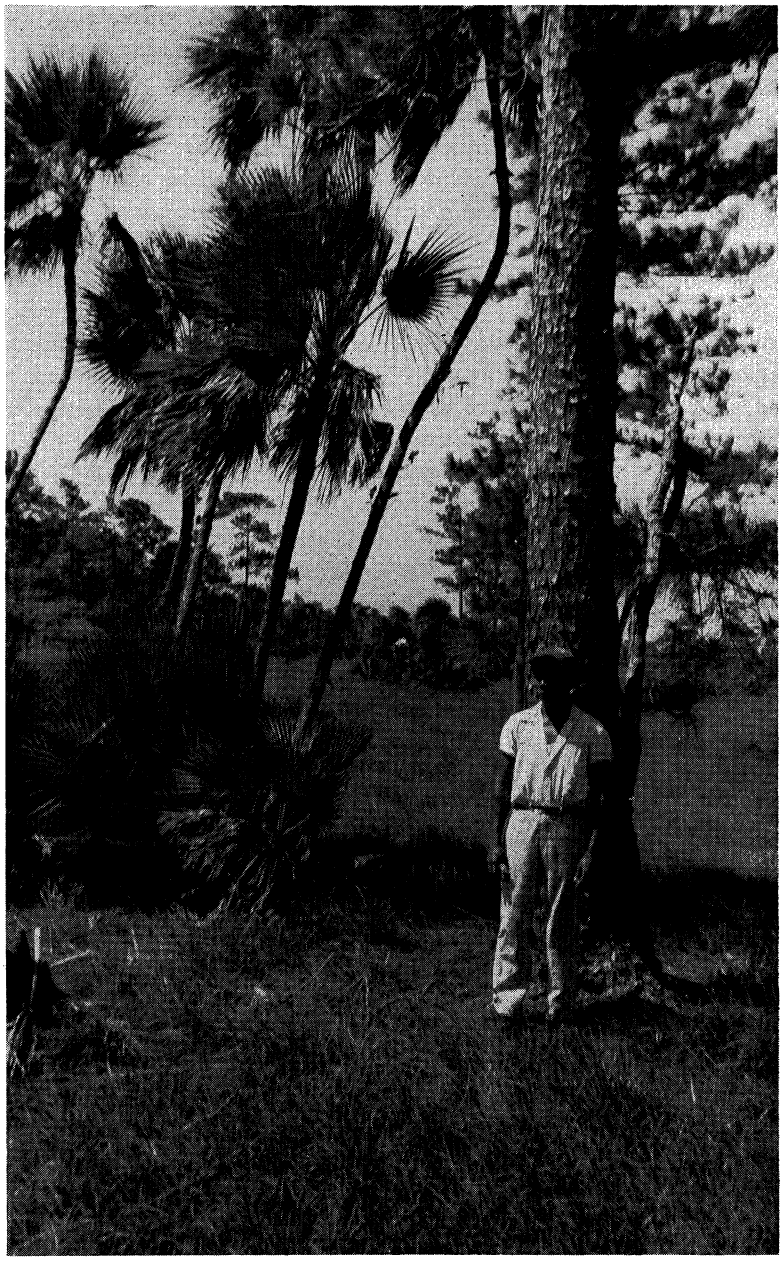

Fig. 4. Miskito Indian boy in front of mature pine growing in association with palmetto palms and short grass.

pogon, Andropogon, Paspalum (grama), *Aristida* and *Leptocoryphium,* possibly in that order. The sward-like gramas are especially on the better soils. Along the margins of the high forest, in the "tension zone" between savanna and monte, these shorter grasses give way to the tall *Arundinella deppennae, Ischaemum latifolium,* and a species of *Tripsacum* locally known as *"teocinte."* These head-high grasses of superior grazing value may well be pioneers in the process of invasion of the savanna by the monte. It would be useful to know in detail the nature of the soil transition from low grass savanna to high grass savanna to forest. The pines which occur with these tall grasses along the "bush line" characteristically are superior specimens of larger than average diameter, perhaps because fires are less frequent here than in the short grass-sedge areas.

Everywhere the high forest environment, damp, dark and insect-infested, contrasts sharply with the open sunny landscape of the pine-bunch grass-sedge savannas where monkeys and parrots chatter incongruously amidst the upper branches of orchid-festooned pine trees. Within the monte or "mahogany bush" there is an extreme diversity of species. Palms and bamboos are prominently represented as are such economically significant rain forest genera as *Swietenia* (mahogany), *Cedrela* (Spanish cedar), *Calophyllum* (Maria), *Carapa* (*cedro macho*), *Hieronyma* (*nancito*), *Dalium* (*comenegro*), and *Castilla* (*caucho*).[26]

