THE ABORIGINAL CULTURAL GEOGRAPHY OF THE LLANOS DE MOJOS OF BOLIVIA

BY

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PREFACE

The field research for this study, carried out in Bolivia between June, 1961, and July, 1962, was supported by the Foreign Field Research Program conducted by the Division of Earth Sciences, National Academy of Sciences, National Research Council and financed by the Geography Branch, Office of Naval Research, under contract Nonr-2300(09). In addition to library and archive studies in La Paz, Sucre, and Cochabamba, I made numerous field trips through the Mojos savannas and adjacent forests by foot, horseback, oxback, oxcart, boat, canoe, raft, jeep, airline, and bush plane. I also have been able to make brief visits to other seasonally flooded savannas in tropical America: the Pantanal of Brazil in 1956 and 1961, Marajó Island and the lower Amazon in 1956, the Miskito Coast savannas of eastern Nicaragua in 1957, locally flooded *campos* in the Planalto Central of Brazil in 1962, the lower Orinoco *llanos* of Venezuela in 1963 and 1964, and the Río Heath savannas of southeastern Peru in 1966.

I wish to acknowledge the assistance given me in Bolivia by the following individuals and institutions: the Bolivia California and Bolivia Shell Petroleum Companies for invaluable information and for use of aerial photographs and maps; the American and Bolivian personnel of the Servicio Agrícola Interamericano in La Paz; the Summer Institute of Linguistics with headquarters in Riberalta; the Bolivian Instituto Geográfico Militar; Martin Cárdenas, the leading Bolivian botanist; Jorge Muñoz Reyes, geologist, geographer, and Rector of the Universidad Mayor de San Andrés in La Paz; Gunnar Mendoza, Director of the Biblioteca y Archivo Nacional in Sucre; George Plafker, former photogeologist of the Bolivia California Petroleum Company; and numerous kind Benianos, both native and foreign.

At the University of California I profited from the criticism, encouragement, and ideas of James J. Parsons, Carl O. Sauer, John H. Rowe, and Woodrow Borah. My interest in Mojos originated in a seminar under Herbert Wilhelmy, now Professor of Geography at Tübingen University in Germany. Others who have read the manuscript and offered valuable suggestions and corrections are Robert L. Carneiro, Gertrude E. Dole, Homer Aschmann, and Donald W. Lathrap. The maps were drawn in the University of Wisconsin Cartographic Laboratory under the direction of Randall Sale. The photographs for plates 12, 16, 17, and 19 were taken by

Tony English of Bristow Helicopters, Inc. Financial support was received from the University of Wisconsin for preparing the final manuscript. I wish to give very special acknowledgment to my wife Susie for editorial assistance and moral support.

I am particularly indebted to four diverse and unrelated but outstanding scholars of Mojos who laid the foundations for this study: Alcides D'Orbigny (1802–1857), pioneering French naturalist and geographer; Erland Nordenskiöld (1877–1932), Swedish ethnologist, archaeologist, and anthropogeographer; Alfred Métraux (1902–1963), French anthropologist and student of the past and present tribes of eastern Bolivia; and José Chávez Suárez (1901–), Beniano historian and resident of Santa Ana de Yacuma. The theme of this study, aboriginal adaptations to seasonal inundation, was suggested gy a paper written by Erland Nordenskiöld in 1916 entitled "Die Anpassung der Indianer an die Verhältnisse in den Überschwemmungsgebieten in Südamerika."

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INTRODUCTION

Nay, they are ignorant of the greatest part of America, which lies betwixt Peru and Bresill, although the bounds be knowne of all sides, wherein there is diversitie of opinions; some say it is a drowned land, full of Lakes and waterie places; others affirme there are great and flourishing kingdomes, imagining there be the Paytiti, the Dorado, and the Caesars, where they say are wonderfull things. I have heard one of our Company say, a man worthy of credit, that hee had seene great dwellings there, and the waies as much beaten, as those betwixt Salamanca and Valladolid. . . .

José de Acosta, in 1590 (1880:1:171)

The Spanish conquistadores pursued many El Dorados in South America, and one of the lesser known but longest and most eagerly sought was that of the Kingdom of the *Gran Moxo* or *Gran Paititi*. Moxos (Mojos)[1] is a region of tropical savannas located in northeastern Bolivia between the Río Beni and the Rio Guaporé and surrounded by rain forest and rugged mountains. It remained an unexplored, inaccessible land of myth until 1617, when weary Spaniards returned from the north to Santa Cruz de la Sierra to report no El Dorado, that Mojos had only swamps and mosquitos and many savage Indians, and that the *Tierra Rica* must be further on. However, the kingdoms or "chiefdoms" of Mojos did exist; and although they lacked silver and gold, except that obtained in trade, they did have dense populations, large villages, and a technology for draining and cultivating the savannas. After the early explorations, Mojos became a mission province, and under the administration of the Jesuit Order from 1668 to 1767 the native cultures deteriorated and the population was rapidly and drastically reduced by European diseases. The savannas became cattle range and never again were farmed.

The chiefdoms of Mojos had achieved a remarkably sophisticated society and technology in a hostile environment characterized by alternating seasonal flooding and drought and generally poor soils. The main purpose of this study is to examine the means by which these peoples dealt with these problems and modified the landscape to accommodate relatively large populations.

The evidence for a reconstruction of the geography of aboriginal Mojos

[1] In this study "Mojos" applies to the Jesuit mission Province of Mojos, unless otherwise stated, located north of 17° S latitude between the Río Beni and Río Itenez (Guaporé) (pl. 1). This area roughly corresponds to the present Department of the Beni (fig. 1). The "Llanos de Mojos" is the area of savanna occupying the greater part of Mojos and the Beni (fig. 2). "Mojo" is the name given to one of the major tribes of the Llanos de Mojos (fig. 3).

consists of early descriptions by explorers and missionaries, archaeology, and the presence of tens of thousands of earthworks and drainage features (mounds, causeways, ditched and raised fields, and canals) built mostly

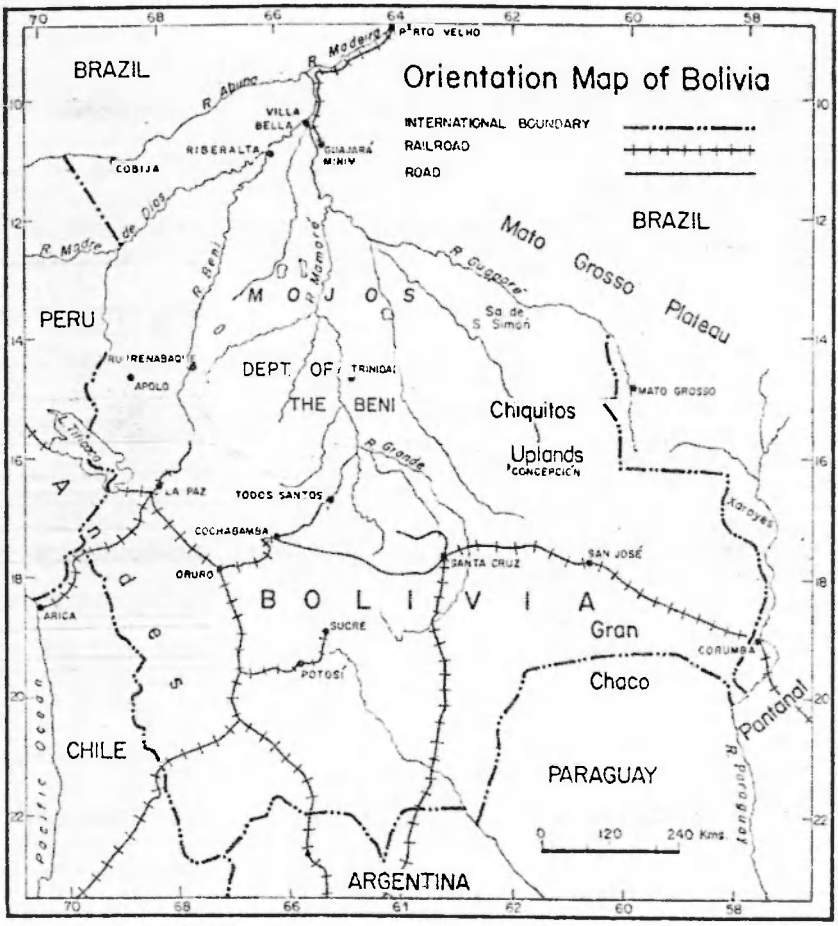


Fig. 1. Orientation map of Bolivia.

in pre-Spanish times to aid in coping with the annual inundations. The drained fields, only recently described, represented one of the most extensive and most successful efforts to cultivate savannas in the history of tropical America.

Ideally, I would like to portray and discuss Mojos as it was in the late six-

teenth century when the first Spaniards came on the scene; however, of necessity, I will be using sources dating through the eighteenth and early nineteenth centuries at which time the Mojos cultures were still recognizable. Furthermore, the various types of earthworks may not all have been in use and under construction at the time of conquest. The golden age of the Mojos chiefdoms actually may have been long before the first Spanish descriptions. This is a problem for archaeologists. Likewise, it cannot be said with certainty what tribes were responsible for certain features and practices. However, even though it is often impossible to say who or when, a great deal can be said about what, where, how, and to some extent why in regard to the major features of the cultural and economic geography of aboriginal Mojos. Hopefully, future research, especially archaeology but also the study of manuscripts in the European archives, will provide the peoples and dates and will fill in the gaps and clarify the uncertainties in this present study.

The Mojos chiefdoms represented unique cultures in a unique environment. To understand and appreciate their ways of life, the cultural landscape they created, and their significance in the cultural history of South America and the cultural ecology of tropical lowlands, it is necessary to study the physical habitat, and how other people have dealt with the same habitat, and how other people have dealt with comparable habitats. Consequently, I am including considerable background information on the physical geography of Mojos, the historical geography of Mojos under European control, and, in the next to last chapter, cultural adaptations to poor drainage elsewhere in tropical America.

Following the introductory chapters I have tried to present a cultural geography of the past, that of aboriginal Mojos at about the time of initial Spanish contact, with emphasis on artificial earthworks and other features and practices providing means of dealing with seasonal inundation. Evidence is then presented for the existence of sizable sixteenth- and seventeenth-century populations in the Llanos de Mojos. Finally, conclusions are presented about the Mojos chiefdoms and their achievements in terms of origins, decline, lasting impact on the physical and cultural landscape, and cultural ecology, with some final remarks on habitat, subsistence, culture, and population in tropical savanna lands.

I. PHYSICAL GEOGRAPHY

Seasonally Flooded Savannas in South America

Seasonally flooded savannas[1] are found in many parts of the humid tropical lowlands of the New World, and they constitute a type of environment that has received little attention from geographers, anthropologists, and ecologists.[2] These sparsely populated savannas are characterized by periodic flooding and drought, impervious soils, and grassy vegetation with few trees. All forms of life are faced with problems of alternating superabundance and scarcity of water, and man adapts mainly by locating his settlement activities on naturally high ground near permanent water. However, in some areas, most notably the Llanos de Mojos, aboriginal peoples raised mounds, crop rows, and causeways to provide dry ground for settlement, agriculture, and roads.

The largest savannas with extensive seasonal flooding in South America are the Llanos de Mojos, the lower Llanos del Orinoco, and the Pantanal of western Mato Grosso. Other areas subject to flooding are found in the eastern half of Marajó Island, in the Bolívar savannas of northern Colombia, along the Amazon floodplain, in the Río Casiquiare region, on the southwest side of Lake Maracaibo, in the Orinoco delta, and near the Río Heath in southeastern Peru. Most of these areas have young alluvial soils. Savannas with senile soils subject to waterlogging and local flooding mainly from accumulation of rain water include the interior Guiana savannas (Rupununi, Gran Sabana, and Rio Branco), the coastal Guiana and Amapá savannas, parts of the Gran Chaco, and scattered savannas in the Amazon Basin, portions of the upper Orinoco *llanos* of Venezuela and Colombia, and small areas (*baixas*) in the Planalto Central of Brazil. In Middle America there are wet savannas in Trinidad, Cuba, and portions of the Miskito Coast of eastern Honduras and Nicaragua. Many of

[1] The term "savanna" is used herein to refer to tropical vegetation communities in which a large percentage of the ground is covered by grass. Savannas may consist of pure grass at one extreme and a partly open woodland at the other extreme. Thus it is useful to distinguish between woodland savannas, orchard savannas with scattered trees, and grassland savannas in which trees are absent or very scattered. The origin and usage of the word "savanna" is critically discussed by Leo Waibel (1943: 379–381) and J. S. Beard (1953: 189–190).

[2] One of the best geographical studies of a seasonally inundated savanna is that of the "Gran Pantanal" of western Brazil by Herbert Wilhelmy (1958). Betty Meggers and Clifford Evans (1957) made a detailed archaeological survey of the wet *campos* of Marajo Island at the mouth of the Amazon. A good land use and resource study was made of the state of Apure in Venezuela, which contains much of the seasonally flooded portion of the Orinoco *llanos* (Venezuela, 1959).

the savannas in the New World tropics have not been mapped, and of those mapped the portions subject to seasonal flooding are seldom distinguished.[3]

Much of the seasonal flooding in South America occurs in the flood plains of the large rivers; there also is flooding in wide, flat basins by water from both rains and overflowing rivers. In this second situation the poor drainage reflects lack of relief and impermeable subsoils more than confinement of waters between natural levees and valley sides. Flooding may last anywhere from a few weeks to six or more months. Climatically, the savannas vary considerably, with precipitation ranging from 45 to 160 inches and the length of the dry season from three to seven months. Soils are typically characterized by impervious horizons, thin topsoils, acidic reactions, and low fertility.

Wherever flooding lasts several months each year and alternates with severe drought, the natural vegetation is mainly grassland, apparently because few woody species can tolerate the extremes of both flooding and drought. Patches of forest occur within "wet" savanna wherever there is high ground that is well drained. Most of the "dry" or well-drained savannas, such as the *campos cerrados* of Brazil, are woodland savannas. Dry, grassy savannas are usually the result of clearing and repeated burning; however, such man-made savannas seem to be more extensive in Africa and tropical Asia than in the New World. Of the roughly 600,000 square miles of grassy savanna in South America at least half is seasonally flooded and much of the remainder is poorly drained and subject to waterlogging.

The Beni Basin

Source Materials.—Northeastern Bolivia has received its share of explorers and scientific travelers,[4] but most of the work has been superficial, and there have been few modern surveys of any kind.[5] Of greatest recent

[3] The vegetation map of Venezuela by Kurt Hueck (Venezuela, 1960) shows different types of savannas, including those that are "periodically inundated." The maps of the Brazilian 1:1,000,000 series (Brazil, 1960) show the seasonally flooded portions of the Gran Pantanal, Marajó Island, and lower Amazon. The World Aeronautical Charts indicate some of the areas that are subject to flooding.

[4] Well-known post-Jesuit explorers included the German naturalist Thaddeus Haenke (1898) in 1794; the French naturalist Alcides D'Orbigny (1835–47) in 1832; the Bolivian engineer Jose Agustín Palacios (1944) who surveyed Lago Rogoaguado in 1845; Lt. Lardner Gibbon (1854) of the United States Navy Amazon Expedition of 1852; and the English engineer Col. George Church (1877, 1898) in the 1870's.

[5] Scientific activities in Mojos in the twentieth century have included the Mulford Biological Expedition of the Amazon Valley in 1921–22 (Rusby, 1927; White, 1922); hydrological

importance have been geological surveys made in parts of the Beni between 1958 and 1960 by oil exploration companies.[6] These companies have taken vertical air photographs and have mapped most of the southern half of the Llanos de Mojos.[7] The map coverage of greatest value for this study is the 1:50,000 Series Planimétricas, 1959, of the Bolivia-California concession of 7,800 square miles located west of Trinidad and centered on San Ignacio, one of the main areas of aboriginal earthworks in Mojos. These maps show one-meter contours, forest and savanna, permanent and temporary streams and lakes, settlements, houses, trails, and many of the old Indian causeways. For northern Mojos all existing maps are still highly inaccurate.

Geology.—The Llanos de Mojos occupies about 70,000 square miles in the center of what some geologists call the Beni Basin, located between the Andean foothills and the western outcrops of the Brazilian Highlands (fig. 2). The basin is filled with fine-grained unconsolidated sediments of Quaternary age overlying a crystalline basement of rock similar to that in exposures of the Pre-Cambrian Brazilian Shield. Seismic studies and stratigraphic drilling indicate that the sedimentary cover attains a thickness of over 18,000 feet at the base of the Andes and decreases to about 2,000 feet along the lower Río Apere. East of the Río Mamoré the cover is less than 1,000 feet thick and is penetrated by erosional remnants of the Shield which form isolated hills, low ridges, and local rapids in the rivers.

The Beni Basin is about 100 miles wide just north of Santa Cruz where it is pinched off by the Chiquitos Uplands and the foothills of the Andes. Six hundred miles to the northwest at the Bolivian border the basin is over 300 miles wide and joins with the main Amazon Basin.

Drainage.—The Beni Basin is drained by the Rio Guaporé, Río Mamoré, Río Beni, Río Madre de Dios, and their tributaries. These rivers join in the northern part of the basin to form the Rio Madeira, a major tributary of the Amazon, which has cut a narrow gap through a low arm of the

surveys by C.M.G. Harrison (1942), Marcel Merlin (1955), and the United States Agency for International Development (S. N. Harrison, 1963); reconnaissance surveys of soils and vegetation by the Bolivian Servicio Agrícola Interamericano (Braun, 1961; Hughes, 1961; and Arce Pereira, 1961); botanical studies by Martín Cárdenas (1945, 1953), Theodor Herzog (1912), and Rafael Pena (1944); and animal ecology by Guillermo Mann (1951).

[6] The oil company studies and data are not available; however, George Plafker, formerly a Bolivia California Petroleum Co. photo geologist, has written an important article on oriented lakes in the Beni (Plafker, 1964).

[7] Topographic map and air photo coverage for Bolivia as of 1963 is shown in the index atlas of Bolivia published by the Pan American Union (1964).

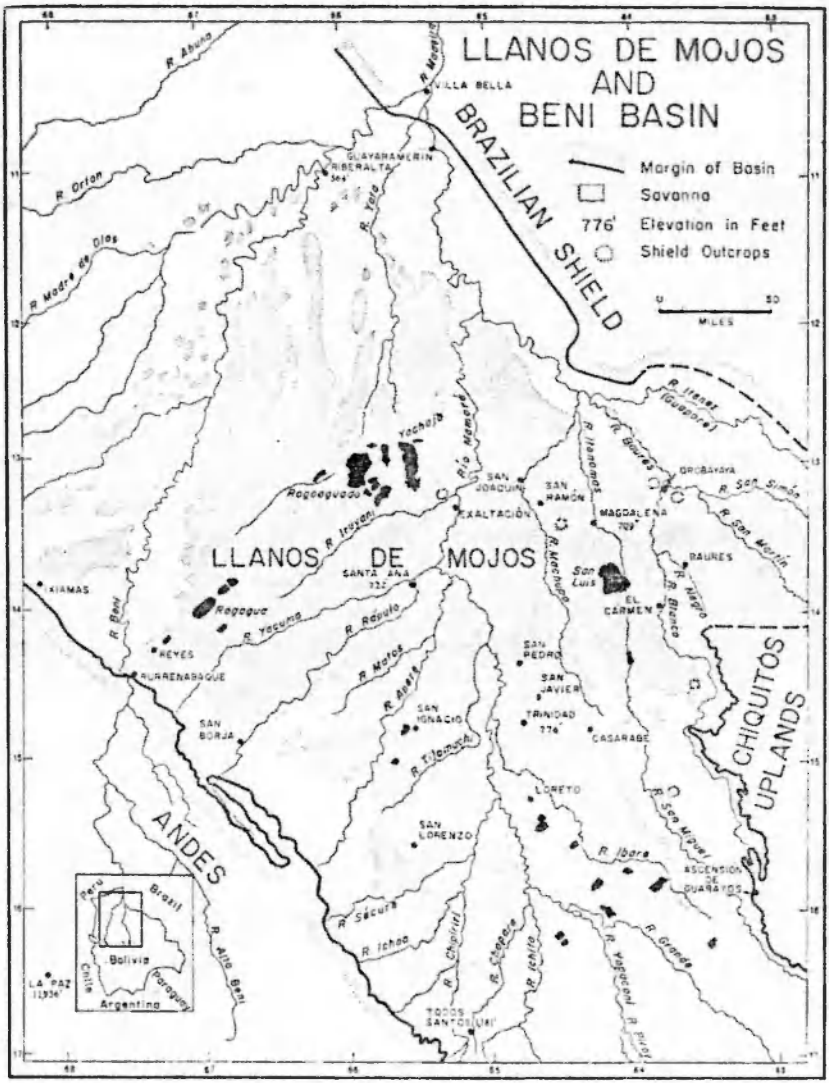


Fig. 2. The Beni Basin and Llanos de Mojos.