STOCK-RAISING ON THE SAVANNA

Although stock-raising has never been of any real importance on the Miskito savannas the possibilities of developing it into a profitable export industry suggested itself to observers from earliest times. Hodgson noted in 1757 that "cattle and mules might be had very cheap in the savannahs, which with proper treatment would make fine pasture," adding that Jamaica's mule requirements could be wholly supplied from this coast.[27] The need for more vessels to carry cattle slowed up the evacuation of English settlers from Cape Gracias á Dios to Belize and Grand Cayman as called for by the Treaty of Madrid in 1786.[28] Cape Gracias, in fact, continued to make small shipments of cattle to Belize throughout the nineteenth century. At present the small amount of beef raised on the savanna goes to supply the gold mining camps at Bonanza and Siuna, a considerable portion of the stock coming from the Honduras side of the Río Coco. Exportation of livestock has

[26] For an extraordinarily vivid description of this forest as it exists behind Pearl Lagoon, Nicaragua, see Archie Carr, *op. cit.*

[27] Col. Robert Hodgson, *Some Account of the Mosquito Territory contained in a memoir written in 1757 . . . etc.,* 2nd ed. Edinburgh, 1822. p. 37. In 1774 Edward Long wrote that "the beef of the savannahs near Cape Gracias á Dios is superior to the North American, and takes salt well." *The History of Jamaica.* London, 1774. p. 318. According to Young the English stock-raising efforts had ended in failure because the Indians had killed the settlers' cattle as well as slaughtering their own indiscriminately. Thomas Young, *Narrative of a Residence on the Mosquito Shore. . . .* London, 1842.

[28] Pedro de Obregon, "Diario de Occurrencias Particulares . . ." in *Relaciones Históricas y Geográficas de America Central,* Manuel Serrana y Sanz, ed. Madrid, 1908. VIII, pp. 221–27.

been a presidential monopoly in Nicaragua and this may have tended to restrict expansion of the industry. Distance from markets has to date restricted the growth of a livestock industry more than any possible nutritional deficiencies in the herbage, which is probably low in phosphorous and without apparent source of lime.

The sedges and grasses appear to have a high palatability for the better part of the year, the tendency toward rankness and coarseness being serious during the latter part of the rainy season. Cattle are said to be in the best shape at the end of the dry season, and this is the breeding season. In Louisiana, where conditions are somewhat similar, the nutritive value of grass and sedge (especially protein and phosphorous) is said to be highest when the leaves are young, decreasing as leaves mature; calcium content, on the other hand, is highest in full leaf and mature leaf stages of growth.[29] Some Miskito Coast ranchers feel that fencing and closer grazing might be beneficial. Others have experimented with plantings of *Hyperhennia rufa* and other introduced pasture grasses with some success. Water is available throughout the year from the numerous full-flowing streams which cut across the savanna, together with the succulent grasses which grow on the alluvial bottoms even when the savanna upland is in its poorest condition. Jaguars, the principal predators, are not a serious menace. The introduction of Zebú blood for crossing with the black creole types of cattle has not yet been attempted.

EARLY TRADE AND SETTLEMENT

As early as 1632 a trading station had been established among the Miskito Indians at Cape Gracias á Dios by English adventurers from the Puritan establishment on Old Providence Island, some 300 miles to the eastward.[30] From the beginning relations between natives and traders were amicable and a sort of symbiotic relationship soon grew up, nurtured in part by mutual antagonism towards the Spanish, that survived for better than two centuries. The Indians were superlative boatsmen and their talents were early and effectively channeled by the English into small-scale raiding expeditions against the thinly held Spanish settlements both north and south. Hijacked cacao, gold, and slaves were exchanged with the English residents of the "Shore" for gunpowder, rum and calico. From time to time Miskito Indians were taken to Jamaica, as in 1688 when they were used by the English as auxiliaries to put down a slave rebellion. Others shipped out on English and Dutch pirate vessels, of which there were few that did not carry at least one Miskitoman as a "striker" to supply fish or turtle for the mess table.

While enough food seems to have been grown to meet local requirements commercial plantation agriculture for export played little part in the British scheme of things. At the close of the 18th century the slaves from Colonel Hodgson's mahogany works at Bluefields began to be used to cultivate cotton on Corn Island; earlier

[29] Robert S. Campbell and John T. Cassady, "Grazing Values for Cattle on Pine Forest Ranges in Louisiana," *Louisiana Agricultural Experiment Station Bulletin 452.* Baton Rouge, 1951. p. 8.

[30] A. P. Newton, *The Colonizing Activities of the English Puritans.* New Haven, 1914.

a few small sugar plantations had been established on the banks of the Black River (Río Negro). There had been an early, but brief, interest in wild pita or "silk-grass" (*Aechmea magdalenae*) as a fiber plant, but the most important local products exported were sarsaparilla root, mahogany, hawksbill turtle shell, salted green turtle meat, and mules.[31] Although no logwood (Campeche wood) grew on the Shore, its bar-protected lagoons and friendly Indians made it the nearest place of refuge for the Baymen who were cutting this wood under Spanish surveillance at Belize and Yucatan.[32] The occupation of the northern portion of the Miskito Coast, and especially the Black River settlement, was closely related to the tides of fortune of these activities. By 1770 mahogany had replaced logwood as the principal export of Belize. The great development of cabinet and furniture making throughout Europe at this time must have encouraged the expansion of mahogany operations on the Miskito Shore, too, until the English evacuation.

As a matter of fact, the principal reputation of the Shore seems to have derived in those days from the salubrity of its climate. From the beginning it served as a sort of sanitarium for the planters of Jamaica whenever the "flux" or tropical fevers became oppressive.[33] In this respect, no distinction seems to have been made between the forested lands about Bluefields Bay and the open savanna country to the north. Indeed, as recently as 50 years ago New Orleans steamship companies were advertising the health attractions of "fever-free Bluefields." The reputation of the modern town (1950 population: 8,016) as a tropical pesthole is quite undeserved and probably stems from the association of the term "Mosquito" (Miskito) with the extraordinarily high rainfall of the area.

The British evacuation of 1786 was at best a half-hearted affair and the influence of the Crown on the Coast diminished but little. No longer a privateering base, its economy in the 19th century depended increasingly on the mahogany logs which were rafted down to the sea on its many rivers. Large-scale colonization plans,

[31] The export duty on sarsaparilla alone was said to more than pay the small expenses of the English administration on the Miskito Shore. Sarsaparilla exports in 1757 were 120,000 pounds (Hodgson, *op. cit.*, p. 17); in 1769, 200,000 pounds. Much of this went to Holland (Robert White, *The Case of the Agent of the Settlers on the Coast of Yucatan and the Late Settlers on the Mosquito Shore . . . etc.* London, 1793, pp. 47 ff). Mahogany from this coast, while plentiful, was coarser grained because of the higher rainfall than that from Belize and so less valued.

[32] The 1,124 persons reported residing under the British Resident Commissioner's jurisdiction on the Miskito Shore in 1757 included 133 white men and 21 white women and children (Hodgson, *op. cit.*, p. 15).

[33] Thomas Jefferys, *The West India Atlas.* London, 1775. p. 16, refers to the Miskito Shore as "one of the healthiest and most beautiful spots in the world." For many years the West India Pilot of the Royal Hydrographic Office carried the statement: "Be the cause what it may experience attests that men usually live here to a greater age than in Europe." A 1699 account, one of the earliest for this coast, describes a 103-year-old Englishman living at Bragman's "who can still walk out 20 or 30 miles a-hunting and bring back a deer on his back . . . which argues much for the healthfulness of that country." M. W., "The Mosquito Indian and his Golden River," *Churchill's Collection of Voyages and Travels,* 3rd ed. London, 1746. pp. 297–312 (reference p. 302).

both English and German, ended as fiascos. The scheming to capture the Atlantic terminus for the proposed Nicaraguan Canal led to the establishment under British aegis of the preposterous "Mosquito Kingdom" in 1860, but by this time the United States had begun to display a diplomatic concern for the area, the end result of which was assumption of complete jurisdiction over the coast south of Cape Gracias á Dios by Nicaragua in 1894. An influx of American speculators and tropical tramps followed for whom this conveniently accessible Central American coast seemed a likely place to set "Manifest Destiny" into operation.

PINE LUMBERING ON THE SAVANNAS

First rubber and bananas, then gold and mahogany, and most recently pine lumbering have provided brief fillips to the economy of the Coast, but resource depletion and plant disease, together with unstable governments, banditry and chronic labor shortages have never permitted any of the incipient booms to get really off the ground. Bluefields, especially, was the center for these hopes at the turn of the century. With an English language daily newspaper and steamship service to New Orleans or Mobile usually twice a week it seemed on the verge of becoming a major American outpost in the Caribbean. Freedom from yellow fever was one of its most publicized attractions. "We need only a Rhodes," wrote a local editor, "to make us the counterpart of Johannesburg."[34] But those days of hope are gone and, with their locational advantages forfeited to Colon, Bluefields and the Miskito Coast are today among the least known, least visited, and most forgotten parts of the entire Caribbean area. Place names like Kansas City, Chicago Farm, and Mississippi bear witness to the visions of American speculators in tropical agriculture, but only liana-covered secondary forest trees are left to mark their locations.

The pine forests of the Miskito Shore interested early observers more as a potential source of tar and turpentine and as a grazing resource than for their lumber. The wood supplied a convenient cooking fuel, of course, and it appears to have been used extensively for torches in night operations in the mahogany works.[35] Hodgson noted in 1757 that the pines "make good boards, planks, scantling and timbers but are too heavy for topmasts."[36] The curious fact that the wood often would not float was attributed to its high pitch content.

Although there appears to have been some sawn lumber shipped from Cape Gracias á Dios to Jamaica in the eighteenth century the first important commercial exploitation of the pine resource dates from much later. An 1892 account reports that there was a small American-operated pine mill on the Río Wawa, per-

[34] *The Recorder,* Bluefields, November 27, 1897.