Brazilian Highlands. This gap, which contains the Madeira-Mamoré rapids, forms a local base level of erosion for the rivers above it, and this has contributed to the leveling of the center of the basin as sediment was deposited into it from the Andes. The main rivers and their tributaries

meander considerably (pl. 10) and are not significantly incised. During high water the Río Madeira gap cannot adequately handle the volume of water being poured into it; the channels of the main rivers are filled to capacity, and water in the lesser tributaries backs up and overflows onto the adjacent plains. The flatness of the terrain prevents any channeling of the overflow, and vast portions of the *llanos* are inundated.[8]

Relief.—The elevation of the llanos ranges from about 900 feet in the south to about 600 feet in the north, and the gradient is about one foot per mile. The llanos are nearly flat with very few relief features over two or three meters in height. The lowest ground, usually old meander cutoffs (*curiches*), may contain some surface water most of the year, while slightly higher or better drained depressions (*bajíos*) are seasonally flooded. Terrain with relief of over one meter is seldom or only briefly flooded, is usually forested, and generally consists of low divides and remains of natural levees. Ground over two or three meters in height includes man-made mounds and shield outcrops at the margin of the basin. Patches of ground high enough to stand above the annual floods are referred to as *islas* or as *galerías* if they are forested natural levees.

Outcrops of rock that form hills within the llanos are well known and are distinguished from artificial mounds by the local people. The few isolated hills in the llanos are shown in figure 2; most of these are about 100 feet high. South of 14° S and beginning about 40 miles east of the Río Mamoré there is a series of parallel, northwest-southeast trending ridges less than 50 feet high. The ridges become higher and the hills more frequent toward the east until the Brazilian Shield becomes well defined on the east side of the Río Blanco. In addition, rock outcrops create small rapids along the upper Río San Miguel (at 15° S), the lower Río Baures, on the Río Mamoré a few miles below Exaltación, and elsewhere. These various outcrops indicate the presence of shield rock at or near the surface well into both the northern and eastern areas of the Llanos de Mojos, while elsewhere the basement rock is buried at considerable depth.

Lakes.—There are several thousand permanent lakes in the Beni Basin, mostly in the llanos, and they range in size up to 200 square miles (Lago Rogoaguado). Most of the lakes are shallow (five to ten feet deep), have

[8] George Church (1898:397) believed that a great lake once filled most of the Beni Basin, and references are still made to ancient Lake Mojos, of which Lakes Rogagua and Rogoaguado are supposedly remnants (*e.g.* Osborne, 1964:26); however, the existence of a former large and deep lake is doubtful.

a narrow low ridge around them, have no inlet or outlet, and seem to be of recent origin. They contain fresh water and seem to be fed mainly by precipitation. Most of the lakes have nearly straight sides which are consistently oriented northeast-southwest and northwest-southeast; many are almost square or rectangular in shape.[9] There are also straight boundaries between savanna and forest and portions of stream channels with the same directional orientations as the lakes. George Plafker (1964:503), who has made a systematic study of these various "oriented" features in the Beni, has concluded that they are produced by either "progressive downfaulting of basement blocks or differential compaction of unconsolidated deposits over basement blocks." Generally, there is no difficulty in distinguishing linear, aboriginal cultural features, such as causeways and canals, from structurally controlled features.

The lakes of Mojos are of some importance to people, wild animals, and livestock as sources of water during the dry season when most of the small streams dry up. Indian villages and Spanish mission towns were frequently located near lakes, and most of the lakes contain a variety of fish, a major source of food for the Mojos Indians.

Climate

The entire Beni Basin, located between 11° and 17° S latitude, has a tropical, winter-dry ("Aw") climate except for the rain forests at the base of the Andes where there is high precipitation all year long ("Af" climate). In the Llanos de Mojos, rainfall averages between 1,500 mm (60 inches) and 1,800 mm (72 inches) annually; the dry season (months with less than 60 mm) lasts from four to five months (May–September). The months of heaviest rainfall are December, January, February, and March, and the driest months are June, July, and August.

Rainfall decreases southeast of Mojos (Ascensión 909 mm) and is about the same to the north (Riberalta 1,800 mm) and to the west (Rurrenabaque 1,829 mm); however, it is considerably higher to the southwest, where moisture-bearing northerly winds are abruptly forced to ascend the steep slopes of the Andes (Todos Santos 2,833 mm).[10] The length of the

[9] The only large Beni lake that is oriented and rectangular is Rogagua. The shapes of lakes in the Beni are greatly distorted on all published maps. On the maps in this study the shape and positions of Rogagua and Rogoaguado are reliable (from air photos); however, the shape and positions of San Luis and Yachaja are only approximate.

[10] Todos Santos, which has the highest recorded average rainfall in Bolivia, is probably representative of climatic conditions at similar positions all along the northeastern Andean front in Bolivia.

wet season increases toward the An[illegible] months at San Borja and Rurrenabaque, 12 months at Todos Santos) and decreases toward the southeast (five months at Ascension). As is characteristic of the tropics, rainfall varies considerably from year to year and from place to place the same year in the same general area. During the period 1950–1960 the Mojos

TABLE 1

AVERAGE ANNUAL AND MONTHLY RAINFALL FOR SELECTED STATIONS IN NORTHEASTERN BOLIVIA, 1946–1960[a,b]

(in millimeters)

Station	Riberalta	Magdalena	Trinidad	San Borja	Todos Santos
Elevation	564 ft	709 ft	776 ft	741 ft	1,181 ft
January	292	231	324	296	406
February	245	200	264	203	399
March	267	245	189	194	389
April	128	109	129	122	234
May	156	48	94	100	185
June	24	15	58	97	115
July	19	6	48	90	126
August	22	24	33	55	74
September	59	54	88	74	124
October	149	126	141	152	192
November	169	181	177	144	196
December	270	227	214	210	393
Year	1,800	1,466	1,759	1,737	2,833

[a] From the records of the office of the Dirección General de Meteorología, Ministerio de Agricultura, Ganadería y Colonización, La Paz. The measurement of climatic phenomena in Bolivia is often poorly controlled, and therefore, all figures are of questionable accuracy.

[b] Annual averages for other stations in northern and eastern Bolivia: Cobija 1,750 mm, Guayaramerin 1,595 mm, San Joaquín 1,597 mm, Santa Ana 1,813 mm, San Ignacio 1,754 mm, Rurrenabaque 1,529 mm, Ascension 909 mm, Santa Cruz 1,231 mm.

stations had years with up to 900 mm above average and up to 800 mm below average, and for some years stations only 50 miles apart differed as much as 1,000 mm in total rainfall.

The years of high rainfall do not necessarily correlate with the years of major floods, because the big floods result from river overflow, which is mainly a product of high rainfall in the eastern Andes. For example, in 1959 when Santa Ana was flooded in February all the Mojos stations recorded between 1,400 mm and 1,900 mm of rainfall, which is normal. However, the towns near the base of the Andes all had higher than average rainfall in January: San Borja, 554 mm; Rurrenabaque, 407 mm; and

Todos Santos [illegible]8 mm. On the other hand, during and before the Trinidad flood of February, 1947, there was steady, heavy rainfall throughout northeastern Bolivia.

The summer season (October–April) is wet and hot, while the winter (May–September) is dry and warm. For Trinidad in 1958 (Bolivia, 1960) the mean annual temperature was 78.4° F; the maximum mean monthly temperature was 81.1° F in March; and the minimum mean monthly temperature was 73.6° F in August. The absolute minimum was 50.6° F on June 21, and the absolute maximum was 102.0° F on November 27. Relative humidity averaged 79 percent and was not unpleasantly excessive except during the months of December and January, when the average was 87 percent.

During the dry season occasional cold fronts (*surazos*) penetrate the llanos from the south, bringing sudden drops in temperature, strong winds, and sometimes rain. Only very infrequently do surazos bring temperatures below 50° F; however, the people find temperatures of even 60° F very uncomfortable. The prevailing winds for most of the year are from the north and average about three miles per hour; rare surface winds up to 60 miles per hour have been reported.

Seasonal Flooding

The period of flooding in the llanos lags behind the rainy season by about two months. Flooding begins in late December, reaches a peak in February, and begins receding in late March. In 1961 I found most of the llanos dry in early December, while well into the following dry season (mid-June) shallow water remained in large bajios in areas visited near Magdalena, Baures, and Trinidad. The curiches contain water until late in the dry season and in some years retain water all year. Overland travel often is still difficult well into July because of mud and ponds of water and because the tall grasses have not yet been fired.

It is uncertain how large an area is subject to inundation. Of the area mapped as the Llanos de Mojos, about 80 percent, or 56,000 square miles, is in savanna and the remainder is in gallery and isla forest. Bush pilots and ranchers say that most years all the savannas are under water, but this seems excessive in view of the large areas of man-made savanna on once forested high ground. Probably about 40,000 square miles normally are covered with water during maximum flooding and from 50,000 to

60,000 square miles during exceptionally high floods that invade the forests. Outside Mojos there are additional large areas of seasonal flooding between the Río Beni and Río Madre de Dios and on both sides of the upper Rio Guaporé.

The depth of flooding varies from a few inches to five or six feet, but seems to average one to two feet during most of the flood period. Generalization about extent, depth, and duration of flooding is difficult, however, because of the great variability from year to year. The 1961–1962 flood period was relatively "dry," and I never witnessed the "vast lake" with scattered islands that travelers have written about (for example, Osborne, 1964:33). Flooding that February was absent or shallow (pl. 9*b*) where I rode across savannas near Trinidad and Santa Ana. At the other extreme are infrequent high floods that inundate towns, damage buildings, kill livestock and wildlife, and ruin crops.

During the past 165 years there have been disastrous floods in 1959, 1947, 1930, 1929, 1928, 1895, 1886, 1853, 1801, and 1799 (Chávez Suárez, 1936 and 1947; Limpias Saucedo, 1942:116–118, 287). Most of these floods affected Trinidad, and those in 1799 and 1801 forced the transfer of the town from near the Río Mamoré to the present site. Some of the high floods, however, are localized in the western or eastern llanos, depending on whether there is heavy rainfall in the headwater regions of the Río Yacuma, the Río Mamoré, or the Río Blanco and Río San Miguel. In 1959, for example, Santa Ana was flooded by the Río Yacuma, while the Río Mamoré stayed within its banks and Trinidad was spared excessive flooding.

In February, 1947, flood waters in Trinidad peaked at just over 239 meters elevation and covered all but the highest ground of the plaza (240 m). The flood received international attention, and planes from neighboring countries and the United States evacuated hundreds of people from Trinidad (*Newsweek*, 1947:54). Such high floods result from extensive overflowing of the major rivers. Normal flooding, however, results from the overflow of small tributary streams onto adjacent llanos and from the accumulation of rainwater wherever drainage is poor because of impervious soils and lack of relief. During most years, ground of 237–238 meters elevation at the edge of Trinidad is flooded, and the townspeople are only moderately inconvenienced (pl. 2*b*).

The seasonal flooding of the Llanos de Mojos reflects climate and land-

forms and reflects nearly every aspect of the physical and cultural landscape: drainage, soils, vegetation, wildlife, land use, communication, and habitation. Of nearly equal importance, however, are the near desert-like conditions prevailing during the height of the dry season, when lack rather than excess of water becomes critical.

Soils

There have been only a few, localized soil surveys in Mojos,[11] and consequently only tentative generalizations can be made about the soil pattern of the region. Most of the soils are poorly drained clay loams underlain by hardpans and are low in fertility.

There are three broad soil conditions which can be roughly correlated with vegetation and degree of flooding: forest soils of high ground, soils of intermediate ground with scrub savanna (*arboleda*), and grassland (*pampa*) soils of low ground.

Forest soils.—Forests grow only on high, well-drained ground—either islas or natural levees. The levee (*galeria*) soils consist of young alluvial fine sands, sandy loams, and loams that are usually light brown in color. The isla soils, consisting of old alluvium, are grayish-brown loams, loamy sands, and occasionally fine sands. Many of the forest soils on the east and west margins of Llanos de Mojos are reddish-brown latosols. No clay pans or mottling were observed in forest soils. Topsoils were found to be strongly to slightly acid (pH 5.2–6.2), except on recently burned *chacos* where they were neutral to slightly basic (up to 7.4). There are no data on the plant nutrient content of forest soils, but they generally have a much higher level of available nitrogen than the savanna soils (Arce, 1961:3).

Soils of intermediate ground.—These soils are seasonally flooded for a few months or weeks and support grassland with scattered trees or scrub savanna. They are mainly alluvial clay loams and sometimes sandy loams or loams, and they tend to be brownish-gray in color. Clay content increases with depth and there is frequently a clay pan present, from two to ten inches thick, at depths of one to five feet. Pans are slight or absent where there is very active deposition but are well formed elsewhere. Subsoils and

[11] R. Earl Storie made a brief reconnaissance of the soils of the Beni in 1950 (United Nations, 1951:123–4; and Storie, 1953:131). Lucio Arce (1961) made a detailed study of the soils of the Trinidad cattle experimental ranch, and the Servicio Agricola Interamericano in La Paz has records of soil analyses from Trinidad and Reyes. I collected surface soils and subsoils from only 20 selected sites in Mojos, and these were analyzed by the Department of Soils and Plant Nutrition, University of California.

color and usually have a slightly yellowish mottling. acid (4.8–5.5) in the topsoil, but the subsoil is moder- Loam soils under scrub savanna near Reyes were very in phosphorus, and medium to high in potassium.

assland soils on low ground occupy over 50 percent of f Mojos. They are flooded for five to ten months of the rivers or by standing rainwater in areas distant from there are brownish-gray clay loams, but these change heavy clays at a few inches depth or less. Actual pans nguishable in areas of young alluvium, but in "rain- re very compact, impervious pans of kaolinitic clays llow depths. In the northern llanos (for example, in Magdalena areas) such sites sometimes have lateritic (*cascajá*) on the surface. These little-disturbed old contain massive laterite layers, but I neither saw nor mpa soils are moderately to strongly acid, with pH o on the surface. Nitrogen content is very low; phos- are low, and potassium is medium (Trinidad area).) has described the savanna soils of the Beni as being

e best soils are, first, those of the galería forests; second, third, the intermediate ground near the rivers with nts of aboriginal drained fields are mostly on low to with young alluvial soils in southwestern Mojos, but r flats with clay-pan soils in northwestern Mojos.

Vegetation

rthwestern Bolivia has not been adequately studied or t has been made here (fig. 2) to delineate only the laries. The boundary for the Mojos savannas is based ny maps and mosaics and is fairly accurate except for rtheastern portions, which were sketched on reconnais-

) reported "a laterite hardpan at depths of 2 to 4 feet," in the Mojos here and may have meant a clay hardpan.

oundary: various Bolivia California and Bolivia Shell maps, includ- uthern Beni forest boundary by George Plafker, 1:500,000, 1960; of North Bolivia," 1:200,000 by R. E. Wegman (1959), based on of 13° N; and reconnaissance flights by the author in northeastern

Of the area mapped as the Llanos de Mojos between the Río Beni and Rio Guaporé, about 50 percent is grassy savanna, about 30 percent scrub or palm savanna, and the remainder isla and galería forest. There are also large savannas between the Río Beni and the Río Madre de Dios. In addition, there are savannas of unknown extent along both sides of the upper Rio Guaporé and in Chiquitos southeast of Mojos. The forests northeast, north, and west of Mojos are semievergreen seasonal; southwest at the base of the Andes there is rain forest and evergreen seasonal forest; and to the southeast there is deciduous seasonal forest. In the south a belt of forest 50 to 100 miles wide separates the Llanos de Mojos from the savannas of Santa Cruz. This belt, seldom shown on published vegetation maps, grades from rain forest in the west to deciduous seasonal forest in the east.

The vegetation of the Llanos de Mojos is sometimes referred to as *pampa-isla* (Braun, 1961:2); that is, grassland (pampa) with scattered patches of forest on high ground (islas). Benianos, however, differentiate various land categories that reflect relief and amount of flooding as well as vegetation. These categories are briefly described below.

Curiches and bajios.—*Curiches,* or abandoned meanders, and *bajios* (depressions) which retain water all or most of the year contain tall grasses, sedges, and floating plants such as the giant water lily (*Victoria regia*) and the water hyacinth (*Eichornia*). On many lakes and curiches in Mojos there are mats of floating vegetation known as *yomomo,* which may attain depths of several feet and support small trees.

Tall bunch-grass savanna.—Grassland, including sedges, with few or no trees occurs where flooding normally lasts for five to ten months. The common grasses, all perennials, include species of *Leersia, Paspalum,* and *Panicum.* On higher ground with flooding for only two to five months there may be scattered trees with the above grasses, plus species of *Sporobolus, Trichachne, Axonopus,* and *Andropogon.* The boundary between pampa and forest may be very sharp or may consist of a transition zone of scattered trees.

Arboleda.—On ground that is only briefly flooded there generally is open scrub, called *arboleda,* and occasionally this is dense enough to form a savanna woodland. *Tajibo* (*Tabebuia suberosa*) and *chaaco* (*Curatella americana*) are two of the most common trees. The term *chaparral* is used to describe a low arboleda thorn scrub with trees (*Acacia, Mimosa, Cassia*) nearly touching. An arboleda dominated by palm trees is called a *palmar.*

These are found mostly in eastern Mojos and usually consist of *carandai* (*Copernicia cerifera*) on low ground (pl. 2*a*) and *totai* (*Acrocomia totai*) on higher ground. In some arboledas in western Mojos the trees grow on termite mounds (pl. 14*b*); however, these mounds are generally quite small and seem to have been built up around individual trees. In contrast, trees have grown *on* the better drained soil of termite mounds elsewhere in tropical savannas (Troll, 1936).

Isla and galeria forests.—The forests (*monte*) within the Llanos de Mojos are semievergreen formations which have been modified considerably by logging, slash-and-burn agriculture, and utilization by animals for flood refuges. Some arboleda species may be present along with secondary or *barbecho* plants such as the *motacú* palm (*Attalea princeps*), *ambaibo* (*Cecropia*), *mompacho* (*Ceiba pentandra*), *Guarea, Inga, Ficus, Bambura, Heliconia,* and occasionally the *caracoré* cactus (*Cereus*). The galerias of the major rivers are more likely than islas to have economically useful forest trees such as *mara* (*Swietenia*), *cedro* (*Cedrela*), *palo maria* (*Calophyllum*), *balsa* (*Ochroma*), the Brazil-nut tree (*Bertholletia excelsa*), and the wild rubber tree (*Hevea brasiliensis*).

Ecology.—Ecologists now generally agree that most grassy savannas in the tropics are produced either by clearing and burning by man or by soil conditions unfavorable to the growth of trees (for example, see Richards, 1952:345). The most important soil consideration is seasonal flooding or soil waterlogging alternating with marked dry conditions; very few tree species are adapted to withstand both severe soil desiccation and prolonged flooding (Beard, 1953:203).

In the Llanos de Mojos most of the vast treeless pampas are on low ground, where there is usually flooding for five or more months of the year. Where flooding is prolonged there are only sedges or bunch grasses; where flooding lasts a few months or weeks there are scattered specialized trees, arboledas, and palmares; and on high ground that is seldom or never flooded there are arboledas and forest. Fires regularly sweep the llanos, but the burning is relatively uniform on both low and intermediate ground and the undergrowth of isla forests on high ground is often burned. Consequently, the degree of flooding, which is determined by local relief, seems to be a more critical ecological factor than fire in explaining basic vegetation patterns.

The ecological role of man's settlement activities in Mojos is difficult to

were being burned by the Indians when the Spaniards first arrived.[14] Fires caused by lightning occur occasionally; however, such fires seem to be most unusual within the tropics. Certainly burning helps determine the species present; all the pampa and arboleda trees are fire tolerant. Also, much arboleda is on high ground originally covered with forest that was destroyed by clearing and burning; now the arboleda is maintained by the annual fires. At least 25 percent of the isla vegetation is secondary rather than mature forest. Grazing intensity by cattle also affects the vegetation, particularly the arboledas and to a lesser degree the isla forests of high ground where cattle take refuge during flooding. Thus burning, clearing for agriculture, and cattle ranching have all influenced the character of the vegetation of higher ground where woody species can grow; however, man seems to have had much less impact on the natural, predominantly herbaceous, vegetation of low ground which is inundated for long periods of time.