[35] In British Honduras it was said that "but for the pine torches the hauling of mahogany, which, on account of the heat and the flies (mosquitos) takes place chiefly at night, could not be carried on." D. Morris, *The Colony of British Honduras, Its Resources and Prospects.* London, 1883. p. 57.

[36] Hodgson; *op. cit.,* p. 26. He describes two sorts of pines, "one very full of tar and turpentine, the other more free from it and whiter."

haps the first on the coast.[37] Mahogany, not pine, was the wealth of eastern Nicaragua and Honduras in those days and the history of the pine industry is intricately interwoven with complicated litigations over mahogany concessions, chiefly within the Nicaragua savanna. The George D. Emery Company of Boston in 1894 had obtained what amounted to a monopoly for cutting timbers of the East Coast of Nicaragua by consolidating two earlier concessions made by the puppet government of the Mosquito Territory, one to the Canadian J. C. Crookshank and the other to the Emery interests (in 1885 on the Río Grande).[38] In their eight years of operations under the Nicaraguan government, until a legal suit forced a close-down, the company had exported logs from the Río Grande to Boston at the rate of 1,000 logs a month. It had employed some 1,300 men in the works, mostly Indians, but including as many as 100 Americans. The company's operations in Colombia were dove-tailed with those in Nicaragua and ships from Cartagena or the Río Sinu often stopped at Río Grande to complete a load.

The Emery case was not settled until 1909 when the company withdrew from the country for a cash settlement of $600,000. Meanwhile several short-lived Nicaraguan governments had made conflicting grants to other groups for the specific purpose of developing the pine lumber resources of the coast which, by one interpretation, were not within the compass of the Emery grant.[39] In 1905, the Louisiana-Nicaragua Lumber Company, controlled by Lomax Anderson of Moss Point, Mississippi, had obtained an "exclusive" 50-year right to the pine forests of northeastern Nicaragua, together with a similar concession from the Honduras government to cut pines north of the Río Coco. By 1906 a small sawmill had been completed at Cape Gracias á Dios. Earlier, in 1903, the Dietrick syndicate (United States and Nicaragua Company) of Pittsburgh had obtained a vaguely worded concession to "mineral lands" south of the Río Coco which included a portion of the pine flats. With it went a monopoly of all steam navigation on the river and of all wharf and warehouse construction at the new town being erected at the Cape. Conflict among the Emery, Anderson, and Dietrick grants resulted in a hopeless mass of red tape and confusion and, aside from the earlier Emery mahogany exports, little lumber production. The Dietrick group for a time was very active at the Cape (renamed briefly Port Dietrick) where the population of 600 included over 50 Americans. The group later became involved in promotion of "plantation

[37] Courtnay DeKalb, "Nicaragua: Studies on the Mosquito Shore in 1892," *Journal of the American Geographical Society,* XXV (1893): 236–88, specifically p. 259. An anonymous 1780 "Report on the Miskito Country" in *Collection of the New York Historical Society,* XVII (1884): 419–31 tells of "some sawmills" being erected 100 miles up the Río Wanks "with a view of procuring lumber for the Jamaica markets." p. 426.

[38] Consular Reports, Bluefields, 1898 (#25–2, Feb. 7, 1898). National Archives, Washington, D. C.

[39] A wealth of materials on the early 19th century lumber concessions in Nicaragua and Honduras is to be found in the State Department papers in the National Archives, Washington, D. C. In the following reconstruction I have used these documents: Cape Gracias á Dios Post Dispatches, 1903–08; State Department Decimal File 817.52/34; 817.602; 817.617; 924.200; 924.267; 924.349.

lands" for sale to American investors along the Río Grande where it had obtained a "two-and-a-half-million-acre" grant with a promise to purchase certain government bonds. Sales had been made to 25 new "plantation companies" before the government finally renounced the original grant in 1914. Yet another grant, to a Managua Italian named Cagliaris, in 1908, was for the exploitation of the pine forests south of the Río Prinzapolca, but this title, too, was long fogged by political upheavals and revolutions.

Modern commercial pine lumbering dates from 1921 when a group of New Orleans and Slidell, Louisiana, lumbermen joined forces with the Vaccaro Brothers (who were later to found the Standard Fruit and Steamship Company) to establish the Bragman's Bluff Lumber Company, purchasing timber rights to 80,000 acres of land behind Bragman's Bluff "adapted to cattle raising or on which there are pine trees." Although there were conflicts with Indian Reserve land claims, the American company poured some five million dollars into the development, establishing the new town of Puerto Cabezas (named for a Nicaraguan patriot) and building deep-water port facilities and some 100 miles of railroad to service both the lumber operations and the new banana plantings along the alluvial bottoms of the Río Wawa.[40] A modern sawmill was moved here intact from Louisiana and a planing mill established. Exports of sawn lumber began in 1925. Revolutions and civil war greatly disturbed operations, more particularly in the banana business, and after 1931 banana plantings were abandoned.[41] In recent years the pine lands held in fee simple have been leased on a stumpage basis to the Robinson interests of New Orleans who have built an extensive network of logging roads throughout the savanna to the banks of the Río Coco at Waspam (Fig. 6) and Bilwaskarma. The town of Puerto Cabezas (1950 population: 3,464), with wharf and waterfront railroad facilities, remains the property of the Standard Fruit and Steamship Company (successors to the Bragman's Bluff Lumber Company). Facilities are leased both to the lumber company (now the Nicaragua Longleaf Pine Lumber Company—"Nipco") and to the two major gold mining interests in the interior at Siuna and Bonanza, which import supplies through "The Port." They are flown to the mines on cargo planes which use either the large new American-built Puerto Cabezas airfield, or the strip at Alamicambra at the head of barge navigation on the Río Prinzapolca. When the modern "Nipco" sawmill at Puerto Cabezas (capacity 60,000 board feet daily) burned to the ground in the spring of 1953 all mill operations were transferred to two portable mills located some 60 miles inland and closer to the remaining stand of merchantable timber.

There are two other smaller pine operations on the Nicaraguan section of the

[40] "A Magnificant Pine Operation in Nicaragua," *The Lumber Trade Journal* (New Orleans), Jan. 15, 1928: 22–23.

[41] The annual report of the Nicaragua Customs Service for 1929 referred to the Standard Fruit banana operations as follows: "The lands have not proven so fertile as supposed, the heavy rains washed out the bridges, the banana disease appeared and the production of bananas was very small for the acreage planted." *Report of the Collector-General of Customs,* Republic of Nicaragua, Administrator of Customs, Managua, 1930.

coast. Waddell's Prinzapolca mill is cutting on the Río Bambana while Empresas Nolen, S. A. (Standard Export Lumber Company) at Karawala has a 45,000 board feet capacity mill which is being supplied from operations behind Macantaca on the Río Grande. Because of the difficulty of crossing the shallow bars at the river mouths for all except the smallest vessels shipments are often loaded at Man-o-War Key, 12 miles off the coast.

North of the Río Coco commercial pine lumbering seems not to have been tried prior to 1946 when an American group set up a mill at Brewer's Lagoon and began to work a large concession of "longleaf yellow pine."[42] The difficulties of crossing the treacherous bar, together with the fact that the standing timber was disappointingly poor due to hurricane damage, led to early abandonment of the operation. The best stands of pines remaining on the Coast, however, lie north of the Río Coco within the so-called "disputed territory," but commercial cutting in the area does not appear likely to be politically feasible within the near future.

THE FUTURE OF THE PINE RESOURCE

The life expectancy of the coastal pine forests of the Miskito Shore cannot exceed a very few years. While the lumbermen have been cutting as much as 40 million board feet annually, termites, beetles, windfall, and, especially, fire have continued to take their toll. The importance of wind-fall is evidenced by the traces of large numbers of uprooted trees, all similarly aligned, that are seen in many areas. There is little fire damage to mature trees for crown fires are apparently unknown although root and basal trunk scars from burning grass may provide access to termites. The most serious effect of the fires is the killing of the young pine seedlings on which the regeneration of the forest depends. In many cut-over areas, moreover, only a very few small, non-merchantable trees have been left standing as seed stock for the future. Replanting, although required by law, is unnecessary, for the pines are prolific seed producers (Figs. 5, 8). What is needed is complete fire protection of cut-over areas for from five to ten years or until the natural regeneration has reached eight to ten feet in height. A simple system of firebreaks would accomplish much towards this end for often a narrow foot trail is sufficient to stop the flames.

At present there is no forester, no fire prevention crew, and no inventory of the merchantable timber still standing on this low-lying Caribbean coast of Nicaragua and Honduras. Like sarsaparilla, turtle, rubber, mahogany, and bananas before, pine lumbering, which has revived the economy of the coast in recent years, will soon drop off to insignificant levels. Under some semblance of a management program, a second crop of timber trees might be ready in another 50 to 75 years. The alternative would seem to be continued destructive fires and continued im-

[42] Jack Harper, "Lumber Heaven—Three Men Think They've Found It," *The Southern Lumber Journal,* July, 1947: 20ff. The president of the company, a Palatka, Florida, lumberman, had cruised the tract by air to select the most favorable site to start cutting. He was quoted as saying: "In 40 years of sawmilling in the South this is the best yellow pine [*sic*] I have ever seen."

poverishment of the pine resource.[43] A few small protected areas, as around the Moravian Church's mission hospital at Bilwaskarma, offer abundant evidence of the pine tree's capacity to reproduce itself here when given the chance.