The Changing Landscape

The Llanos de Mojos is an unstable landscape that is subject to relatively rapid physical change. Great quantities of sediment from the Andes are steadily being deposited on the llanos, and rivers are constantly changing course as they meander across the Beni Basin. The Río Mamoré is gradually being pushed eastward as the main load of sediment is being deposited west of it (pl. 10). Some river changes are more abrupt. Air photographs, for example, clearly show a former course of the Río Beni extending from just below Rurrenabaque in a northeast direction south of Lago Rogoaguado to the Río Mamoré. And the Río Grande may have once flowed directly north into the Río San Miguel. The possibility of rapid formation of lakes has been mentioned and also the periodically high floods. Changes in drainage and deposition have, of course, influenced soils and vegetation. There is no evidence of a significant climatic change over the past 1,000 years or so; however, normal fluctuations in rainfall can result in great floods or droughts which might affect the populations and distributions of plants, animals, and man.

Thus, change and disasters are normal in Mojos, and man has learned

[14] Juan Antonio Justiniano, a member of the Solís Holguín expedition of 1617, reported seeing the grasslands full of smoke from Indian fires (Lizarazu, 1906:187). Padre Castillo (1906:333) wrote in 1676 that the Indians burned the llanos when they hunted game: "Para cazar mejor, queman las dichas pampas."

to live with them, to adapt, and to recover. One probably need not look to nature to explain cultural decline and disappearance here. Then, too, some of the most striking changes in vegetation, relief, and drainage are the result of man's own activities. Indeed, there is more stability in the landscape of Mojos than might be expected. The survival of tens of thousands of aboriginal earthworks over 300 years old indicates a long survival of both natural and cultural relief features before they are obliterated by sediment or erosion. Also, most of the old causeways still cross low, seasonally flooded savannas between high, forested ground, indicating that in such areas there has been little change in the basic pampa-isla vegetation and drainage pattern since the causeways were built.

For all forms of life the most significant changes in the landscape are not the semipermanent and unusual ones, but rather the regular seasonal changes. During the wet summer, rainfall is plentiful and the vegetation is verdant; but as the season progresses the pampas are converted into vast marshes dotted with scattered islands and sinuous bands of gallery forest. Great flocks of bright-colored birds fly overhead and fish come out of the rivers and swarm over the flooded llanos. Terrestrial life, including man, seeks the high ground but also of necessity becomes amphibious.

During the dry season everything changes. The marshes first become muddy and are filled with stagnant pools, rotting dead fish, and rank grasses; and then they dry out completely. Rains are infrequent, many trees lose their leaves, the grasses turn brown, and the clay soils crack. The aerial view is one of tall pampa grasses, scattered scrub trees and palms, and forest patches. The bajios and small rivers dry up, but the shallow, rectangular lakes persist. The trails become dusty, and grass fires fill the sky with smoke. The aspect is one of bleak grayness and aridity. Overland movement is easy, but water is at a premium; birds migrate north and mammals move toward the permanent lakes and rivers. For the traveler who has seen the llanos during flooding it is disconcerting to return in August and find water being brought many miles by oxcart to be sold in town and to see canoes tied up to the hitching post of a ranch house with the nearest body of water many miles away.

II. ARCHAEOLOGY

The natural islas, gallery forests, and artificial mounds of Mojos contain great numbers of artifacts, consisting mainly of potsherds with a few items of bone and stone. Much of this material is on or near the surface, and it is not at all unusual to hear of or to see children playing with elaborate vessels dug up by their fathers in *chaco* clearings.

Unfortunately, there has been very little archaeological work in eastern Bolivia; most important are the excavations by Erland Nordenskiöld in the southwestern Beni. A few trained people have made some minor collections on the eastern side of the Río Mamoré and along the Río Beni, but almost nothing is known of the archaeology of the vast area covered with earthworks between the Río Beni and the Río Mamoré. Consequently, it is difficult even to begin to present a picture of the distribution of cultures in time and space. Problems of cultural origin, migration, diffusion, outside influences, disappearances, demography, and dating can only be vaguely speculated on. Nevertheless, without considering earthworks and social features, there is enough known ceramic ware of some complexity to suggest the existence of relatively advanced cultures, compared with postconquest tropical-forest cultures, in the Mojos region.

Mound Excavations by Nordenskiöld

The best-known and most carefully excavated archaeological sites in the Beni are three mounds (Velarde, Hernmarck, and Masicito) in the savannas south of Trinidad and east of the Río Mamoré which were excavated in 1908–1909 by Erland Nordenskiöld. The following information is based on Nordenskiöld's descriptions.[1]

Mound Velarde was located in a large forest isla five kilometers southeast of a ranch named San Miguelito and about 35 kilometers southeast of Loreto. The mound was 5 meters high, 45 meters long, and 25 meters wide. Two distinct cultural layers were distinguished in the refuse around the mound. The lower level extended under the mound (fig. 5, chap. V), and unbroken shells and large sherds suggested refuse accumulation under a pile dwelling. There was a variety of pottery in this level (pl. 4) but no tripod vessels, handles, urn burials, or incised designs. Decoration was

[1] See Nordenskiöld (1913, 1917, and 1930*a*: plates 47–50); also Métraux (1948:410–411); Bennett (1936:394–399); and Wiley (1948:176, 184–187).

[illegible] typical short spiral design often associated with a triangle, and by rim modeling. Rim lugs representing human heads were common along with clay grinders and small figurines, and many of the vessels had four feet.

The upper cultural layer of Mound Velarde contained dwelling-site refuse and painted burial urns with tripods. Ceramics showed less variety than in the lower level; there were no rim lugs, four-footed vessels, or spiral designs. Painted monochromatic geometric designs predominated, including checker patterns, parallel lines, pyramid steps, triangles, and crosses. Characteristic items included ribbed grinding platters, clay rollers, clay figurines, vessel covers with handles, three-legged clay stools, tripod vessels, bone artifacts, and a polished stone ax head.

Mound Hernmarck was located one-half kilometer northwest of Caimanes[2] and was 225 meters long, 85 meters wide, and 3 to 4 meters high. Ceramics in the mound resembled those of Upper Velarde but were not identical; curvilinear designs with stylized faces were common (pl. 5) and some painting was polychromatic. In one section of the mound Nordenskiöld found 43 urn burials.[3] The urns were globular and often one lay within another.

Mound Masicito was located one to two kilometers east of the Río Mamoré and 25 kilometers southwest of Loreto. The mound was 300 meters long, 150 meters wide, and 3 meters high. The pottery differed from that of both the other mounds, mainly because of decoration by fine-line incision, coarse appliqué, stamping, and modeling rather than painting. Closely hatched triangles often combined with punctuation was a frequent design. Shallow bowls with tripods molded into heads and feet were common. There were clay rollers and grinders and ribbed grinding platters, but no handles. Although in the general tradition of the ceramics of the other mound sites, shapes and designs differed considerably (pl. 6). The occurrence of fairly elaborate and uniform ceramic designs in all the mounds suggests some degree of craft specialization.

[2] I searched for Mound Hernmarck in April of 1962 but was frustrated as well as excited by finding five large artificial mounds in the vicinity of Caimanes. The one most likely to be Hernmarck is the mound known as El Cerrito de Caimanes, located about four kilometers north of the Caimanes schoolhouse; however, I found this mound to be about 15 meters high, which is much higher than Nordenskiöld's Hernmarck.

[3] Most of the urn burials in northeastern Bolivia were secondary; that is, a normally buried body was disinterred, the bones were scraped and sometimes painted, and then they were placed in an urn and reburied. Urn burials were a common practice in much of lowland South America. Urns have been found in many of the mounds in the Beni but were not attributed to any of the tribes described by the Jesuits.

The Velarde and Hernmarck mounds were surrounded by borrow pits which filled with water during rains; however, the mounds were located in forest and apparently were on sites not subject to flooding, as is true of other mounds in the region. Mound Masicito, on the other hand, was surrounded by water during the time of flooding. Two causeways extended out of the woodland in which Velarde was located, and on the east side there was a curious rectangular causeway. Nordenskiöld also mentioned a long causeway about 3 meters wide and one-half meter high between Caimanes and Tajibo 10 kilometers northwest of Caimanes, passing through the Hernmarck mound. This may have been the same causeway I saw extending north from Caimanes, which is at times as much as 2 meters high and 5 meters wide and is situated on high, forested ground.

The only archaeological link with the historical Mojo was a perforated vessel in Upper Velarde similar to those once used by the Mojo for preparing *chicha* (Métraux, 1948:411). Padre Marbán (1898:150) mentioned elaborate painted animal designs on Mojo pottery, but these are not known archaeologically.

Other Sites

Archaeological reports from other areas of Mojos are sketchy. At Chimay below Covendo on the Río Alto Beni, Nordenskiöld (1924*c*:229–234) found incised and appliqué ware that he related to Lower Velarde, and there is a resemblance in terms of vessel shape, use of four legs, use of inward-facing adornos, and in style of modeling.[4] Posnansky (1928) found similar features at Rurrenabaque, including a large effigy urn (Nordenskiöld, 1930*a*: pl. 45).

Stig Rydén (1941:133–140) excavated a mound one kilometer south of Casarabe (east of Trinidad) at Cañada de la Loma Vieja. The mound was in dense forest, with adjacent pools of water, and was not more than ten meters high. Sherds found here and at other sites in the region were very similar to those of Upper Velarde and Hernmarck (grinding pans, grooved mullers, clay vessel feet); however, decoration was by incision as well as by painting. Unbroken shells, not trampled to pieces, suggest that these mound builders also may have been pile dwellers. Rydén obtained zoomorphic pottery feet from a site near the Río Mamoré below Torno Largo that closely resembled feet found in nearby Mound Masicito.

[4] Bennett (1936:400) and Métraux (1948:410) found a closer overall similarity between Chimay and Masicito than between Chimay and Lower Velarde. Donald Lathrap (personal communication), however, is in agreement with Nordenskiöld.

Wanda Hanke (1957) excavated a mound near E[illegible] east of Casarabe and found shallow bowls and lids with painted geometric designs. At Tugure near Baures she found an unpainted vessel with applique designs that she attributed to an Arawak culture.

Just south of Mojos in the Province of Sara in northern Santa Cruz, Nordenskiöld (1913:255) excavated two groups of urn burials along the Río Palacios. The urns and pottery were decorated with corrugations and appliqué strips and are probably related to similar pottery in the Río Paraná region. Nordenskiöld believed the sites represented a late Guaraní penetration into central-eastern Bolivia from the southeast.

In mounds near Caimanes I found large amounts of sherds on the surface and at shallow depths. Urns have been found in the same mounds. The fragments included painted red-on-white cross-hatched designs, pieces of ribbed bowls, and simple tripod feet. From the sides of the mound at Eviata (pl. 8) I found sherds decorated with painted red-on-white bands. In the mound at Espiritú Santo near San Javier I recovered unpainted and painted sherds with short feet that may represent tripods.

There have been no systematic excavations between the Río Mamoré and the Río Beni, but there are indications that an elaborate ceramic style existed there, with resemblances to the Chimay tradition (modeling, appliqué, and incision rather than painting). Summer Institute of Linguistics personnel dug into a mound at Desengaño on the Río Apere and uncovered intact a large unpainted ceramic object (effigy urn ?) about two feet high and two feet long with a modeled human face and studs at one end and a large hollow tube at the other. Sherds I recovered in a mound near San Ignacio were undecorated and of white clay, similar to contemporary Movima pottery.

The archaeological museums in La Paz, Sucre, and Cochabamba have very few items from the Mojos area and nothing that is striking.

Possible Inca Ruins.—The subject of Inca forts in the Bolivian lowlands has received some attention. Two have been described in the foothills west of Santa Cruz at Pucarilla and at Samaipata (Bennett, 1936:394), which were probably built late in the Inca period as defenses against Guaraní invasions. Other Inca forts and ruins have been reported, but not verified, along the Río Beni, and some writers have attributed these to Inca expeditions. Sixty miles north of Rurrenabaque on the east side of the Río Beni, Marius del Castillo (1929) reported finding ruins which included mounds

and fortifications. On the west side of the Río Beni opposite Riberalta at Las Piedras there is a well-known "Inca fort," which I visited in 1961. It is entangled in dense secondary forest and consists of several rock walls two to three feet high extending out from a rock and earth tower that is 10 feet above ground, 6 feet below ground, and 8–10 feet wide. A partially rock-lined canal or ditch extends from the site for some five kilometers to an arroyo that enters the Río Beni. Little is known about the artifacts recovered here, although Chávez Suárez (1944:42, no source) says they resembled ceramics in Peru. Padre Armentia believed that causeways north of Apolo in the savannas west of the Río Beni had been built by the Incas (Chávez Suárez, 1944:42); however, it is doubtful that the Incas, road builders that they were, were responsible for the causeways of the eastern savannas. There is no authenticated evidence of the Incas in the Río Beni region.

Artificial Earthworks and Drainage Features

The artificial earthworks and drainage features of the Llanos de Mojos consist of causeways, mounds, a variety of types of raised fields, canals, and circular ditches or moats. The very numerous remnants of these features, which will be described and discussed in detail in later chapters, can be seen today in many parts of the Mojos savannas (see fig. 4). Most of these remains are of pre-Spanish origin. They have been mentioned only briefly in the past, and no one seems to have been aware of their size, number, and diversity until the recent availability of aerial photos and the geophysical and aerial operations associated with oil exploration between 1958 and 1961 (Plafker, 1963; Denevan, 1963*a*). The causeways and canals show up clearly on vertical aerial photographs, and some causeways have been mapped as fences on the 1:50,000 maps of the Bolivia California Petroleum Co. concession west of Trinidad. The drained fields can be seen on vertical and oblique aerial photographs, although magnification is often necessary. It is difficult to identify artificial mounds and islas with certainty on air photos unless there are obvious borrow pits adjacent. Unfortunately, aerial photographs are available for only about one-third of the Llanos de Mojos. Surficial digging exposed no pottery in either the fields or the causeways.

Cultural Sequence

Bennett (1936:399) has suggested a relative sequence for Nordenskiöld's mound cultures of Lower Velarde, Upper Velarde and Hennmarck, and

then Masicito. Donald Lathrap (personal communication) sees four distinct ceramic traditions in Mojos: Lower Velarde and Chimay, Upper Velarde and Hernmarck, Masicito, and most recently (early contact period) the Río Palacios corrugated ware, which occurs only on the southeastern margin of Mojos. There is a marked change in ceramic style and burial practice between the upper and lower levels of the Velarde mound, thus providing an age relationship. Upper Velarde and Hernmarck are similar. There is less basis for determining the position of Masicito in the sequence; however, Lathrap considers it a late precontact complex on the basis of similarities with ceramics of such age elsewhere in the Amazon Basin and the Orinoco region (Arauquinoid styles). Gordon Willey (1958: 371) gives tentative dates for Lower Velarde of A.D. 500 and for Upper Velarde and Hernmarck of A.D. 1,000. Lathrap speculates that the Lower Velarde style entered Mojos around A.D. 600 or 700. In Mojos there have been no Carbon-14 studies or other attempts at dating or positive correlations with dated materials elsewhere.

Correlations of ceramic styles with earthworks, with archaeological cultures elsewhere, with historical cultures in Mojos, and with linguistic groups is difficult. The areal extent and the time duration in Mojos of the various ceramic traditions are also still unclear. If Lower Velarde, Chimay-Rurrenabaque, and Desengaño are related, then at least this one tradition was widespread in Mojos: and significantly, there are causeways at Velarde and remnants of drained fields near Desengaño. Of little help are the reports by the early Spanish explorers in Mojos that the Movima Indians were nonpainters and that the Mojo Indians were elaborate painters.

Cultural Connections

In Mojos most prehistoric cultural influences seem to have been Amazonian, probably combinations of western Amazonian developments and Arawak and other contributions brought in from the north and east. Influences from Tiahuanaco, the Incas, the Paraná region, and northwest Argentina seem to have been of secondary importance. Some of the speculation about the affinities of the Mojos cultures and ceramic styles follows, but there is still too little knowledge of Amazonian archaeology to give strong support to any of the arguments.

(1) There is a general assumption that the Arawak tribes in Mojos (Baure and Mojo) were responsible for the earthworks (Métraux, 1943;

Steward and Faron, 1959:255; Nordenskiöld, 1916:152). Nordenskiöld (1917:18–19) associated the mounds, causeways, and related artifacts of southeastern Mojos with an Arawak mound culture because he thought that the Mojo Indians were the main tribe in the area at the time of contact. Bennett (1936:406) believed that the Upper Velarde and Hernmarck cultures represented an Arawak intrusion into northern Bolivia from Brazil. Donald Lathrap (personal communication) believes that the Lower Velarde-Chimay ceramic style is in the Barrancoid tradition of Venezuela, which also is represented by some of the materials at Yarinacocha in Peru and from the Obidos and Santarém regions on the Amazon. Lathrap (1958:387; 1962:558; 1963) believes that the spread of this ceramic style along with intensive agriculture based on bitter manioc was associated with the latest movement of Arawak-speaking people into the Amazon Basin from northern South America. Lathrap (personal communication) speculates that these Arawaks brought both the Lower Velarde-Chimay style and the idea of fairly well-developed earthworks to Mojos.

The historic Arawak in Mojos used and probably built various types of earthworks, and Arawak (Taino, Paressí) elsewhere in tropical America built causeways or agricultural mounds. Nevertheless, there is no conclusive evidence that the Arawak were responsible for all the earthworks in Mojos, that earthworks were not being built before the arrival of the Arawak, or that earthworks were not built by other tribes after the arrival of the Arawak.[5] The ceramics from the mounds excavated by Nordenskiöld are from several, quite different cultures; and in the seventeenth century neither the Arawakan Mojo or Baure lived in the main areas of drained fields. The earthworks may have been the products of several cultures and linguistic groups over a long period of time.

(2) Rydén (1964) has recently noted that the rim decoration of the tripod hemispherical bowls from Upper Velarde and Hernmarck is also found on bowls from the northwestern Argentine, in certain Inca bowls, and, especially, in basket patterns in the northern Amazon Basin and the Orinoco

[5] In opposition to the theory of Nordenskiöld recently revived by Lathrap (1963)—that Arawak-speaking people were major culture carriers in tropical South America—is a more cautious statement by Howard (1947:87): "There is no evidence for the superiority of a so-called Arawak culture. . . . That there existed on the mainland a distinctive Arawak culture and that it is distinguished by a relatively uniform style of pottery still remains to be demonstrated." Also, see Steward and Faron, 1959:287. There is accumulating evidence, however, that modeling and incision (Meggers and Evans, 1961:386; Cruxent and Rouse, 1958: 1:27), bitter manioc, and migrating Arawak-speaking people all moved from Venezuela into the Amazon Basin and that they reached western Amazonia about the same time, although not necessarily together.

Basin. In addition, Rydén says that the only known counterpart of the [illegible] grinder or grater bowls of Upper Velarde and Hernmarck is in the Palikur area of Brazilian Guiana, an area that is also seasonally flooded. Rydén thus infers a likely origin of the Upper Velarde-Hernmarck mound culture in northeastern South America north of the Amazon.

(3) Nordenskiöld (1917:18), Bennett (1936:396, 404), and Willey (1958: 372) saw a Tiahuanaco (Mizque and Cochabamba) influence in Lower Velarde, mainly on the basis of the characteristic triangle spiral motif, and believed the cultures were contemporaneous. Donald Lathrap (1962:533, and personal communication) agrees that the triangle spiral is one ceramic trait of the lowlands that has "probably" diffused from the Andes, but that it is not a basic element. John H. Rowe (personal communication), however, believes that none of the material from Nordenskiöld's mounds "has any significant resemblance to Tiahuanaco pottery."

(4) Nordenskiöld (1917:16) saw little relation between his Mojos mound cultures and the mound builders of Marajó Island (the Marajoara culture); however, Gordon Willey (1948:187) and George Howard (1947:85) believe that the Hernmarck style has resemblances to Marajoara. Even if there is a resemblance, it would not necessarily mean that there was a connection between mound building in the two areas.

(5) The Polychrome Painting Style or Horizon (Evans, 1964:437–442) is represented by sites on Marajó Island (Marajoara), the Río Napo, the Río Ucayali, the middle Amazon, and Amapá, as well as Mojos. Meggers and Evans (1961:380; 1958:16) believe this style originated in the northern Andes and was carried into Amazonia by tribal migrations out of the Andes. Donald Collier (1958:18), however, believes that the painting tradition was associated with "Classic Montaña" cultures which developed near the base of the Andes between Colombia and Bolivia and which "took over painting and slipping as a result of highland influence," with a long ceramic development in the *montaña* being followed by migrations down the Amazon from the montaña rather than from the Andes. Donald Lathrap (personal communication), on the other hand, sees the question of the origin of the Polychrome Style unresolved, with even the possibility of influences from northwestern Argentina.