LUMBER AND BANANA EXPORTS

Although the first pine shipments from Puerto Cabezas were logs destined to Honduras for use on Standard Fruit Company banana properties there, export markets for sawn lumber were rapidly developed, first in the Caribbean and later in Europe. Nicaraguan exports reached 9.6 million board feet in 1929, dropped off sharply during the early 'thirties and reached 8.2 million board feet ten years later,

FIG. 5. Unusually dense stand of young pine near Karawala. This area was probably cut over early, then protected from fire.

when shipments were three times the value of Nicaragua's mahogany exports. During World War II operations slackened, but with expansion of the Puerto Cabezas operations and those at Prinzapolca and Karawala pine shipments had climbed to a record 39.8 million board feet by 1952, valued at over two million dollars (U.S.). Of this, about two-thirds moved out of Puerto Cabezas (Fig. 7); the other third, from Karawala and Prinzapolca. In general, the large timbers of finer-grained wood move to European markets, the sawn lumber from coarser-grained stock to local Caribbean markets, especially Cuba, Jamaica, and Panama.

[43] Report of the FAO Mission for Nicaragua (United Nations Food and Agriculture Organization), Washington & Rome, 1950, and The Economic Development of Nicaragua (International Bank for Reconstruction and Development), Baltimore, 1952, both urge strongly the introduction of modern forest management principles to the wasting pine forest asset of the Caribbean coast.

In Nicaragua's economy exports of coffee, gold, cotton, and, occasionally, sesame seed have all ranked above pine lumber in value in recent years. Honduras' exports of pine are nearly double those from Nicaragua (in 1950–51 they accounted for ten per cent of that country's exports by value), but all of this comes from the highland pine forests of the arid interior. These extensive tracts of pine, extending into Nicaragua for some 75 miles in the neighborhood of Jinotega (Fig. 1), make it certain that Honduras production can be maintained for a considerable number of years even in the face of careless cutting methods and fire damage.

In neither Nicaragua nor Honduras are mahogany exports, once with bananas of major economic significance, any longer of much importance. The more readily

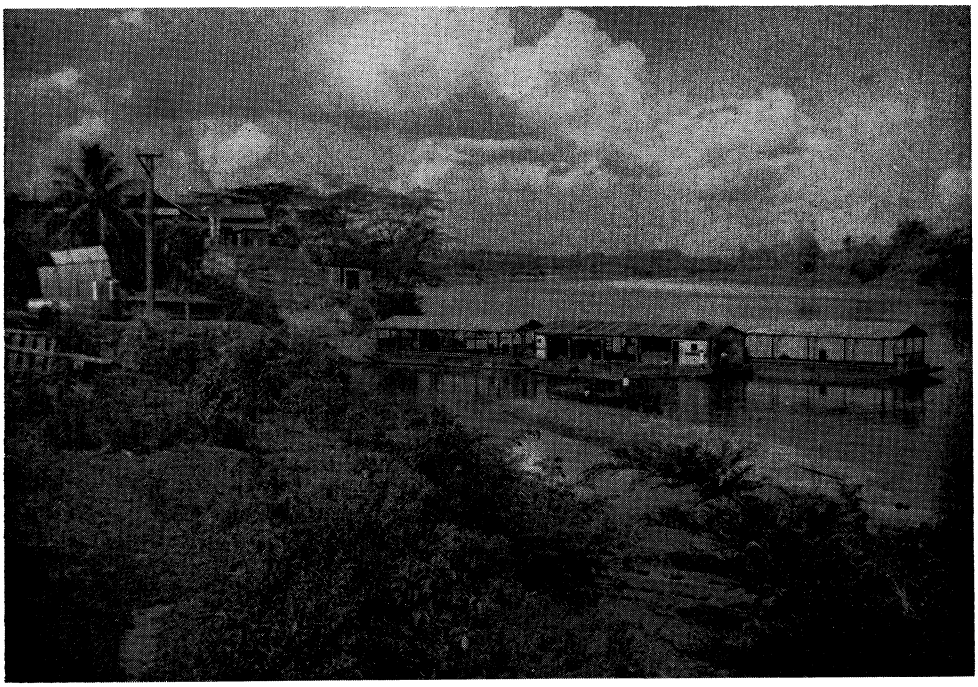

FIG. 6. The Río Coco at Waspam. Banana barges, in foreground, go upstream to San Carlos for fruit which are shipped from Cape Gracias to Tampa, Fla., on regular bi-weekly schedule.

accessible stands tributary to the navigable rivers on the Caribbean coast have been exhausted. Moreover, the system of concessions, in Nicaragua at least, is said to have discouraged investment in access-road construction. The revolution and banditry in 1925 and later seriously affected mahogany operations in both countries and by 1930 most of the large American concerns had pulled out.[44] With the return of peace and prosperity there has been some revival of the trade, with exports of ma-

[44] One U. S. mahogany concern still floats several thousand logs a year down the Río Coco from its upper reaches to Kisalaya (above Waspam) where they are sorted, made into rafts and taken down to Cape Gracias. The former sorting point at Boom, lower down on the river, has completely silted up.

hogany and cedar together reaching perhaps one-third the value of pine exports. Plantations of mahogany, cedar, and teak on abandoned banana lands along the Río Escondido by the United Fruit Company show much promise, but important production cannot be expected from these plantings for some years.[45]

Neither the United Fruit Company nor Standard Fruit and Steamship Company have grown bananas on this coast for 25 years. The former once had extensive properties both behind Bluefields and Río Grande in Nicaragua and between Cape Camerón and Trujillo in Honduras. Panama disease and Sigatoka disease are the twin culprits. The former, a soil fungus, is the more serious. It can only be fought by large-scale flooding of the land for periods of 5 to 6 months, as is being done in

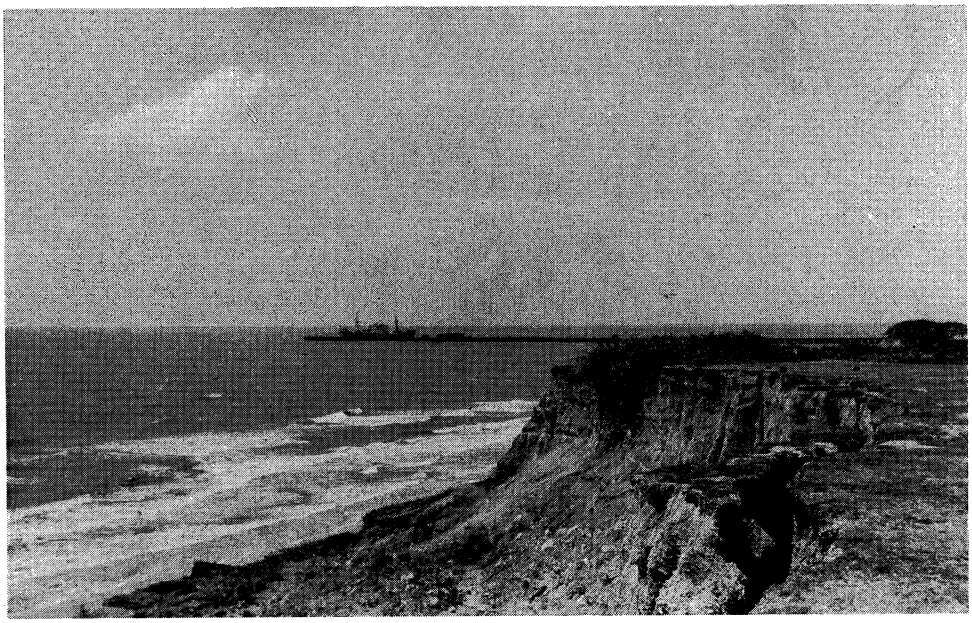

FIG. 7. Wave-cut cliff and Standard Fruit and Steamship Co. pier at Puerto Cabezas.

Honduras and Panama, but conditions on the Miskito Coast do not lend themselves to this sort of operation. In Nicaragua independent buyers still obtain native-grown fruit along the Río Coco, the Río Escondido, and the Río San Juan, and small bi-weekly shipments are made in refrigerated ships to Tampa, Florida. But this is a far cry from earlier days when bananas were the economic mainstay of the coast. They reached their peak production in Nicaragua in 1929 when exports exceeded four million stems and accounted for 27 per cent of all Nicaraguan exports by value. In the same year Honduras exported 29.8 million stems, a figure which had dropped

[45] Between 1896–1904 the Emery interests established nurseries and planted mahogany along roads and in openings on the Río Grande according to the requirements of Nicaraguan law rather than pay off inspectors as was the usual custom. In 1928 these plantings were cut over again with several hundred trees reaching diameters of 14 to 22 inches. F. Bruce Lamb, "The Status of Forestry in Tropical America," *Journal of Forestry,* XLVI (1948) : 721–26.

to 12.7 million stems by 1950–51. Honduras production today is confined to the fertile recent alluvial soils of the north coast (Trujillo to Puerto Cortez) where major flood reclamation operations can be used to cleanse the land of Panama disease fusarium and, at the same time, to deposit a thick layer of neutral silt.

CASTILLA RUBBER AND TUNU

Rubber, too, was at one time an important export from the Nicaragua portion of the Miskito Coast. The Castilla rubber tree is an important element of the mixed rain forest behind the "bush line" and the rivers draining eastward to the Caribbean through the savannas provided highways of commerce for the native

FIG. 8. Cut-over pine land along "Nipco" logging road between Puerto Cabezas and Waspam. Note excellent regeneration in foreground as result of protection from fire for two years.

caucho tappers. The earliest center of activity seems to have been the Río San Juan valley, shipments from San Juan del Norte (Greytown) beginning in 1860 and reaching 700,000 pounds by 1871. The rubber boom had burst, however, by the end of the century in the face of over-bleeding and competition from Hevea-type products from the Amazon and from the new plantations of Southeast Asia. An export duty of ten cents a pound had not helped, and the flush of enthusiasm for the banana business and the rush to the new gold mining districts drained off much of the limited labor supply.