While there was regional specialization, some similarity can be seen in elaborately painted pottery in the montaña, along the Amazon, and in Mojos. Evans (1964:441) points out that the polychrome pottery excavated

from mounds in Mojos by Nordenskiöld is "reminiscent in both technique and motif of the Polychrome Horizon Style," and undoubtedly is related to the style as a whole. Howard (1947:85) associated the Mojos painting tradition with the polychrome-design cultures of Amazonia, but believed that the latter developed in Amazonia rather than in the montaña or Andes.

The "Classic Montaña" cultures were "relatively complex," compared with most historical tropical forest cultures, and some of the pre-Arawak tribes in Mojos may belong with them. These older tribes (Cayuvava, Movima) could even have been farming in the savannas before the Arawak arrived. The apparent importance of seed crops (maize, beans, squash) at the time of the Holguín expedition may reflect Andean influence on these western Mojos cultures, while bitter manioc was the staple of the Arawak tribes of eastern Mojos (see chap. VII).

III. EUROPEAN MOJOS

Although peripheral to the main themes of this study of native people, it will be useful to examine the history of the European conquest and settlement of Mojos. The Europeans were responsible for the destruction of the native cultures and populations; the European patterns of settlement and land use offer striking, but not necessarily superior, contrasts to native practices; and European explorers, missionaries, and settlers were responsible for the relatively large amount of literature on the Indians of the Mojos savannas.

The Search for Mojos[1]

The El Dorado of Mojos, located in the lowlands east of Cuzco and north of Paraguay, became a major objective of the Spaniards soon after the conquest of Peru.[2] The origin of the legend of this land of "fabulous wealth" is uncertain. In Peru it seems to have been derived from the tradition of a great Inca campaign of conquest to the eastern foothills of the Andes. According to Garcilaso de la Vega (1959:3:53), "one of the greatest provinces [east of Cuzco] was that known as Musu...." The Spaniards in Paraguay combined this tradition with confused stories of the Inca Empire itself which had filtered through the tribes of the *Oriente* to Paraguay. Finally, there is now evidence that the Llanos de Mojos was heavily populated by well-organized societies, so that while there was no great wealth, there was some factual basis for the Mojos legend.

During the sixteenth century Mojos was never thought of as a region of savannas. Between 1539 and 1569 at least ten unsuccessful Spanish expeditions were made into the Oriente from Cuzco, Camata, Cochabamba, and Opatari. None reached the savannas east of the Río Beni, mainly because of extensive rain forest at the base of the Andes. The large Maldonado expedition of 1539 did visit the Toromono Indians in the savannas between the Río Beni and Río Madre de Dios, and Diego Alemán (1897:196–199)

[1] The main sources for this section are original accounts in Maurtua (1906*a*, vols. 6, 8, 9, 10) and the Bolivian Historians Enrique Finot (1939:265–298) and Jose Chávez Suárez (1944:3–155, 177–204).

[2] In the mid-sixteenth century the term "Mojos" (or "Moxos") was applied to vague areas in the Andean foothills by the Peruvian Spaniards and to the unknown area north of Asunción by the Paraguayan Spaniards. Terms often used synonymously for Mojos or areas within Mojos were "Paititi," "El Imperio de Enin," "Tierra Rica," "El Dorado," and "Candire." "Chunchos" was a collective term for the hostile tribes of the *montaña* of Peru and Bolivia, but in some early accounts it is used in association with Mojos or Paititi. All of these terms continued to be used through the eighteenth century.

claimed to have seen *sabanas grandes* and to have reached the Río Viane (Beni) in 1563. The first expeditions to reach the Llanos de Mojos called the main tribe the "Torocosi," "Toros," "Morocosi," or "Mojocosi"; later the Jesuits applied the name "Mojo" to these people. During the eighteenth century the Jesuit province of Mojos came to be defined as bounded by the Río Beni, Rio Guaporé, and the base of the Andes and Chiquitos Uplands (see pl. 1). The expression "Llanos de Mojos" also was used in the eighteenth century (Archivo de Mojos, 5:I, 1778).

Spaniards from Santa Cruz de la Sierra finally explored the Llanos de Mojos in the late sixteenth century. In 1543 the men of Alvar Nuñez Cabeza de Vaca reached the Xarayes marshes on the upper Río Paraguay and heard stories of great kingdoms to the northwest with gold, white Indians, and other typical El Dorado features. Such stories inspired further exploration out of Asunción by Nuflo de Chávez who founded Santa Cruz in 1561. In 1560 the Viceroy of Peru officially designated the unexplored region north of Santa Cruz as the Province of Moxos and named Nuflo de Chávez the Lieutenant Governor of Moxos. Because of the many failures of expeditions to Mojos and loss of lives, a 1573 royal decree stated that the conquest of Mojos was reserved to the people of Santa Cruz (Real Cédula ... de 1573, 1906).

Between 1580 and 1583 Don Lorenzo Suárez de Figueroa, Governor of Santa Cruz, led an expedition to Mojos overland via Chiquitos which reached the Tapacura and Timbu Indians. The Timbu wore nose ornaments that were characteristic of the Mojo, and for this reason Métraux (1942:56) believed the Timbu were the Mojo. If so, then Don Lorenzo's expedition marks the first known *entrada* into the Llanos de Mojos. Suárez de Figueroa sent a second expedition to Mojos in 1595 under Juan de Torres Palomino via the Río Guapay (Grande) for 80 leagues (about 250 miles) to the land of the Morochossies. The Jesuit Padre Hierónimo de Andión accompanied the expedition, and his descriptions of the Indians seem to apply to the Mojo (Andión, 1885:77-81). In 1602 an expedition was led down the Río Grande to southern Mojos by Juan Mendoza Mate de Luna, Governor of Santa Cruz.

In 1617 Gonzalo de Solís Holguín, Governor of Santa Cruz, led an expedition of 75 men through Chiquitos and the Tapacura Indian area (east of Mojos) to the villages of the Toros (Mojo) in the savannas of southeastern Mojos. A series of *relaciones* by members of the expedition provides

the first details about the Mojo Indians (Lizarazu, 1906). Solís Holguín sent a second expedition to Mojos in 1624 which was unsuccessful. None of these expeditions founded a settlement, and they only explored southeastern Mojos and the upper Río Mamoré. As result of the first Solís Holguín expedition in particular, the Spaniards realized that there was no gold or great civilization in Mojos, and further government exploration was halted. The actual conquest of Mojos proceeded under Jesuit missionaries after 1668.

Jesuits in Santa Cruz were given permission by a Cédula Real in 1597 to establish missions in Chiquitos and Mojos. Two Jesuit padres, Miguel de Urrea and Bernardo Rheus ventured into Mojos alone and were killed by Indians in 1597 and 1629. Then in 1631 the Franciscan Padre Gregorio de Bolívar disappeared into the montaña near the Llanos de Mojos and was believed to have been killed by Mojo Indians. The padres were justifiably discouraged by this time and stayed out of Mojos for 35 years, although the Franciscans remained active in Apolobamba west of the Río Beni. What Spaniards—civil, military, or religious—might have entered Mojos between 1631 and 1667 is not known. However, the citizens of Santa Cruz probably conducted slave-raiding expeditions to Mojos, considering the later fear by savanna tribes that the Jesuits were going to enslave them.

As a result of the early expeditions to Mojos, friendly relations were established with the Mojo tribe; and throughout the seventeenth century Mojo trading parties traveled to Santa Cruz to trade cotton products and captured Indians (as slaves) for metal tools. In 1667 the Mojo requested military aid from the Spaniards in Santa Cruz in a war against the Canacure Indians (unidentified), and the Cruceños accepted with the intention of obtaining slaves. The Jesuit Juan de Soto accompanied the expedition in order to determine the feasibility of establishing missions, having been encouraged by contacts with the Mojo in Santa Cruz and by the reports of large numbers of Indians by Jesuits with earlier expeditions. Upon his return, Juan de Soto recommended to Jesuit authorities that missions be established in Mojos. In 1668 he organized a two-year expedition to Mojos with Padres Jose Bermudo and Julián de Aller, but he failed in his efforts to establish a mission because of the Indians' fear of being carried off to Santa Cruz. In 1675 Padres José Castillo, Pedro Marbán, and Cipriano Barrace entered Mojos from Santa Cruz. They remained for many years and established the first Jesuit missions, beginning with Loreto in 1682

(Anonymous, 1691–5) or 1684 (Eguiluz, 1884:15). After nearly 150 years of explorations and interest, a Spanish settlement had finally been founded in Mojos.

The Jesuit Missions

The period of Jesuit activity in Mojos lasted exactly 100 years; Padre Juan de Soto and his companions entered in 1668, and the last Jesuits left in 1768 following the royal decree of 1767 expelling the Jesuits from the Americas. The impact of the padres was much greater than might be expected considering their small numbers. The Jesuits contributed to the depopulation of Mojos by introducing disease and creating conditions that fostered epidemics. They established new political and settlement patterns by rounding up the dispersed village Indians and establishing them in large mission towns. They destroyed much of the native culture and replaced it with new languages, new crops, new crafts and skills, and new traditions. In general, the Jesuit mission story in Mojos was similar to that in Paraguay. However, the story has received little attention from English-language historians,[8] and few scholars are even aware of the chain of successful Jesuit missions that extended into northern Boliva.

The Jesuits founded 21 semipermanent missions in Mojos and founded others in the Chiquitos, Guarayos, and Chapare regions. The number of missions at any given time varied as new missions were added and others were abandoned because of epidemics or poor locations. Some missions lasted only a year or two; sites were often shifted; and some towns, such as San Borja, survived despite being on the verge of extinction. All of the missions were in existence in 1744, but in 1767, there were 15 (René-Moreno, 1888:133) plus several others that were barely surviving. Today all the major towns within the Llanos de Mojos were originally Jesuit missions, including Trinidad, Loreto, San Javier, San Pedro, Baures, Magdalena, San Joaquín, Exaltación, Santa Ana, Reyes, San Borja, and San Ignacio.

All the missions were built initially on the banks of navigable rivers. Each was settled with Indians from several tribes, but the most common language prevailed in each. Mojo was the mandatory language in all of the southern missions, and Baure, Canichana, Movima, Cayuvava, Itonama, Maropa,

[8] There is a general account of the Mojos missions by J. Fred Rippy and J. T. Nelson in *Crusaders of the Jungle* (1936:220–225). In addition to the studies by the Bolivian historians René-Moreno (1888), Finot (1939), and Chavez Suarez (1944) there is an article on the missions in German by Richard N. Wegner (1931).

and Moré were spoken in the others. Mainly because of disease, the individual mission populations seldom surpassed 4,000 Indians despite constant rounding up of additional Indians. In 1713 not one of 16 missions had a population exceeding 2,100 Indians, and the total population was 24,914 (Maurtua, 1906*b*; map 18).

The entire Province of Mojos, a Jesuit mission reserve, was closed to any secular Spanish activity of any kind. One or two Jesuits ran each mission under a political-economic system that was distinctly socialistic. The padres controlled all production, issued food and tools, and periodically slaughtered cattle for groups of families. In addition to religious training the padres taught the Indians various skills and crafts and established a cotton textile industry. All the churches had elaborate wooden carvings and also considerable wealth in silver (imported) ornaments, altars, and utensils.

The Jesuits introduced several Old World crops to Mojos, the most important being rice, coffee, citrus, and the tamarind. They also introduced cacao, which although native to tropical South America was apparently not cultivated previously in northern Boliva. The Jesuits found sugar cane and plantains already being cultivated when they arrived. The native system of slash and burn, shifting farm patches (*chacos*) in the forests was maintained for food crops, but upland rice became equally as important as the native manioc as a food staple. Both cotton and cacao were raised in large forest plantations.[4]

The Jesuits in Mojos maintained regular trade relations with Santa Cruz and through Santa Cruz with Charcas, Potosí, and Cochabamba. Cattle and horses and some goods in oxcarts were moved over a dry-season trail along the Río Piray and Río Mamoré, but most produce was shipped by boat and canoe. The main port of transfer to and from Santa Cruz was Pailas on the Río Grande, 12 leagues from Santa Cruz. The chief exports from the Mojos missions were cotton textiles, cacao, and tallow. Other commercial products included sugar, dried fish, hides, tamarind seeds (for drinks), and coffee.

The Jesuit missions in Mojos acted as a barrier to the Portuguese advancing west through Mato Grosso and up the Rio Madeira, and they played an active role in the frontier dispute that resulted in the Río Itenez (Guaporé) becoming the international boundary between northeastern Bolivia and Brazil in 1771. A Portuguese-Spanish disagreement over Jesuit

[4] Mission agriculture was described best by Padre Eder (1888:42–56), and early postmission agriculture by Orbigny (1946:380–375).

missions on the Iten[illegible] resulted in an army being sent from Charcas to Mojos in 1764. An agreement was reached before the army arrived, but the army remained in Mojos under Coronel Aymerich and in 1767 was charged with overseeing the expulsion of the Jesuits and organizing a new civil government. The Jesuits departed peacefully but destroyed their archives (René-Moreno, 1888:482).[6]

Post-Jesuit Decline

The early years after the Jesuit expulsion were chaotic. Inefficient and corrupt curates were given dictatorial control of the mission towns and Indians. Between 1767 and 1788, 15 major missions with 30,000 people were reduced to 11 towns with 20,000 people, and several other weaker mission towns were finally abandoned. Governor Lizaro de Ribera (1786–1792) instituted a complete reform that left the curates responsible only for religion, while commerce and government were placed in the hands of civil administrators. Conditions improved somewhat, commerce was stabilized, and much of the Jesuit system was maintained; abuses continued, however, and groups of mistreated Indians revolted or fled into the forests.

The independence of Bolivia in 1825 and the unending succession of revolutions that followed brought an even more extreme social, economic, and political deterioration to Mojos which persisted through the first half of the twentieth century. Revolutionary armies periodically entered Mojos to round up cattle and horses or to confiscate the silver in the churches. The sad state of Mojos was observed and commented on by nearly all the travelers to the area—by Orbigny, Gibbon, Keller, Nordenskiöld, and others.

The decline of the Indian population of Mojos was accelerated by the rubber boom which saw thousands of Indians, as well as whites, leave the pampas for the rubber *barracas* of the Beni forests. In 1900 there were only about 10,000 Indians left in the Llanos de Mojos as compared with probably several hundred thousand in the sixteenth century, 50,000 in 1737, and about 15,000 at the present time (see chap. IX).

Economically, the nineteenth century and early twentieth century saw a major shift in emphasis from agriculture (cacao and cotton and some sugar, tobacco, tamarinds, and coffee) to gathering of forest products (first vanilla and beeswax, then quinine, then rubber, and finally Brazil nuts).

[6] The Portuguese dispute and Jesuit expulsion are described in detail, but not always accurately, by Chávez Suárez (1944:273–283, 309–330). The Bolivian campaign against the Brazilians in Mojos has been well studied by Leandro Tormo Sanz (1962).

e scheme of economic evolution envisioned by some scholars, a change agriculture to gathering would be looked upon as degeneration, and e case of Mojos it was in many respects. Throughout this transition, ing was the dominant way of life but remained economically of secy importance until recent years.

e Department of the Beni was created in 1842, and Trinidad became apital, replacing San Pedro which had been the Jesuit capital. The nt boundaries of the Beni roughly coincide with those of Jesuit Mojos.

Contemporary Mojos

significant events have dominated the historical and contemporary aphy of European Mojos: (1) the rule of the Jesuits from 1668 to (2) the rubber boom from about 1870 to 1915; and (3) aviation since d War II. The impact of aviation is striking and has had both benend deteriments; certainly it has lessened but not eliminated the iso- of Mojos from the rest of Bolivia. The rubber boom was peripheral Mojos, and the major effects of the boom died with it; but there was a oulation of Mojos and a decline of agriculture and ranching, while navigation and new river settlements were stimulated.[6] The Jesuits, he other hand, established the patterns that have shaped the cultural conomic geography of Mojos up to the present. The changes since suit expulsion are mainly changes in number, emphasis, and location. Jesuits founded most of the llanos towns, introduced cattle and rice plantations of cotton and cacao, and laid the major trails. Underlying resent cultural geography, however, are traditions and ways of life descended from the Indians, including the subsistence agriculture various adaptations to flooding.

lement.—Most of the original Jesuit town sites were on natural levees ely free from flooding; but the locations on the Mamoré, except for f Exaltación, proved to be unsatisfactory due to the changing of the course, collapsing banks, and overflows. The towns of Loreto, Trini- San Javier, and San Pedro were all moved away from the river banks ge savanna islas. The towns of San Ignacio, Reyes, San Borja, San zo, Cármen, and San Ramón are also on savanna islas, while Magda- Baures, Santa Ana, and San Joaquín are located on tributary rivers. of the present town sites are still subject to inundation during un-

alta, Villa Bella, Guayaramerin, and Rurrenabaque. Riberalta is now the second city Beni with about 10,000 people.

usually high floods, and even during normal floods they may be surrounded by water (pl. 2*b*); roads and airfields become submerged, and isolation is complete. Flood-control schemes considered after the 1947 Trinidad flood were never carried out.

The estimated population of the Beni in 1960 was 158,000 (Bolivia, 1961). Of this number about 120,000 lived within the llanos, and the remainder in the peripheral forests, mainly north of 12° S. The llanos cover an area of about 70,000 square miles, and thus have a population density of about 1.7 persons per square mile. The increase in population in the Beni from 119,770 in the 1950 census has been mainly in the larger towns, while some rural areas and small towns have declined in population. Of the savanna towns, only Trinidad, Santa Ana, and Reyes show any evidence of the prosperity that has recently come to many ranchers. Most of the other towns number less than 3,000 people and are in a general state of deterioration. Trinidad, the capital and largest town in the Beni, had an estimated population of 13,800 in 1960 (Bolivia, 1961).

Transportation.—The Llanos de Mojos are nearly as isolated, except for aviation, from the cities of the Bolivian Altiplano today as in the eighteenth century. There are no all-season roads in or to the llanos. The only major seasonal trail out of the Beni is one from Trinidad to Santa Cruz via Ascensión de Guarayos. From Santa Cruz there is a highway to Cochabamba, but the route is long and circuitous. Although most of the Beni rivers are navigable, their northern outlet via the Rio Madeira and Amazon is blocked by rapids, and their upper courses still have poor connections with roads into the highlands (see fig. 1, Introduction).

Rivers have been the highways in Mojos since aboriginal times. Most of the nineteenth-century travelers, including Orbigny, Gibbon, Keller, and Church as well as many Bolivians, were almost fanatic in their belief that northeastern Bolivia would offer great economic opportunities if steamboats were introduced and a canal or railroad was built around the Madeira rapids. Stimulated by the rubber boom, steamboats began to appear in the 1870's, and in 1913 the famous Madeira-Mamoré railroad was completed around the rapids in Brazil. However, the rubber boom collapsed, and the anticipated benefits were never realized, as other products failed to attain the economic importance of rubber. By 1952 commerce in the Beni was dominated by air transport, and river transport upstream to Todos Santos and downstream to Guayaramerin had slowed to a trickle.

The great paddlewheelers were all abandoned, and their rusting hulks can now be seen on the banks of the Mamoré, Yacuma, and Beni.

In the dry season, jeeps and trucks can be driven over the llanos on trails and even cross-country; but after the rains begin, mechanized movement is impossible except locally, and travel is by horseback, oxback, oxcart, and canoe. During high floods almost all movement is by canoe (pl. 9*b*).

Ranching and the impact of aviation.[7]—Cattle were introduced to Mojos by the Jesuits in 1682, and although numbers increased to over one million by 1900, cattle were of minor economic importance. Many cattle ran wild, while primitive ranches produced meat, milk, and cheese for local consumption and exported some hides and tallow to Santa Cruz by trail. After World War II Bolivian meat companies began flying beef out of the Mojos savannas to the cities of the Altiplano, making nearly worthless cattle suddenly quite valuable. Subsequently cattle were slaughtered at a faster rate than they reproduced and only numbered about 350,000 in 1962. As a result, many ranches have been abandoned recently, and there has been some rural depopulation. The adverse effects of a newly available market for beef will undoubtedly be reversed as increased efforts are made to establish a modern ranching economy in the Beni.

Agriculture.—Commercial crop production has decreased considerably since the 1952 revolution, partly because of economic chaos but also because of rural depopulation, the exodus of upper class management, and the emphasis by landowners on cattle. All agriculture is on forested high ground and is never in the savannas. However, wet rice might be grown successfully in the grasslands despite poor soils; and for other crops there is the aboriginal precedent of savanna utilization by mounding, ridging, and ditching. Adequate surveys of the soils, ecology, and agricultural potential of the Mojos savannas remain to be made. Despite current pessimism, the llanos may be capable of sustaining major agricultural colonization.

Adaptation to flooding.—Adaptation to the annual inundations can be seen in every aspect of the cultural landscape of modern Mojos. This adaptation consists primarily of locating towns, buildings, roads, corrals, and farms on naturally high ground subject to little or no flooding. Only occasionally and to a minor degree are the constructions themselves built

[7] For a more detailed account of the history of ranching in Mojos, see Denevan (1963*b*).

with safeguards against flooding. In general the people passively accept the hardships of flooding, except for seeking high ground and hoping each year that the waters will not be high enough to flood their houses and farms. There is little attempt to build dikes, drainage ditches, or artificial earthworks or to raise buildings on pilings. This adaptation by location rather than by alteration of the landscape and methods of construction has been characteristic of European Mojos, with some exceptions, since the founding of the Jesuit missions. In sharp contrast the native people of pre-Jesuit Mojos adapted to flooding by using both natural high ground and artificially raised ground for their settlements, roads, and farms.

The Literature on Native Peoples

There is a considerable body of published material on the native peoples of the Llanos de Mojos, including descriptions by Spanish explorers and Jesuit missionaries, by nineteenth century travelers, and more recently by a few anthropologists. The available ethnological information has been well synthesized by Alfred Métraux (1942, 1943, 1948). There is, however, much additional material of interest to cultural geography in the literature on Mojos. The most complete bibliographies on the eastern Bolivian tribes are by Harold and Mary Key (1961) and Timothy J. O'Leary (1963).

Most of the known descriptions of Mojos by Spanish explorers and by the Jesuit priests who founded the first settlements have been published; however, many of these *relaciones* are bibliographical rarities available in only a few libraries. Some of the explorers' accounts appear in volumes 9 and 10 ("Mojos") of *Juicio de límites entre el Perú y Bolivia,* edited by Víctor M. Maurtua in 1906; and some of the early Jesuit writings were published in the late nineteenth century through the efforts of the Bolivian historiographer Manuel Vicente de Ballivián.

The most important explorers' accounts are those of the 1617 expedition sent out by Gonzalo de Solís Holguín, Governor of Santa Cruz. In planning a new expedition to Mojos, Don Juan de Lizarazu, Presidente de la Audiencia de Charcas, called together all the available members of the Holguín expedition in 1635 and from them obtained 12 different relaciones (Lizarazu, 1906). Although differing considerably in details, the accounts are essentially in agreement about the main events of the 1617 expedition. Some of the accounts written by these men included their knowledge of previous expeditions to Mojos. The only first-hand account

of the Mojos Indians from one of the earlier expeditions, that of Padre Hierónimo de Andión (1885) who accompanied the second Figueroa expedition in 1595.

The first detailed geographic descriptions of Mojos are those of Jesuit padres Joseph de Castillo (1906) and Pedro Marbán (1898). Both were written about 1676 before the establishment of the missions and the breakdown of the savanna societies. These relaciones include information on the various tribes, populations, numbers and sizes of villages, plants, wildlife, climate, the river systems, flooding, hunting, fishing, crafts, houses, defenses, and agriculture. Padre Antonio de Orellana (1906) wrote a short description of Mojos in a letter in 1687, and he may have authored a life of Padre Cipriano Barrace, first published in 1703, describing the Province of Mojos, the founding of the missions, and the death of Barrace at the hands of the Baure Indians (Anonymous, 1743). Padre Marbán also compiled a Mojo vocabulary which was published in 1701.

In 1696 Diego de Eguiluz, a Jesuit leader in Lima, wrote a *Historia de la Mision de Mojos* (1884) based on reports he received from the padres in Mojos. He recounted the founding of the first six missions, the tribes involved, the number of baptized Indians in 1691, and numbers of Indian villages reported and population estimates for various tribes. There is also a short relación by Padre Agustín Zapata (1906) in 1695 describing his journey north to the land of the Cayuvavas, which at that time was still thought to be that of the legendary Paititi. A detailed later account is that of the Jesuit Diego Francisco Altamirano (1891) based on a short visit to Mojos in 1700 and first published in 1712. Altamirano is probably also the author of two "Breve noticia ... de Mojos," one in 1699 (Altamirano, 1891) and the other in 1713 (Anonymous, 1713). For 1715 there is the *Visita* of Padre Antonio Garriga (1906) which gives the jurisdictional area of each mission.

For the period from 1715 to the expulsion of the Jesuits in 1767 very little has been published, and there are only a few manuscripts in the Bolivian National Archives in Sucre.[5] The Jesuits, however, wrote numerous reports during this period, and many of them can be found in archives in Spain and in the Vatican. Some of this material has been examined by

[5] In the National Archives in Sucre for the colonial period from 1765 to 1820 there are over 200 uncataloged manuscripts on Mojos and 41 volumes of cataloged manuscripts on Mojos and Chiquitos in the René-Moreno collection (see René-Moreno, 1888). Most of this material is on administrative matters, but there is some commercial information.

Professor Leandro Tormo Sanz of the Instituto de Cultura Hispánica in Madrid while preparing a study on the Jesuit missions of Mojos. In the Maurtua collection the only important item for the period 1715 to 1767 is the short *Informe* of the Governor of Santa Cruz, Antonio de Argamosa, in 1737 on the state of the Indians and the missions.

In 1791, more than 20 years after the expulsion, there appeared in Budapest the most informative of all the Jesuit accounts of Mojos. This work is the *Descriptio Provinciae Moxitarum in Regno Peruano* by Padre Francisco Javier Eder based on his service in the Mojos missions between 1752 and 1767 and containing descriptions of the physical geography, biogeography, and the economic and technological activities of the Mojos Indians. The Latin original edition is now very rare; however, a Spanish translation lacking map and sketches was made by the Franciscan Padre Nicolás Armentia in 1888.

Numerous nineteenth- and twentieth-century travelers have mentioned the Mojos Indians but have little to add to our knowledge of the aboriginal savanna tribes except in portraying their final destruction as cultural entities. The few anthropologists who have worked in the Beni, such as Erland Nordenskiöld, Stig Rydén, and Allan Holmberg, have concerned themselves mainly with archaeology and linguistics or with the ethnology of isolated forest tribes such as the Sirionó, Moré, and Chácabo. Nordenskiöld wrote numerous books and articles about his expeditions to eastern Bolivia in 1904–1905, 1908–1909, and 1913–1914. Members of the Summer Institute of Linguistics currently are working with the acculturated remnants of Ignaciano (Mojo dialect), Itonama, Cayuvava, Movima, and Baure Indians.

IV. THE SAVANNA TRIBES[1]

Eastern Bolivia is one of the most diversified cultural and linguistic areas of South America. The Summer Institute of Linguistics (Key, 1961) has mapped 28 existing tribes, and there were possibly twice this number in the sixteenth century. In addition to tribes belonging to the Panoan, Tacanan, Arawakan, Macro-Ge, and Tupi-Guaraní language groups, there are still a number of tribes speaking unclassified languages. This diversity is partly the result of the spread of tribes and the diffusion of cultural traits up the Amazon and Madeira rivers from the north and up the Paraguay Rivers from the south into the plains and hills of eastern Bolivia, plus some influence from the Andes. The variety of languages found at the headwaters of many South American rivers suggests that migrations tend to move upstream as weaker groups are displaced by more powerful groups downstream, where subsistence resources and river transportation are more favorable and tribal unity therefore is enhanced.

For what is now the Beni, Jesuit accounts list dozens of tribes; but many of these were subtribes that spoke the same language or closely related dialects. Padre Eguiluz (1884), for example, listed 38 *naciones* in Mojos, many of them being Mojo subtribes. Linguistic and cultural distinctions and tribal organizations were broken down rapidly under the Jesuits as Indian groups speaking different languages were gathered together in the same mission. Mojo, the most common language, became the official and compulsory language in many of the missions. Nevertheless, most of the tribes surviving in the Beni are still found in the general area where they first were encountered by the Spaniards.

Six important and distinct Indian tribes have been recognized in the Mojos savannas since the eighteenth century: the Arawakan Mojo and Baure and the linguistically unclassified Cayuvava, Itonama, Movima, and Canichana. These people carried out many activities on the savannas, in contrast to neighboring forest tribes, and are here referred to as the Mojos savanna tribes.

[1] The approximate locations in the early eighteenth century of all tribes mentioned here are shown on figure 3. The linguistic classification used is that of the Summer Institute of Linguistics (Key, 1961), which is based mainly on McQuown (1955). The recent provisional classification by Greenberg (1960) differs somewhat. In particular, Greenberg found relationships for Bolivian tribes that McQuown and the Keys considered "unclassified"; Leco is included in the Andean family, Canichana and Movima in the Macro-Tucanoan family, Chapacura in the Arawak subfamily of the Equatorial family, Yuracaré and Cayuvava in the Equatorial family, and the Mosetenan subfamily is placed in the Macro-Pano family.

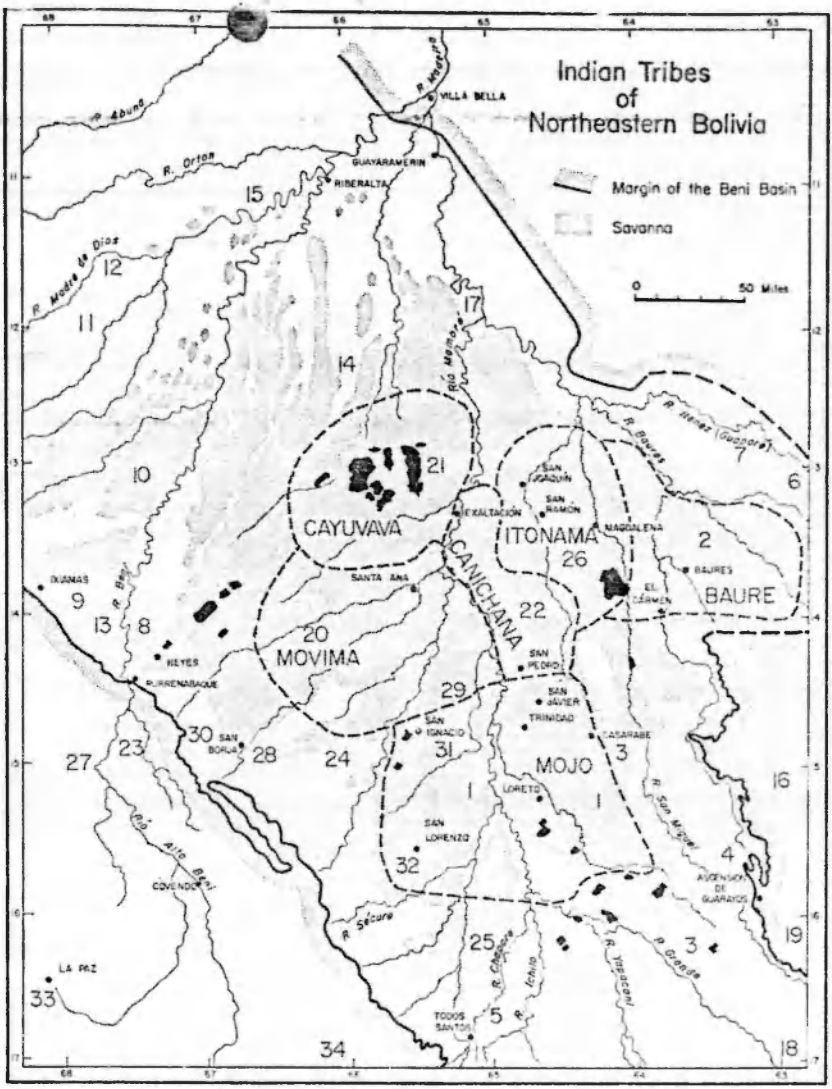


Fig. 3. Indian tribes of northeastern Bolivia, about 1700. (See text for identification of numbered tribes.)

Below are listed all or most of the surviving Indian tribes of northeastern Bolivia by linguistic groups and also some of the now extinct tribes. On figure 3 the main areas occupied by the six major savanna tribes of Mojos are enclosed by heavy dashed lines, and the other tribes are indicated by number only. Locations are only approximate. Extinct tribes are indicated in the list by "(E)." Major sources include maps showing the distribution of tribes in eastern Bolivia by Alfred Métraux (1942), John Rowe (1951), the Summer Institute of Linguistics (Key, 1961), and the Jesuit map of about 1713 (Maurtua, 1906*b*: map 18).

ARAWAKAN (South Arawakan)
1. Mojo (Trinitario, Ignaciano)
2. Baure (Maure)

GUARANIAN
3. Sirionó
4. Guarayo (Guarayu)
5. Yuqui (Chorie)
6. Pauserna
7. Jorá

TACANAN (Pano-Tacanan)
8. Maropa (Reyesano, Chiriba)
9. Chama (Tiatinagua, Guakanahua)
10. Toromona
11. Caviña (Cavineña)
12. Araona (E)
13. Tacana

PANOAN
14. Chácobo
15. Pacaguara (Pacahuara)

UNCLASSIFIED

Chapacuran (16, 17)
16. Tapacura (Chapacura) (E)
17. Moré

Chiquitoan (18, 19)
18. Chiquitano (Chiquito)
19. Manasi (E)

20. Movima
21. Cayuvava (Cayubaba)
22. Canichana

Mosetenan (23, 24)
23. Mosetene (Rache)
24. Chimane (Chumano)

25. Yuracaré
26. Itonama
27. Leko (Chuncho)

UNKNOWN
28. Ticomeri (E)
29. Mujanaes (E)
30. Tiboita (E)
31. Manesono (E)
32. Subirano (E)

HIGHLAND
33. Aymara
34. Quechua

The Mojo and Baure were relatively late arrivals in Mojos, undoubtedly from the north, while the other four tribes probably have been in the region a very long time in view of the absence of related languages elsewhere in South America. The Mojo, Baure, and Cayuvava were socially stratified agricultural people with large populations and large villages. The Movima and Itonama apparently had no unusual sociopolitical features, but were large tribes. The Canichanas were a small, warlike tribe with little agriculture.

Of the numerous other savanna tribes mentioned by the Jesuits, all were absorbed into the missions or by forest tribes, or were wiped out. Most were probably related linguistically and culturally to the major tribes.[2] Some of the extinct tribes that were fairly certain to have had separate languages were the Ticomeri of the San Borja area, the Manesono west of Trinidad, and the Subirano on the Río Sécure (Métraux, 1942:79). In addition there are a number of tribes that lived or still live near the edges of the Llanos de Mojos and at times in forest patches or gallery forests within the llanos. These marginal savanna tribes include the Sirionó, Moré, Chácobo, Maropa, Caviña, Chimane, Guarayo, and Tapacura.

This study of aboriginal Mojos considers mainly the six savanna tribes. They were most important politically and numerically; they were all faced with the problems arising from seasonal flooding; they or related predecessors were most likely to have been responsible for the earthworks on the savannas; they are the best-known tribes historically; and they are all represented by cultural and linguistic remnants today.

The Savanna Chiefdoms

The Mojo and Baure Indians of the Llanos de Mojos, the extinct Manasí of the forests east of Mojos, the extinct Xaray of the Xarayes Pantanal region of the upper Río Paraguay, and the Paressí[3] of the upper tributaries of the Rio Guaporé have been classed as theocratic "tropical forest chiefdoms" by Julian Steward and Louis Faron (1959:252–261). The Cayuvava of the Mojos llanos could also be considered a "chiefdom," and undoubtedly there were once other such groups in the central interior of

[2] Nordenskiold (1924*b*:16) believed that the extinct tribes were not numerous. The names that were listed repeatedly in the early accounts have lived on, while the names only mentioned once were probably subgroups of the major tribes.

[3] The Mojo, Baure, and Paressí spoke Arawakan; the Xaray language is unknown but may have been Chiquitoan; the Manasí have been classed as Chiquitoan, but may actually have been Chapacuran (Metraux, 1942:127), which may be related to Arawakan.

uth America. Steward's and Faron's (1959:12) chiefdoms also include
ies in northern South America, southern Central America, the Greater
tilles, and the southeastern United States.[4]

teward's five South American cultural types are "central Andean irri-
ion civilizations," "theocratic and militaristic chiefdoms," "southern
dean farmers and pastoralists," "tropical-forest-village farmers," and
omadic hunters and gatherers." The differentiation is based mainly on
gree of social organization and stratification, with close relationships
environmental potential, actual food production, and population den-
y. The chiefdoms and irrigation civilizations produced sufficient food
plus to support nonworking classes of religious, military, political, and
nical specialists. The chiefdoms are characterized by class structure,
e gods, a priesthood, and craftsmen, but particularly by the organization
several communities into small states, as distinguished from large irri-
ion states and empires, independent farm villages, and hunters and
herers.

The value of Steward's classification, and especially the chiefdom cate-
y, may well be questioned in view of the great cultural diversity of the
efdoms and the fact that they ranged politically from the relatively
e Chibcha states to the Xarav, consisting of only four villages loosely
ted under a single chief. On the other hand, some of the tribes classed
"tropical-forest-village" apparently had a fairly elaborate material cul-
, semipermanent villages with over 1,000 people each, technical special-
, and a highly productive, often permanent agriculture. The difficulty
doubtedly lies, as suggested by Lathrop and Myers (1964), with the
that the composite picture of tropical-forest-village culture is based
marily on relatively recent descriptions of Amazonian tribes. Judging
n archaeology and early fragmentary descriptions, many of these tribes,
ticularly riverine tribes, could well have been categorized as "chief-
s" before they underwent rapid sociopolitical breakdown as a result
European contact. The reason why Steward is able to classify certain
jos tribes as chiefdoms, but not other Amazonian tribes that may once
e been just as developed socially, is largely because of the lateness of

[4] The "chiefdoms" correspond to the "Circum-Caribbean" and "Sub-Andean" tribes of the *Handbook of South American Indians* (Steward, 1946–1959). The change in terminology is apparently made in order to avoid using geographical expressions for types or levels of culture.

direct European contact in Mojos and because of the survival of good descriptions of the Mojos tribes made by the Jesuits soon after contact.

In any event, several of the Mojos savanna tribes did have characteristics rating them as intermediate between the Andean civilizations and the independent tropical-forest-village Indians. The Mojo and some of their neighbors had social classes, were grouped into small political units beyond the community level, had elaborate crafts (although more characteristic of the forest tribes than of the Andean cultures), formed large villages and large populations, and were efficient food producers. These tribes, or their not-too-distant predecessors, also engaged in major community drainage projects, including the building of raised and ditched fields for cultivation, causeways, canals, and mounds. The term "chiefdom" is used here for convenience to designate the Mojos tribes having these characteristics.

In the remainder of the present chapter the distribution, social organization, and the artifacts of the Mojos savanna tribes at the time of Spanish contact are discussed briefly. Some of this material is covered in more detail by Alfred Métraux (1942, 1948). Succeeding chapters describe settlement features, communication, agriculture, and other subsistence activities. The emphasis here is on the forms of the cultural landscape and production, on how the savanna tribes have utilized their semiaquatic habitat.

Mojo

Distribution.—The relative importance of the Mojo among the savanna tribes of northeastern Bolivia was indicated by Padre Marbán (1898:133) who wrote in 1676 that Morocósi (Mojo) and its dialects were spoken by three-fourths of the province, which then was known only as far north as about 14° S. Padre Castillo, 1906:294–302) reported 18 Mojo subtribes in 1677. He said there were Mojo groups as far south as just above the Río Grande-Río Piray (Yapacani) junction and the lower Río Sécure, and as far north as the upper Río Machupo. The Mojo dominated the savannas east of the Río Mamoré and south of Trinidad, and apparently they extended at least as far west as present-day San Ignacio. Villages were located both along the Río Mamoré and its tributaries and on small savanna islas. The Mojo Indian area shown on figure 3 contains the original sites of all the Mojo Indian missions (Loreto, Trinidad, San Javier, San Ignacio, San José, and San Luis). Although Mojo was spoken by most of the

original Indians of Loreto, the Indians initially gathered in Trinidad, San Ignacio, and some of the other missions were from several tribes in addition to the Mojo.