World War II once more brought an enthusiasm for rubber as the U.S. Gov-

ernment, through the Rubber Development Corporation, pumped millions of dollars into the Caribbean coast of Nicaragua (and much smaller amounts into Honduras) in an effort to stimulate production. Labor was always short, partly because the gold mines continued in operation, and costs were excessive, but, by the end of April, 1945, Nicaragua's east coast had produced 3,374 long tons of rubber for the U. S. Government.[46] Over 40 commissaries had been established on the Coast to supply 5,000 Indian and Creole tappers and a salaried staff of 165 persons. Thirteen landing strips for small aircraft had been constructed, chiefly in the area between the Río Grande and the Río Coco, and thousands of miles of access trails were opened. Many of the airstrips could be built quickly and cheaply on the edge of the savanna, as at Waspam, Bilwaskarma, Awastigny, Alamicambra, Brewer's Lagoon, and Caratasca, but those cut out of the monte have long since been overgrown except where found to be adaptable to mining company requirements.

Among the adulterants (always a problem to the R. D. C.) one of particular interest frequently found in rubber coming out of the upper Río Coco area was *tunu* (*tuna*) gum.[47] This latex, likened to balata, was well known to the Miskito and Sumu Indians of the upper Río Coco where the thick inner bark of a certain tree, composed of many layers of strong, interlaced fibers had long been used for the making of sleeping mats, blankets, hammocks, and clothing. That tunu was not entirely unknown to the outside world is indicated by reference to "tuno blankets" and "tunna" in the list of exports from the Cape Gracias á Dios custom house in 1909–10, along with rubber, deer and cattle skins, mahogany logs, and gold.[48] It remained for an American trader at Waspam to develop a legitimate export market for tunu gum, which for the last five years has been shipped by air, via Managua, to Chicago chewing gum manufacturers. The black blocks of tunu are brought down the Río Coco in dugout canoes to Waspam where they are cut up, boiled in water, and washed in a stream until the gum is white and clean, whence it goes by plane to the U. S. The tunu tree apparently occurs in commercial quantities almost exclusively in the upper Río Coco drainage, San Carlos being the principal collecting place for gum gathered on either side of the river. Some 2,000 persons are said to be currently engaged in the industry.

Botanical identification of the tree from which it comes seems not to have been made with certainty, but from descriptions it is probably *Poulsenia armata,* a medium to large lactiferous tree with armed (prickly) twigs and a buttressed trunk which occurs sparingly throughout much of tropical America.[49] The apparent

[46] The record of the war-time rubber effort in Nicaragua is contained in the Rubber Development Corporation papers, Sets 1 and 2, Nicaragua, in the National Archives, Washington, D. C.

[47] Rubber Development Corporation, Set 1, Nicaragua, No. 35a (1942), National Archives, Washington, D. C. Nicaragua's rubber production was the highest of any Central American country under the R. D. C. program.

[48] Cape Gracias á Dios Post Despatches, Invoice Book 1908–10, National Archives, Washington, D. C.

[49] Samuel J. Record and Robert W. Hess, *Timbers of the New World.* New Haven, 1943. p. 394.

localization of production to the San Carlos area, from which exports of 700,000 pounds were reported in 1952, may relate to Indian interest in the tree. The tree is reported to occur gregariously, apparently as an aggressive, secondary forest element in old fields, hurricane blow-down areas, and on savanna margins. Its caustic seeds are said not to be touched by the peccary (*wari*) as are those of the Castilla and so are less widely distributed.

With good cutters taking 10 to 12 pounds of latex a day (worth the equivalent of perhaps 10 cents a pound U. S. money), pressure on the tunu resource is heavy. Trees are tapped two times a year, with tapping being conducted for all except one or two months at the end of the dry season. The sap is coagulated with lye or with the use of a jungle vine much as is the milky fluid from the Castilla rubber tree.

* * * *

An English- and Miskito-speaking Protestant enclave within a Spanish-speaking Catholic world, the Miskito Coast of Nicaragua and Honduras with its 80,000 inhabitants has been until very recently a land of mystery for which Managua and Tegucigalpa have had little understanding or concern. Until the establishment of regular airline service from Managua to Bluefields, Puerto Cabezas, and the gold camps, it was easier to get to the Miskito Shore from New Orleans than from the interior capitals, but now that is all changed, at least for the country south of the Río Coco. The opening of the often-delayed truck road from Managua to Rama may likewise stimulate further economic development and settlement by Spanish-speaking peoples, especially along the Río Escondido. But economic prospects are at best modest. The United Fruit Company's 1,400 acres of African oil palm and 2,500 acres of mahogany, cedar, and teak plantations on abandoned banana lands along the Río Escondido represent the first serious attempts at tree-farming in this tropical high-rainfall area where tree crops may provide one of the few possibilities for a really permanent agriculture. Perhaps, too, the planting of introduced pasture grasses on forest soils behind the "bush line" may one day be dove-tailed with a beef cattle industry on the savannas. A better knowledge of tropical soils, their potentialities and limitations, is obviously necessary. The understanding of the causes underlying the presence here of an extensive pine savanna, for which a tentative theory has been suggested above, would be an important step in this direction.

Accepted February, 1954