Social organization.—The Mojo villages seem to have been largely autonomous; however, the existence of causeways connecting villages suggests the cooperation of communities under some kind of authority. Also, members of the Solís Holguín expedition reported being told of a leader called the *Yaya*,[5] to whom villages paid tribute (Lizarazu, 1906:177, 181). Orbigny (1946:189) wrote that villages were independent but were all under the leadership of a *cacique* who had little authority. Padre Orellana (1906:7) said that each village annually elected its own headman,[6] and Padre Eguiluz (1884:6) said that each village was independent. Although little is known of the Mojo headmen (rulers of single villages), they were probably similar to those of the Baure who did not work, had full command during wars and hunts, could impose the death sentence, could decide when a village should be moved, and were in charge of the cultivation of the plants from which drinks were made. The Baure headmen were hereditary and had two male and two female slaves; their wives had to be daughters of other headmen (Altamirano, 1891:109; and Eder, 1888: 106–107). Presumably chiefs (leaders of several villages) or headmen had jurisdiction over the building of major earthworks. The headmen and chiefs thus had a status far superior to most people.

Second in social importance was a priest and shaman class[7] whose members conducted magic rites and village and temple ceremonies and acted as oracles, spirit helpers, and medicine men. The existence of highly developed crafts suggests, but does not prove, that there was also an artisan class. There was a slave class based on enemy captives (Anonymous, 1743: 446); however, slaving may have originated after Spanish contact as a result of the slave trade with the Spaniards. Thus, there is some indication of social stratification; however, the evidence in the early sources is not sufficient to indicate a situation significantly different from that of a number of other tribes in the Amazon Basin.

The Mojo had a fairly involved religious system based on a jaguar

[5] Any interpretation of oral information received by the Solís Holguín expedition must be regarded with skepticism since the expedition had no interpreters. *Yaya* is the Inca word for "father" and was used by some missionaries for *padre*.

[6] Election of village headmen may have been a Spanish introduction.

[7] It is not certain whether the priests were full-time or part-time specialists.

cult, village gods and idols, and ceremonial temples with major scheduled ceremonies (see Métraux, 1942:74–78).

To what extent, if any, Mojo villages banded together for warfare is not known. Apparently warfare was not as important as among the Baure, who had elaborate village defenses. The main reasons for warfare are not known.

Economically, the Mojo were efficient food producers, as is indicated by Spanish reports of large farms plus the existence of ditched and raised crop rows in the western savannas of the Mojo territory. In addition, wild game, fish, turtles, and birds were very plentiful and were sought in major communal hunts (see chaps. VII and VIII).

The Mojo had far-reaching trade relations, which probably accounted for their being well known beyond the limits of the llanos. They had regular contact with the Chiriguano of the Santa Cruz region, from whom they obtained salt (Castillo, 1906:328), and with the Moseten in the headwater area of the Río Beni, from whom they obtained salt, beads, and knives (Marbán, 1898:140). Since stone is absent in the Llanos de Mojos, except for a few outcrops in the east, the stone implements found in Mojo sites must have been obtained from tribes in the Andean foothills and from the Chiquitos Uplands.

Manufactures[8]—The crafts of the Mojo and Baure Indians were of high quality and beauty. Textiles were made from both bark and cotton thread. Bark was used from the *bibosi* tree (*Ficus* spp.), and the source of cotton was probably the woody, perennial cotton presently cultivated in the Beni. The vertical or Arawak loom is used by the savanna tribes today and was probably pre-Columbian in Mojos. The Mojo, Baure, Itonama, and Movima have all been famous as weavers of cotton textiles since Jesuit times.

One member of the Solís Holguín expedition reported that the Torocosis (Mojo) had many wooden fish and painted birds (Lizarazu, 1906: 176). This account suggests skill in wood carving and is supported by the ability of the Mojo for carving reproductions of images for the mission churches. Padre Eder (1888:146) maintained that the greatest art of the Mojo was featherwork. Elaborate mosaics were made by sewing feathers and down onto cloth. Eder (1888:149) also said that the Mojo made "very

[8] Many of the material culture traits of the Mojo and other savanna tribes are described and their South American distribution mapped by Erland Nordenskiold (1924*b*).

elegant mats" with fine, stained reeds forming a "beautiful variety of flowers," and colored baskets, hats, and bags which were eagerly sought by the Spaniards. Altamirano (1891:107) said that the walls of the Baure huts were covered by curious woven tapestries.

Padre Marbán (1898:150) noted the elaborate pottery of the Mojo, often with paintings of different animals, or of animal markings according to Padre Castillo (1906:320). Most of the pottery excavated by Nordenskiöld, however, was characterized by simple geometric designs; but clay figurines and zoomorphic vessels have also been found (see chap. II). Padre Castillo (1906:320) said that "everything made of clay is very good . . . having a very beautiful varnish." According to Padre Eder (1888: 35) the Mojo tempered pottery with the ashes of a sponge spicule (*Parmuda batesii?*) which provided unusual resistence. The same is done by the Movima Indians today using a siliceous sponge plant found on the banks of the Río Yacuma and also by the Chácobo and Canichana.[9]

For weapons the Mojo used bows and arrows, spear throwers, blowguns with poison darts, slings, and bolas. The Baure used shields made of intertwined reeds and cotton threads. Musical instruments included panpipes made from twisted bark (Métraux, 1942: pl. 4). The panpipes used in the missions were enormous, up to six feet long.

Stone tools obtained through trade were highly prized.[10] Nordenskiöld found stone axes in the mounds of southeastern Mojos, and I saw several large stone ax heads that had been recovered in the vicinity of San Ignacio. Smooth stones were and still are used for pulverizing manioc flour. Manioc flesh was originally grated on a board that had thorns and pointed sticks inserted into it (Eder, 1888:149). Large wooden mortars were used for grinding corn and are now used by most Beniano families for grinding both corn and rice. Nordenskiöld (1913) found ribbed-clay grinders and clay rollers and platters, possibly for grinding corn, in the mounds he excavated. Cutting and sawing tools were made from bone, teeth, and from *chonta* palm wood.[11]

[9] Tempering with siliceous sponge (*Canixí* in Brazil) is characteristic of incised and modeled pottery found on the middle Amazon and at Santarém and also at the Late Ronquín and Arauquín sites in the Orinoco llanos (Hilbert, 1962: and Howard, 1947:84). See Linne (1925: 49–57) for a discussion of ceramic tempering using a paste made from the ashes of sponges.

[10] The value of stone to the Mojo is indicated by a passage by Orbigny describing his journey in 1832 from the llanos to Cochabamba with Mojo boatmen. When the first stones were seen, the Indians began to gather them up excitedly, "as if they were gems" (Orbigny, 1958:786). I saw grinding stones that had been kept in families for generations.

[11] The use and invention of stone substitutes in Mojos and other stoneless areas of South

Gold and silver objects, mostly ornaments, were all probably obtained in trade; however, legends persist to this day of both ancient Mojo and Jesuit gold mines in the Sierra de San Simón near the Rio Guaporé. Metal tools from Spanish sources were obtained in trade even before direct Spanish contact. Padre Marbán (1898:148) wrote in 1676 that the Mojo took all their new cotton *tipoys* (long shirts) and hammocks to Santa Cruz to trade for knives, axes, machetes, and objects of tin and silver.

Within the area occupied by the Mojo in the seventeenth century there are aboriginal earthworks, but they are not as numerous as in the territories of the Baure, Movima, and Cayuvava. Most of the large artificial mounds are in the Mojo area, and there are scattered causeways and canals; however, there are only a few drained fields east of San Ignacio and possibly none east of the Río Mamoré. The region with large numbers of causeways and drained fields west of San Ignacio is marginal to the centers of both the Mojo and Movima tribes. Either group may once have dominated the area and been responsible for these features.

Today the Mojo language is spoken by Indians in Trinidad, San Ignacio, San Javier, and Loreto and also in scattered smaller settlements such as San Lorenzo. Mojo spoken in San Ignacio (Ignaciano) is somewhat different from that spoken elsewhere (Trinitario), but the two dialects are more closely related to one another than either is to Baure. Willis Ott (personal communication) of San Ignacio, who is studying Ignaciano, believes that the Jesuits standardized the Mojo language and that the Trinitario and Ignaciano dialects have diverged since the Jesuit expulsion.

In his description of Santa Cruz in 1788, Francisco Viedma said that the Mojo Indians used a written sign language.[12] However, if the Mojo had some form of pre-Jesuit writing, then it surely would have been mentioned by the Jesuits.

Baure

Although the Jesuits were long aware of the Baure (Maure) Indians,[13] the first to visit them was apparently Padre Barrace after he founded Trinidad in 1687 and before 1692 when Padre Equiluz (1884:22) described Barrace's

America is discussed by Nordenskiold (1930*b*:33–34). For example, bolas were filled with clay, and arrows were wooden tipped.

[12] "Un indio Moxo escribe los anales de su pueblo en una tabla ó en un pedazo de caña, por medio de varios signos, cuya inteligencia y manejo pide mucha combinación y una memoria feliz" (Viedma, 1900:2:505; from an *Informe General* written by Gov. Ribera in 1788).

[13] Padre Andión (1885:80), who accompanied the 1595 expedition from Santa Cruz, said that near the Mojo were the Maure: "well dressed and political people . . . with large well-made houses facing a plaza . . . and considerable agriculture."

travels. The Baure originally occupied the savannas between the Río Baures and the Río Itonamas, with their main concentration being along the lower Río Blanco. They extended north and south along these rivers roughly to the limits of the savanna. The Baure language, related to Mojo, was spoken in the original missions of Concepción de Baures, San Joaquín, Cármen de Mojos (El Cármen), San Simón, San Nicolás, and San Martín.[14]

The social and material culture of the Baure was apparently very similar to that of the Mojo; however, the missionaries described them as more civilized than the Mojo. There were a great number of well-constructed villages with streets and plazas (Anonymous, 1743:466). For defense the villages were surrounded by palisades and ditches, and pitfalls were dug in the paths (Altamirano, 1891:136). Extended mounds were raised for settlements which were connected by causeways and canals (Altamirano, 1891: 107). The Baure were clean and "tractable" people, and all wore clothes.

Cayuvava

The Cayuvava (Kayuvava, Cayubaba) occupied the savannas west of the Río Mamoré and north of the Río Yacuma. Northern and western limits are unknown, but Cayuvava groups have been reported at various times west and north of Lago Rogoaguado. Many villages were located along the west bank of the Río Mamoré and also along the Río Iruyani. Indian place names are of some aid in determining former tribal distributions. Rogoaguado and Rogagua, for example, are Cayuvava names, while Yacuma is Movima. However, several of the lakes near Lago Rogoaguado, including Yachaja, have Movima names, suggesting that the Movima had moved into Cayuvava territory after Jesuit control, if not before. There are apparently no Cayuvava place names south of the Río Yacuma.

In 1693 Padre Agustín Zapata visited the Canichana villages along the Mamoré and was told that there were numerous people further down river called the Cayuvava. Zapata visited the Cayuvava the same year trading knives, axes, and machetes for peanuts, maize, and manioc. He reported seeing seven villages, averaging 1,800 people each, ruled by one chief who was bearded and called Paititi. In 1695 he entered one large village that had a plaza, streets, and a temple; people were dressed with feathers and *mantas:* a big fire was burning day and night; and sacrifices were made of deer, rabbits, and birds (Eguiluz, 1884:33–6).

[14] San Nicolás was located east-southeast of Baures on the Río San Martín, and San Martín was located just below the junction of the Río San Simón and the Río San Martín. Both missions were abondoned shortly after the Jesuit expulsion in 1767.

The Spaniards had been searching for the El Dorado of Paititi for over a century, but they apparently came to doubt its existence after the exploration of southern Mojos. Then in 1695 Padre Zapata matter-of-factly stated that the chief of the Cayuvava villages was called the "Paititi," and this was repeated by Eguiluz and also by Altamirano (Anonymous, 1891:11). Padre Armentia (1905:233, no sources) commented that the Jesuits of the Cayuvava mission of Exaltación spoke of the *gran laguna del Paititi,* and that Jesuit maps of the period 1700–1711 labeled the area between the Río Beni, the Río Mamoré, and the Río Yacuma as *Missiones del Gran Paititi.* Armentia concluded that this was the legendary Paititi and that the *Río del Paititi* was the Río Beni, and he suggested that Lago Rogoaguado was the original *Laguna del Paititi.*

Did the name "Paititi" actually originate in northwest Mojos? Probably not; however, there was a Spanish tradition locating the Paititi nation, *cacique,* and *laguna* filled with gold and pearls in this area. The sixteenth-century explorers from Cuzco believed Paititi was east of the Madre de Dios and the Beni; the explorers who reached southern Mojos thought that the Paititi must be further north,[15] and this was supported by Mojo Indian accounts of a kingdom to the north. That Padre Zapata associated the big Cayuvava villages with Paititi, even though no wealth was found, is not surprising.

Alfred Métraux (1942:56), Harold Osborne (1964:82–84), and others have concluded that the stories of the El Dorados of Mojos and Paititi were simply misplaced rumors originating with the Inca Empire and disseminating through the lowland tribes. On the other hand, although highly exaggerated, these stories to some extent may have been based on an advanced culture in the northern Mojos savannas. This theory is suggested by several things: (1) Many of the rumors about Paititi, Mojos, and the *Tierra Rica* of the lowlands did not begin in Asunción and Santa Cruz but rather with Spaniards in Cuzco and La Paz whose source was the highland Indians; (2) the Incas sent an expedition of conquest to the Río Madre de Dios and the borders of northern Mojos; (3) the Jesuits believed the Cayuvava region was Paititi; (4) the Jesuits found large, politically unified villages; and (5) there are numerous remnants of large raised fields and trenches in the Cayuvava region, suggesting a former large and well-organized population.

[15] A good example is Padre Castillo (1906:302) who in 1677, shortly before the first missions were founded, said that Paititi lay 50 leagues north of Mojos.

Little is known about the Cayuvavas before they were settled in the Exaltación mission in 1704 other than that which was reported by Zapata and Eguiluz. Orbigny (1946:203) mentioned that "they march into combat organized into phalanges captained by special chiefs." He also noted that when he visited Exaltación in 1832, the Indians were divided into eight groups which apparently corresponded to former subtribes headed by different chiefs (Orbigny, 1959:361). By 1909 little remained of the Cayuvava culture that was distinctive (Nordenskiöld, 1923:77–78), and today the tribe is near extinction. When I visited Exaltación in December, 1962, with Harold Key, there were only a handful of people in town who spoke Cayuvava; a few others were scattered about in small settlements mainly along the Río Iruyani. As is true of most of the survivors of the savanna tribes, these people have few or no traditions or legends that antedate the Jesuits.

Movima

At various times, Movima Indians have been reported throughout the savannas west of the Río Mamoré between 13° and 15° S. Their main concentration, however, has been along the Río Yacuma, with southward extensions along the Río Rapulo-Manique, Río Mata, and Río Apere. In the seventeenth century the Movima extended at least as far north as the Río Iruyani, south to San Ignacio, and southwest to San Borja.

The first mention of the Movima was by Padre Gregorio de Bolívar (1906:218) who was with an expedition that reached the llanos in 1621. Bolívar told of the *Moymas* down the Himana (Mamoré) River, who were "a naked people, vile and addicted to witchcraft." At the end of the seventeenth century, the Movima were settled in the missions of San Borja, San Luis,[1] San Pablo, San Lorenzo, and Reyes. Santa Ana on the Río Yacuma, founded in 1709, soon became the main Movima mission and has since remained the center of Movima life.

Altamirano (1891:150) wrote that the Movima were naked barbarians living in misery and without government, and that they were fishermen, hunters, and farmers. There seems to have been nothing remarkable about the Movima except that they were a large tribe occupying a large territory. This territory, however, contains the greatest concentration of causeways and drained fields in the Beni. It seems unlikely that the Movima were responsible for these features, but the tribe may have degenerated consid-

[1] The mission of San Luis, abandoned shortly after 1782, was located south of San Borja on the Río Rapulo.

erably by the time the Jesuits visited them. Possibly the Movima had displaced the Mojo or some other tribe. The Movima do have legends about a longheaded tribe once living south of the Río Yacuma, and they believe that these people made the elaborate pottery found at such sites as Desengaño on the Río Apere. These longheads may have been the Tiboita who practiced cranial deformation; however, Eder (1888:105) said that the Tiboita were simple hunters and fishermen. Orbigny (1946:201) spoke more favorably of the Movima, saying that their customs (food production, government, religion, industry) were identical to those of the Mojo, and this is still relatively true today. The similarity between the Movima and Mojo may be largely the result of mutual Jesuit domination. The Movima do have legends about visiting large towns, and Robert Judy of the Summer Institute of Linguistics believes that these towns may have been pre-Jesuit religious centers.

Canichana

The Canichana (Kanichana, Canisiana) formed a small tribe located on the east side of the Río Mamore between Trinidad and the Río Yacuma and along the upper Río Machupo. Farming was apparently less important than hunting and fishing.[17] The Canichana were very warlike, were feared by their neighbors, and were reputed to be cannibals. Padre Arlet (1781: 40) wrote that they kept prisoners as slaves or roasted and ate them. Villages were generally small and fortified with palisades and moats (Orbigny, 1946:198). Warfare was not carried out for purposes of tribute or conquest, and there is no evidence of any social stratification.

Itonama

The Itonama were a "completely naked" people with "bestial customs" located in the savannas between the Baure and Canichana tribes. They were first described in 1704 by Padre Lorenzo Legrarda, who encountered them while opening up a road from San Pablo to the Baure area (Altamirano, 1891:99). Most of the Itonama villages were along the Río Itonama, extending south to Laguna Cármen (Lago San Luis). The Itonama did not have large villages and farms as did the chiefdoms, but they probably borrowed many traits from the Mojo and Baure. They used slings and bolas, cultivated maize, played giant panpipes, and were noted as weavers of baskets and cotton textiles.

[17] "Dedicados principalmente a la pesca y a la caza, descuidaban la agricultura" (Orbigny, 1946:198).

Early twentieth-century travelers, including Erland Nordenskiöld, believed that the savanna tribes of the Beni were nearly extinct; however, numerically all except the Canichana and Cayuvava have been holding their own, if not increasing, and are maintaining racial and linguistic integrity. On the other hand, all the savanna tribes were highly deculturated when studied by Nordenskiöld (1924:12–14, map 1) and retain very little of their original culture today.

Marginal Savanna Tribes

The most important tribes who have lived along or near the margins of the Mojos savannas are the Sirionó, Moré, Chácobo, Maropa, Caviña, Chimane, Guarayo, and Tapacura. Except for the Sirionó, these tribes were typical tropical-forest villagers with a well-developed slash-and-burn agriculture.

The Sirionó (Holmberg, 1960; and Rydén, 1941) were Guaraní-speaking hunters and gatherers with little agriculture who lived between the Río Itonama-San Miguel and the Río San Martín. Groups once occupied the forest patches in the savannas east of Trinidad, and migratory bands occasionally may have crossed the Río Mamoré. Nordenskiöld (1911:16) mentioned Chácobo Indians north of Lago Rogoaguado fighting with Sirionó Indians. The largest number of Sirionó are now settled at Casarabe and Eviata; however, there are still a few nomadic forest bands. A still hostile, closely related tribe, the little known Yuquí or Chorie, is found in the Chapare region.

The Moré (Iténe) (Métraux, 1942:86–95), who belong to the Chapacuran linguistic family, live in the forests near the junction of the Río Itenez and Río Mamoré and once extended up the Mamoré nearly to Exaltación. The tribe remained hostile until recently.

The Panoan-speaking Chácobo (Nordenskiöld, 1923:79–111; Métraux, 1942:45–50) are located north of the Cayuvava and Lago Rogoaguado. Only a few members of the tribe survive today, all in small villages in forests west of the Río Yata. Nordenskiöld, however, visited two villages in forest islas within savanna near the northwest side of Lago Rogoaguado.

The Maropa (Chiriba, Reyesano) (Métraux, 1942:30–45) are a Tacanan-speaking tribe originally located along the Río Beni west of the Cayuvava and Movima. Many were settled in the Reyes mission on the western edge of the Llanos de Mojos. The region between the Río Beni and the Río Madre de Dios, which includes large savannas crisscrossed by old cause-

ways, was occupied originally by other Tacanan tribes including the Chama (Tiatinagua and Guakanahua), Toromono, Caviña (Cavineña), and Araona.

The Chimane (Chiman, Chumano) (Métraux, 1942:15–27) occupied the area between the upper Río Rapulo-Manique and the Río Apere. Most of this zone is forested, but long arms of the Mojos savanna extend into it. The Chimane are located on the margin of and partly within the area of numerous drained fields and causeways between San Borja and San Ignacio. Métraux (1942:19) commented on these features and suggested that they "were made either by a large and industrious population which preceded the Chiman or else by the original stock from which the modern Chiman are descended." It is not clear whether this area was occupied by the Mojo, Movima, Chimane or some other tribe at the time of the Spanish entry. On the other hand, causeways and fields have been reported near Nuevo Mundo within forests well into Chimane territory.

The Chimane with their neighbors in the Andean foothills, the Moseten (Rache), form another independent linguistic group in the Beni. The Moseten maintained close relations with the Aymara and may have been subjugated by the Incas. The Moseten also had active commercial relations with the Mojo, trading mainly salt for cotton textiles.

The Guarayo (Guarayu) (Métraux, 1942:95–110) originally were concentrated between the upper Río San Miguel and the upper Río Blanco. In the nineteenth century the tribe was settled in this region in the Franciscan missions of Yotaú, Ascensión de Guarayos, Urubichá, Yaguarú, and San Pablo. The Guarayo are descendents of Guaraní Indians who migrated toward the Andes from Paraguay in the late fifteenth and early sixteenth centuries. Some of these Guaraní may have reached the eastern Mojos savannas. The tribe is now widespread in eastern Bolivia, and many work on ranches in the Beni. Causeways crossing swamps in Guarayo territory probably were built by the Franciscans.

The now extinct Tapacura (Métraux, 1942:86–95) were a Chapacuran-speaking tribe which apparently formed a powerful nation in the seventeenth century in the forests east of the Mojo Indians. They are mentioned in nearly all the early explorer and missionary accounts. Large palisaded villages were reported, and Padre Eguiluz (1884:22) said the tribe spoke the same language as the Mojo. In the classification of South American tribes by Joseph Greenberg (1960), the Chapacuran groups are considered

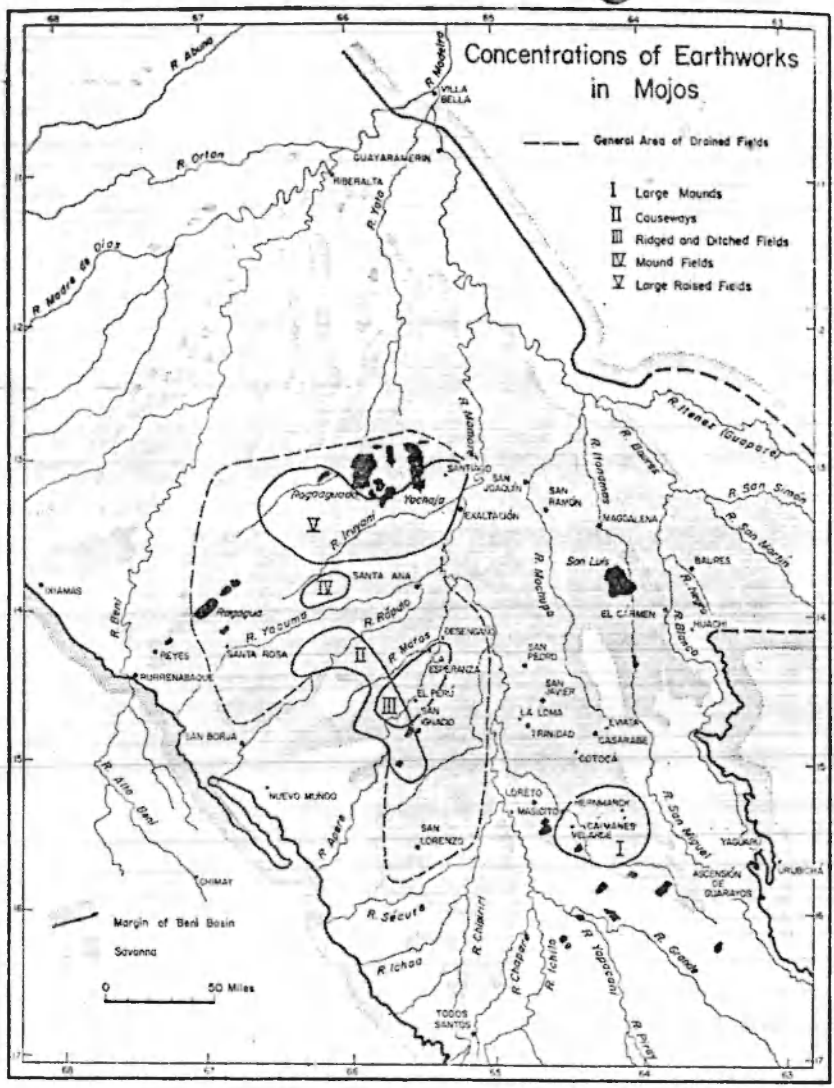


Fig. 4. Location of aboriginal earthworks in Mojos. The general area of drained fields is shown by a heavy dashed line. The areas enclosed by heavy solid lines have known concentrations of certain types of earthworks. Mounds and causeways are found throughout Mojos, and causeways are also found in the large savannas west of the Río Beni.

Arawak. Possibly the Tapacura was another socially advanced tribe (chiefdom) as were their eastern neighbors, the also extinct Manasi. The Manasi, usually classed as Chiquitoan, were of the same nation as the Tapacura, according to their discoverer Lucas Caballero (1933:18). Possibly both tribes were Arawak.

Thus, the Llanos de Mojos and adjacent areas contained a wide variety of tribes speaking unrelated languages and ranging culturally from the simple hunting and gathering Sirionó to the more complex Mojo, Baure, and Cayuvava chiefdoms. Of the six clearly recognized savanna tribes, only the Mojo, which probably was the largest tribe at the time of conquest, was well described in the early literature. Therefore, in the following chapters most of the material based on first-hand accounts concerns the Mojo. A positive statement of who was responsible for the earthworks and the drainage features of the region is not possible at the present time. It may have been the Mojo, one of their neighbors, some unknown tribe, or several different tribes. Whatever tribes were involved, they must have had a relatively well-developed social organization, as did the Mojo. The concern here is not so much with individual tribes, but with how the aboriginal people of the Llanos de Mojos dealt with the problem of seasonal flooding, particularly in relation to settlement, communication, and subsistence activities.

V. SETTLEMENT FEATURES

The aboriginal villages of the Mojos savannas were characterized by great diversity in size, site, permanency, organization, and protective mechanisms against flooding. Because of inadequate evidence, it is impossible to describe fully the villages of any single tribe or to contrast the settlement features of different tribes. Certain local and regional characteristics can be pointed out, and the remnants of habitation mounds can be described. The locations of mounds and other aboriginal earthworks in Mojos are shown on figure 4.

Villages

For the six main savanna tribes, Jesuit missionaries reported 356 villages in the 1690's, and undoubtedly there were many more at the start of the seventeenth century. Padre Marbán (1898:133) said that in the Province of Mojos there were so many villages so closely spaced that five or six villages were encountered every five or six leagues (25–30 km). Some of the villages were unusually large. Mojo towns were reported to have had as many as 400 houses in 1617 and as many as 200 houses in 1676. Cayuvava villages were said to have from 1,800 to 2,000 people each. However, most villages had around 20 houses and probably 100 people or less.

Tropical-forest-village size is controlled to a considerable extent by agricultural production. Agriculture based on shifting cultivation on the forest islas within the savannas would not support large or permanent villages because of the limited amount of arable land available, and undoubtedly this was the situation of many of the savanna villages.[1] The large villages reported in Mojos must have had considerable farming land, either sizable tracts of forest or cultivated savanna. The Mojo villages visited by the Solís Holguín expedition were associated with large forest farms, and the big Cayuvava villages were in an area of drained savanna fields. Large villages also suggest some permanency of site, and this would have been made possible by better than average soils, such as occur in gallery forests, or by a system of savanna cultivation. Many aboriginal village sites, however, were shifted frequently because of flooding and changing of river courses (Orellana, 1906:15), as was also true of supposedly permanent mission sites. Villages were also shifted periodically to sites with better hunting and fishing (Eder, 1888:105).

[1] This thesis has been developed for another savanna tribe, the Yaruro of the Orinoco llanos, by Anthony Leeds (1961).

There is only very general information on the location of aboriginal villages. Padre Marbán (1898:132–133) said that most of the villages were on the banks of rivers, so close that at times they were washed away; some villages were in the reeds and others in the *monte,* while the remainder were in the pampas near lagoons full of fish. Padre Eguiluz (1884:6) said some villages were on river banks, others beside lagoons, and others in the pampa. There are other references to settlements along rivers and near lagoons; and such locations not only reflect superior soils, avenues of communication, and good fishing, but also the availability of water, a serious problem during the dry season. The distribution of potsherds indicates that people have lived mainly on the high ground of natural levees, islas, and artificial mounds.

The villages of the savanna tribes were characterized by well-ordered streets and plazas (Mojo, Baure, and Cayuvava), palisades, and moats (Baure and Canichana).

Houses

The Spaniards on the Solís Holguín expedition as well as the Jesuits mentioned three different types of constructions in the Mojo villages: houses, kitchens, and "drinking places" (men's club houses or temples). Juan de Limpias (Lizarazu, 1906:170) said that one village had 400 houses, 90 kitchens, and 9 drinking places. Mojo houses were round, were about four to five *varas*[2] high and four to five varas wide, had walls of wattle and daub,[3] had conical grass roofs supported by a center pole, and were raised on earth platforms one vara high. The houses were windowless and had low, skin-covered doors, while the kitchens were square or rectangular and had open sides (Marbán, 1898:133; Castillo, 1906:318–319; and Eder, 1888: 105–106). Baure houses were larger, 24 varas long and 13 varas high, with an open door facing a plaza. Floors were elevated (by platforms?) for drainage, and walls were of clay mixed with grass (Eder, 1888:171). By way of contrast, today the houses of savanna Indians are rectangular with walls of either wattle and daub, bamboo or *caña brava* slats, or adobe bricks, and roofs are of either grass thatching or palm fronds. Lean-tos (*chozas*) consisting of palm fronds or bamboo were, and still are, used by the Mojo while working in a *chacra* field or camping on a *playa* (Castillo, 1906:345).

House sizes apparently varied. Padre Marbán (1898:133) wrote that two

[2] A *vara* measures approximately 33 inches.

[3] "... de cañas clavadas en tierra, embarradas por adentro" (Marbán, 1898:133).

to three families (probably one extended family) shared a house and kitchen. This is the only mention of several families sharing a house. Castillo (1906:318) said each Mojo house had space for six to eight hammocks, but this does not necessarily mean that there were two families living in each house. Eder (1888:105) said each hut housed one complete family, which sometimes numbered up to 12 people. The former existence of mound settlements suggests communal living because of limited space; however, most early sources speak of single-family dwellings. In northeastern Bolivia only the Chácobo are known to have lived in large communal huts (Nordenskiöld, 1920:2).

According to Padre Marbán (1898:132), when the rivers overflowed the Mojo erected frame platforms (*barbacoas*) on which they piled earth and built their cooking fires. Padre Orellana (1906:18–19) said the Indians lived on *barbacoas* within their houses during flooding, and only left their huts by canoe for fear of being bitten by *palometas* (piranha). The practice of sleeping and partly living in hammocks was also a means of avoiding the flood waters that periodically covered the floors of houses.[4] Many Indians thus adapted their daily life to flooding without moving out of their houses. This is still true today. Many huts have bamboo sleeping platforms built along the sides of the walls (by families not using hammocks), and some families move into the rafters during floods. In the nineteenth century most haciendas were two storied, and the people simply retired to the upper floor during flooding. "Like the ants, he keeps in the upper part of the house until the water falls" (Gibbon, 1854:223).

Individual houses were and still are built on high ground which may be inundated only briefly or during unusually high floods. Nevertheless, the family on an isla surrounded by water is faced with other problems, since the high ground is sought and shared by life other than man:

> The Indian builds his hut on those elevated places which remain islands; when the great flood of waters come down, crickets, lizards, and snakes crawl into his thatched roof; droves of wild cattle surround his habitation. Armadilloes rub their armor against the pottery in the corner of his hut, while the tiger and the stag stand tamely by. The alligator comes sociably up, and the *gran bestia* seats himself on the steps by the door. The animal family congregate thus strangely together under the influence of the annual deluge. Those of dry land meet where the amphibious are forced to go, and as the rains pour down, they patiently wait. Birds fly in and light upon the trees and top of the hut, while fish rise from out of the rivers and explore the prairie lands (Gibbon, 1854:253).

[4] "Cuando el río se entra en los pueblos que no es todos los años, levantan las amahacas mucho mas de lo ordinario y en ellas duerman" (Marbán, 1898:133).

Partly to combat infestations of insects, reptiles, and rodents, the Movima, Mojo, and Baure separate their garden from their house and maintain an open space around the house which is kept clean of all vegetation and refuse. Eder (1888:171–172) noted that the Baure kept cleared spaces 70 paces wide around their houses, but he thought this was for fire protection.

There are no indications in early descriptions that any of the Mojos savanna tribes used pilings to raise their huts above wet ground. Raised cooking platforms have already been mentioned, and the early explorers saw maize barns on pilings (*percheles*) in southeastern Mojos (see chap. VII); Nordenskiöld (1920:3) saw similar sheds among the Chácobo. However, true pile dwellings are not used by any of the tribes in northeastern Bolivia, although they are found in various other parts of the Amazon Basin and in northern South America. Pile dwellings would seem to be an obvious adaptation to flooding, but appear to have been ignored in favor of mounding and a dry earth floor, or elevated interior platforms, or else were just not within the cultural experience of the Mojos savanna tribes.[5]

There are, however, some archaeological suggestions of the use of pile dwellings. In the lower level of Mound Velarde and in the mound near Casarabe excavated by Rydén, unbroken shells and large vessel fragments in refuse deposits may owe their preservation to having been thrown under rasied huts instead of being trampled to pieces in dooryards. Systematic archaeology should demonstrate conclusively whether any past Mojos people were pile dwellers, and should also provide some indication of village size and site duration.

Defensive Features: Palisades and Moats

The Baure, Canichana, and Tapacura villages were often surrounded by palisades for protection against enemy attacks. Such features were found among various Indian tribes in the Americas. Nordenskiöld (1918) in his study of palisades concluded that most were pre-Columbian culture traits and that they had been introduced to Bolivia from northwestern South America by the Arawak and Guaraní. The palisades in Mojos were not well described, but they were probably similar to palisades elsewhere in South America which consisted of closely spaced, vertically implanted tree trunks. Some tribes (Tupinambá, Araucanians) had double palisades with

[5] Meggers and Evans (1957:399) suggest that the house mounds of Marajó Island were devised by the Marajoara people, who had migrated from elsewhere, to provide dry dirt floors rather than using stilts which they probably had seen but were not used to.

pitfalls containing sharp stakes beyond the outer wall and loophalls for archers in the inner wall. The single-wall Baure palisades did have pitfalls and loopholes (Anonymous, 1743:466–467). One of the members of the Solís-Holguín expedition described a palisade in northern Chiquitos consisting of fig trees (probably *Ficus*) and cedar trees planted close together so that their branches and trunks formed a wall (Lizarazu, 1906:199–200).

Some palisaded villages were also surrounded by ditches which probably contained water for much of the year and served as defensive moats.[6] This was true of Baure villages according to Altamirano (1891:107). Orbigny (1946:1:95, 195) attributed *trincheras* (trenches) between San Ramón and San Joaquín to the Canichanas, and these were probably the same features as the *fosos* (pits, moats) he says surrounded fortified Canichana villages.

There are remnants of large numbers of circular ditches (*zanjas*), which were probably moats, east of the Río Mamoré. (In western Mojos similar trenches around artificial islas are usually borrow pits.) Near Magdalena I saw several of these curious ditches surrounding patches of forest within savanna. Eight kilometers east of Magdalena on the trail to Estancia Valparaiso there is a cluster of four circular ditches. Two of these ditches are apparently surrounded by a third outer ditch with a diameter of about 600 meters where it crosses the trail, and thus it encloses an area of at least 30 hectares. There is a small fourth circle about one kilometer further east. The large inner circle I saw was a maximum of 8 feet deep and averaged 15 to 20 feet in width (pl. 7). The outer circle where I observed it was 6 feet deep and 9 feet wide, and the eastern circle was only 1 to 2 feet deep and from 5 to 10 feet wide. The center of the large outer circle was in second growth forest, including *cusi* and *motacú* palms, grading outwards to an open woodland (mainly *chaaco* trees) and then pure grass, thus indicating a gentle slope down from the center outward. My Itonama companions said that some ditches contain water during the wet season, but others do not; that the encircled areas were always good for crops; and that pottery may or may not be found within the circular ditches. They believed that the ditches or moats were mainly intended to protect crops from animals rather than to protect villages from human enemies. Everyone agreed that these and other circular ditches they had seen are very old.

I was told of another double circle at Cajoba 25 kilometers northeast of

[6] Trenches and moats have been reported in a number of tropical forest areas of South America. Long trenches were recently described in the Upper Xingu region by Gertrude Dole (1960:403–406).

Magdalena; the outer circle encloses 170 (?) hectares, and the inner circle only 10 hectares; the ditches are about 6 feet deep and 10 feet wide. Further inquiry brought reports of circular ditches within dense forest as far north as Guayaramerin and Villa Bella on the Rio Madeira, around savanna islas near San Ramón and Baures, near Lago Victoria (south of El Cármen) and Lago Huachi (southeast of Victoria), and further south in northern Chiquitos. On a later trip to Huachi I was again told of circular ditches in that area. The sixteenth-century explorer Nuflo de Chávez was reported to have encountered ditches or moats surrounding palisades in Chiquitos (Días de Guzmán, 1835:103), and Nordenskiöld (1918:230) mentioned a large moat at Matucare on the Rio Guaporé and a five-meter-wide trench surrounding a mound between Mound Velarde and San Miguelito (fig. 5) (1913:225). There is also reported to be a ditch around a mound at Estancia Monrovia near Trinidad. The explorer Agustín Palacios (1944:23) discovered defensive trenches near Lago Rogoaguado in 1845.

Further study should indicate whether or not the circular ditches usually enclose former village sites. While their purpose may well have been defensive, the ditches were not true moats since many of them are on ground too high for filling by flood waters or streams, although rains may have provided water for part of the year. With or without water, the ditches were probably secondary defenses that were combined at times with pitfalls and possibly outer palisades to hinder an enemy advance on the main palisade wall and the village within.

There are remains of a ditch forming an arc around the south side of Magdalena. It is only 1 to 2 feet deep and 3 to 5 feet wide, and the tree-lined bank on the side facing town has been built up 4 to 6 feet above ground level. The ditch and bank were probably built by the Jesuits for either defense, drainage, or as a protective dike. Since the high bank is consistently on the town side, it must have served as a dike to hold back flood waters. The ditch itself is not very large or deep and was probably incidental to the dike, although it may have aided drainage. Orbigny (1958: 771) mentioned a similar dike built by the Jesuits around the mission of Exaltación for flood protection.

None of the aboriginal circular ditches I saw had high banks that would suggest a diking function, and there is no evidence that the Mojos tribes ever built embankments for flood protection. There is also little evidence of aboriginal drainage or diversion ditches. One such possibility is found

adjacent to the former Tani leper colony near Baures where there are two parallel ditches about 60 feet wide, 1,000 yards long, 8 to 10 feet deep and leading to a low-lying bajío (Walter Herron, Magdalena, personal communication). Some of the larger ditches in areas of ditched and ridged fields may have served for drainage purposes.

Artificial Mounds

Classified by size, there are three types of man-made mounds in northeastern Boliva: (1) artificial mounds (3–16 meters high and up to 300 meters long); (2) artificial *islas* (1–2 meters high and 10–50 meters long); and (3) house mounds, less than one meter high and 3–7 meters in diameter). These mounds were usually, but not always, built to provide flood-free sites for villages and individual houses.

Artificial mounds are found throughout Mojos. I have seen, have been told of, or have read of 55 such mounds (table 2), and there are probably at least 100, possibly several hundred. These are earthen mounds that were raised intentionally for habitation and burial sites and possibly for religious purposes. Alfred Métraux (1942:63) believed that the Mojos mounds were natural features, except for increased height due to refuse accumulation. This is undoubtedly true of some low islas, but not of the high mounds considered here, almost all of which are over three meters in height.

The artificial nature of a mound can be determined with some certainty by (1) the occurrence of burial urns and potsherds at depth; (2) an abrupt rise up from the surrounding ground level; (3) an unusual height in comparison with natural islas, which are seldom over two meters high; (4) a location on a deep alluvial plain far from rock outcrops; (5) a composition consisting of unpacked, unconsolidated material, often pocked with rodent and peccary holes; (6) an oval rather than an irregular shape; and (7) excavation (borrow) pits at the base of the mound. Possibly some of the mounds listed in table 2 are natural, but most are man-made. Benianos are quite explicit in differentiating between artificial mounds and natural islas.

The mounds average 5 meters in height and 50 to 100 meters in length. I saw two mounds (El Cerrito de Caimanes and Loma Espíritu Santo) that were about 16 meters high, and two different people told me about the Cotocá mound being 30 to 35 meters high. The height of the latter is remarkable, if indeed it is an artificial mound, and yet it is located at least 25 miles from the nearest outcrop of the Brazilian Shield. The largest

TABLE 2

KNOWN ARTIFICIAL MOUNDS IN MOJOS

Location	Source[a]	Remarks[b]
1. El Cerrito de Caimanes; 4 km NW of Caimanes airfield	Denevan	16 m high; 100 m by 200 m; on high forested ground; causeways connected or nearby; potsherds and urns; borrow pit on one side; plantains grown on edge
2. 1 km SE of Caimanes	Denevan	4 m high; 20 by 25 m; in second growth forest; causeway adjoining; borrow pits on two sides; potsherds and urns; maize grown adjacent
3. 1½ km NW of Caimanes	Denevan	2 m high; 10 m by 20 m; in second growth forest; causeway nearby
4. 1 km NW of Caimanes	Denevan	5 m high; 100 m by 220 m; borrow pits; second growth forest and manioc crop
5. 1 km NW of Caimanes	Denevan	4 m high; 100 m by 200 m
6. 1 km NW of Caimanes	Denevan	2 m high; nearly flat on top with rice crop in second growth forest; about ½ hectare in area
7. Palmera; 10 km NW of Caimanes	Reported by owner	3 to 4 m high; 2 hectares in area; potsherds and burial urns
8. Caimanes Afuera; 2 km SE of Caimanes	Reported	4 m high; ½ hectare in area; grassy savanna on one side, second growth forest on other side
9, 10. Hernmarck; ½ km NW of Caimanes	Nordenskiold (1913:225–226)	3 to 4 m high; 225 m by 85 m; on edge of large forest; borrow pits adjacent; connected to long causeway; urns and potsherds; small mound adjacent; see fig. 5

TABLE 2—*Continued*

Location	Source[a]	Remarks[b]
11. Between Hernmarck and Tajibo	Nordenskiold (1913:225)	About 1 km long
12. Tajibo, 10 km NW of Hernmarck	Nordenskiold (1913:225)	2 m high; 55 m by 125 m; see fig. 5
13, 14, 15. Los Cusis; 20 km SSE of Caimanes	Nordenskiold (1913:225, 238)	Rectangular and elongated; no details; at least two other mounds in vicinity; see fig. 5
16, 17. Velarde; 5 km SE of San Miguelito and 35 km SE of Loreto	Nordenskiold (1913:215)	5 m high; 45 m by 25 m; on forested high ground; borrow pits adjacent; causeways nearby; potsherds in two different cultural horizons; small mound adjacent; see fig. 5
18. Between San Miguelito and Velarde	Nordenskiold (1913:225)	1½ m high; 30 m wide; surrounded by a trench; see fig. 5
19, 20. Concepción; 10 km N of San Miguelito	Nordenskiold (1913:225)	Not seen; two mounds
21. San Rafael; 20 km from San Miguelito (?)	Nordenskiold (1913:225)	Not seen
22. Roma (Mandarino); 25 km W of Caimanes	Reported	5–6 m high; ½ hectare in area
23, 24, 25. Cotoca; ESE of Loreto near Perotó on the trail to Caimanes (?)	Reported	30–35 m high; steep; ¼ hectare in area; might be an outcrop; mentioned by several people; at least two other small mounds in the vicinity
26. Masicito; west of Loreto 1–2 km from the R. Mamoré	Nordenskiold (1913:240)	3.3 m high; 150 m by 300 m; in grassy savanna; potsherds and burial urns; see fig. 5
27. Santo Domingo; east of Asunta between R. Mamoré and Loreto	Reported	5–6 m high; in second growth forest; 1½ hectares in area

TABLE 2—*Continued*

Location	Source[a]	Remarks[b]
28. San Pedro; 10 km from Masicito (?)	Nordenskiold (1913:210)	Not seen
29. Torno Largo; on R. Mamore 25 km S of Masicito	Nordenskiold (1913:240)	No details; potsherds and a stone ax found
30. West side of R. Mamore just downstream from Masicito	Nordenskiold (1913:240)	No details
31. Monobi; 20 km NNE of Trinidad	Reported	No details
32. Monrovia; 5-10 km N of Trinidad	Reported	No details; surrounded by a ditch
33. La Loma (Loma Suárez); 12 km N of Trinidad	Nordenskiold (1913:241); Farabee (1922:180 and pl. 23a.)	2 hectares in area; 25 ft high and 150 ft in diameter; ranch site and major refuge during floods; potsherds and stone ax heads found
34. Loma Espíritu Santo; 10 km SE of San Javier	Denevan	16 m high; 80 m by 100 m; on high forested ground with top in plantains, yuca, and maize; potsherds
35. 1 km E of Espíritu Santo	Reported	High; no details
36. Las Pintas; near Espíritu Santo	Reported	High; no details
37. Loma Cernandí; near Espíritu Santo (?)	Reported	No details
38. San Nicolás; 50 km ENE of San Pedro	Reported	30 m high (?)
39. Lomita; N of San Pedro on R. Cocharcas	Reported	10 m high; one hectare in area.
40, 41. Between Casarabe and Trinidad (?)	Rydén (1941:135)	Not seen; stone axes found; at least two mounds
42. 1 km S of Casarabe; 60 km E of Trinidad	Rydén (1941:134-135)	10 m high; probable borrow pit adjacent; potsherds

TABLE 2—*Continued*

Location	Source[a]	Remarks[b]
43. Eviata; 5 km E of Casarabe	Denevan	6 m high; 75 m by 30 m; built on a low ridge; potsherds and burial urns; mission church on top; see pl. 8
44. Santa Fe; near Eviata	Hanke (1957:137)	A small mound; potsherds
45. San Lorenzo	Reported	No details; associated with causeways; urns found
46. San Francisco; NNE of San Lorenzo (?)	Reported	No details
47. Santa Rita; 20 km SE of San Ignacio on San Lorenzo trail	Reported	4 m high; potsherds
48, 49. San Juan; S of San Ignacio on San Lorenzo trail	Reported	5 m high; in savanna; potsherds found; a second smaller mound
50. Loma Yapereji ("pile of bones"); 6 km S of San Ignacio	Denevan	5 m high; 35 m by 80 m; borrow pit on one side; causeways in vicinity; on high, forested ground; pot-herds; coffee and plantains growing on one side
51. Dolores (San Andres); 50 km E of San Ignacio	Reported	8 m high; in savanna; potsherds; extended burials and no urns
52. Dos Islas; 60 km E of San Ignacio	Reported	5–7 m high; in savanna
53. Los Ajos; 70 km E of San Ignacio	Reported	5–7 m high; in savanna
54. Camiaré; hacienda on the middle R. Rapulo	Reported	No details
55. Desengano; R. Apere near Porvenir	Robert Judy (Summer Inst. of Linguistics)	3–6 m high; 50 m long; modeled potsherds

[a] Where the source is given as "Reported" the reliability of the information is variable, having been obtained from people who have seen the mound in question but whose memories were often uncertain.
[b] Measurements are all rough estimates.

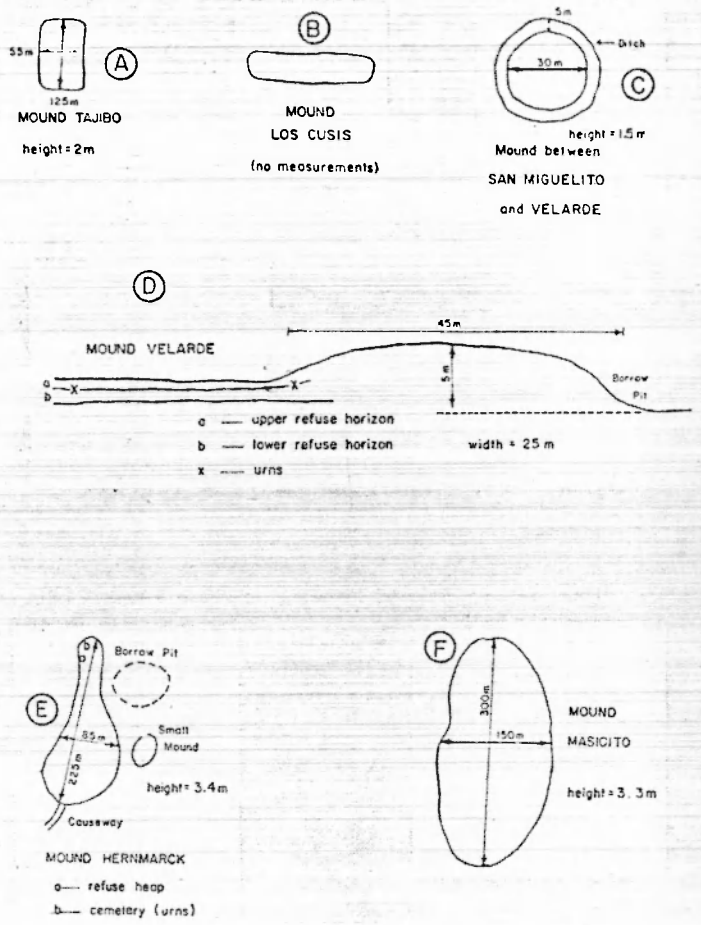


Fig. 5. Sketches of mounds studied by Erland Nordenskiold (1913:216, 225).

mound known is Masicito, which is 150 meters wide and 300 meters long. The variable shapes of the mounds studied by Nordenskiöld are shown on figure 5. There are causeways adjacent or attached to several mounds, thereby suggesting common origin and age.

Many of the mounds, including Hernmarck, Velarde, and Espíritu Santo, are on high, forested sites not subject to flooding, while other are found in open, seasonally wet pampa. Thus the origin and purposes of mound build-

ing in the Mojos region may have been unrelated to drainage; however, this seems unlikely. The people who built mounds, and also causeways, on low ground probably continued to do so when they established settlements on naturally high ground. This would have been especially likely to have happened if mounds had acquired importance for ceremonial and burial purposes. Although mounds were built for nondrainage purposes in many parts of the Americas, there were no mound builders in northeastern Bolivia and adjacent areas except within and along the margins of the Llanos de Mojos.

The frequent presence of both burial urns and ceramic kitchenware in the same mound indicates that some mounds were used both for burials and settlement sites. This contrasts with Marajó Island where house mounds have been distinguished from cemetery mounds (Meggars and Evans, 1957:398). In some mounds, such as Hernmarck, all the urns and household ceramics belong to the same culture, but this is not true for all mounds. Some mounds were apparently used by different tribes through time, and the type of use may also have changed.

Altamirano wrote that the Baure Indians built mounds for settlement sites,[7] and Padre Zapata (1906:26) said there were villages on small hills in the Cayuvava region. Thus it seems fairly certain that mounds were still being built and lived on after Spanish contact. The possibility that certain mounds also had religious significance is suggested in the anonymous account of the life of Padre Barrace, which states that at times of the new moon the Mojo priests gathered all the people on a particular hill near the village for fasting and then drinking, singing, and dancing (Anonymous, 1743:448).

Artificial Islas

In addition to the fairly obvious artificial mounds in Mojos, there are a large number of small islas, usually less than two meters high, that appear to be natural but actually are man-made, either intentionally or by refuse accumulation or both. Intentional mounding of low islas is hard to verify but is certainly indicated when the isla is bordered by an excavated pit (pl. 9*a*).

[7] "... no obstante que es toda la tierra pantanosa, si bien á trechos se levantan algunas lomas, que segun mas ó menos estendidas, dan lugar á mayores ó menores poblaciones; y como por invierno se ven todos rodeados de agua, por la similitud se llaman islas, dándose comunicación las unas con las otras con surcos ó canales hechos á mano..." (Altamirano, 1891:106–107).

Small round islas, 50 yards or less in diameter, often can be seen in open pampa, sometimes thousands of yards or even several miles from any other high ground. They show up clearly from the air and on aerial photographs. Their shapes and isolation are difficult to explain by other than human factors. Round islas have been described in flooded savannas north of Santa Cruz by Carl Troll (1936:307) and in the Pantanal (*capãos*) by Herbert Wilhelmy (1958:65–66); in both instances the features are overgrown termite mounds or ant hills. These mounds occur in clusters and are much smaller than the dispersed, round islas of Mojos. The termite mounds of Mojos are very small and seldom support trees. I have seen moundlike ant hills only in forest.[8]

Some of the round islas of Mojos are associated with fields of small crop mounds (Plafker, 1963: fig. 7; see chap. VII). On aerial photographs taken west of Santa Ana there are groups of these mounds that are all very near round islas. Frequently the tree vegetation of round islas is sharply circumscribed (pl. 9*a*), in contrast to most natural islas in which tree growth thins out from scrub forest on the highest ground to arboleda and then grass as the slope gradually descends. Most but not all artificial islas in open savanna have no transitional arboleda on their margins.

At La Esperanza amidst drained fields I saw an irregularly shaped artificial isla (2 m high and 10 m by 20 m) connected to a causeway. Many such mounds in the vicinity of fields and causeways are probably man-made. However, the presence of artifacts is not indicative of artificiality, since potsherds are found in all types of high ground. Also, most causeways were built to connect natural islas, not artificial ones.

The only round isla that I saw from the ground was near San Ignacio, but I did see over 50 such mounds from the air while flying between Trinidad and San Ignacio and San Ignacio and La Esperanza. I also saw a few east of the Río Mamoré. The rancher at La Esperanza said that directly west just beyond the Río Matos there are a large number of low, round artificial islas that are often surrounded by water-filled ditches. The islas are in open savanna and are covered with secondary forest (pl. 9*a*). Crude excavations have uncovered horizons of snail shells along with broken pottery. Flying back to San Ignacio I saw several water-filled ditches adjacent to round islas. Such ditches may only be borrow pits, which is probably

[8] Carl Troll (1936:309) suggested that the tribes of the Mamoré savannas may have gotten the idea for building earthworks from examples set by ants and termites.

true of those that are not encircling, or they may be intentional moats such as those found east of the Río Mamoré.

The round islas of western Mojos are usually too small to accommodate more than a few houses or a very small village. The absence of high ground around or near them suggests that there may have been no high ground originally. A site may have been chosen for agricultural potential and possibly in open pampa for defensive reasons. A circular ditch was dug and material thrown in the center to form a low mound; refuse gradually increased the height of the mound. In areas where such islas are not associated with ditches or borrow pits, pile dwellings may have been used, and a mound was created by the accumulation of refuse beneath the huts. Most of the well-defined round islas are not connected to causeways or associated with drained crop rows; however, some are surrounded by fields of small crop mounds. Since most of the round islas are some distance from each other as well as from other areas of high ground and potential settlement, labor would not have been available for building major earthworks. For small, isolated villages on artificial islas, fields of small mounds may thus have been the agricultural alternative to raised crop rows.

House Mounds

A third type of habitation mound found in Mojos may have served for individual houses. These are very small circular mounds (undoubtedly artificial) that are only large enough for a single house (pl. 16). I saw none on the ground, but on oblique aerial photographs they seem to be about 3 to 7 meters in diameter. They occur west of the Río Apere and only in association with drained fields, usually appearing in the midst of crop rows. "House" mounds probably served as temporary shelter sites for people working in the fields during flood periods. However, it is possible that they were actually crop mounds. Many Indian houses in Mojos today are on earth platforms a foot or so above normal ground level, and from the air such platforms would appear very similar to the old house mounds. Very few of the house mounds in the Río Apere region support trees; occasionally there is a single palm. This probably means that the mounds and associated fields are very low and are under water for long periods of time, and thus they are not true islas. Either the house mounds and fields were raised only slightly or their original height has been reduced by erosion and the deposition of silt over a long period of time since construction.

VI. COMMUNICATION

For tropical-forest cultures, movement usually involves simple trails and a variety of watercraft. In Mojos, however, from pre-Columbian times to the present people have altered the physical landscape in order to improve and to create overland and overwater routes of movement and transportation. Artificial causeways and canals have left hundreds of clearly visible scars on the face of a land where man's imprint has been considered to be insignificant and transitory.

Waterways

Communication by water in Mojos was improved in several ways; canals were dug and maintained adjacent to causeways and between streams and lakes, and river meanders were shortened by artificial cuts through their necks (*cortes*). Some of these canals were dug or at least maintained by mission and municipal authorities; many, however, are of aboriginal origin.

Canals adjacent to causeways.—While causeways facilitated foot travel during periods of flooding, they did not have the utility of watercraft for transporting food, belongings, and fuel. When flood waters rose to a height of several feet on the pampas, canoes could travel unhindered cross-country over vast seas of water. This is the common practice today; during flooding everyone travels everywhere by canoe (pl. 9*b*). However, during years of little flooding or when normal flood waters recede, the pampas become nearly impassible (by foot or canoe) morasses of entangled grasses, mud, shallow water, and disconnected ponds. Thus it was a definite advantage to have navigable channels through the pampa that were usable for most of the year, as well as the causeways. Canals would have been especially useful to transport crops to villages at harvest time after the rainy season when flood waters were dropping.

Many of the causeways were constructed by digging a trench on one or both sides. The trench then served as a canal for canoes well into the dry season, as long as it was kept clean of vegetation and silt. These canals, along with associated causeways, connected villages to one another, to rivers, and to areas of cultivation.

The Jesuits mentioned canals adjacent to causeways only for the Baure Indians. According to Eder (1888:36), "when the *campos* dried up, water remained next to the *calzadas* in the ditches, and made it possible for the

[Baure] Indians to carry crops and other necessities of life to their *pueblos* in canoes." Altamirano (1891:107) wrote that the Baure settlements were connected by "*surcos* or *canales* made by hand, like those of the Andes, usable only by small boats."

Of the causeways I have seen on the ground or studied on air photographs, a number were lined by shallow depressions that may have been either borrow pits or true canals. People often mentioned having seen causeways with ditches beside them. Undoubtedly, these ditches silt up fairly rapidly if not cleaned out periodically. From Baures west to the Río Blanco I followed a long causeway (about 12 km) lined by a water-filled canal some two to three meters wide and one to two meters deep. The canal was used until the 1930's when it was last cleaned out.

River-connecting canals.—Table 3 lists and partially describes 14 canals that are probably artificial. They served to facilitate water travel by joining different river systems or lakes or by connecting areas of settlement with navigable streams. These canals range in width from two to seven meters and in length from 50 meters to 15 kilometers. Nordenskiöld (1916:146) described a series of such canals joining streams making it possible to travel by canoe from the Río Mamoré to Baures on the Río Negro. This route was in use in 1916 according to Nordenskiöld's guide. Most of the canals are in open pampa, but the one connecting the Río Grande and the Río Mamoré is in dense forest, and if artificial, the digging must have been difficult. Additional canals have been observed by oil company personnel southwest of San Ignacio both beside causeways and cutting through low divides between adjacent stream drainages (Plafker, 1963:377).

There is no clear evidence that any canals, other than those adjacent to causeways, are of aboriginal origin. Many of the other known canals are near mission sites (San Ignacio, Baures, Magdalena, and San Pedro) and could have been dug by the Jesuits.[1] Certainly canals were maintained by the Jesuits and their successors, in some instances up to the present. According to local tradition the canals near San Ignacio and Baures are very old and were probably built by the Jesuits. Nordenskiöld (1916:147), however, believed that most of the canals were aboriginal, and that if the Jesuits dug any canals they obtained the idea from the Indians. Also, it is difficult to be certain that the apparent canals seen from the air actually

[1] Franciscan padres in the nineteenth century dug a ditch (*zanjón*) two leagues long to provide navigation for the people of the Guarayos mission of Yaguarú from an adjacent lagoon to the Río Blanco (Cardus, 1886:130).

TABLE 3

KNOWN ARTIFICIAL CANALS IN MOJOS

Location and length	Source	Remarks
1. Baures to R. Blanco; 12 km	Denevan; Nordenskiöld ? (1916:146)	Adjacent to a causeway; 2–3 m wide and 1–2 m deep; last used in 1930's
2. San Ignacio to R. Sencro; 5–6 km	Denevan	3–5 m wide and ½–1 m deep; banks built up ½ to 1½ m; still cleaned and used; Jesuit?
3. Connecting tributaries of R. Grande and R. Mamoré (15° 51′ S, 64° 44′ W); 2 km	Aerial photo (Bol. Gulf P 350/58–40, 5069–159, 195S)	Unusually straight; pond at one end; in dense forest
4. Connecting R. Mamore and R. Ipurupuru just N of San Pedro; 2,000 m	Nordenskiold (1916:146); Aerial photo (Bol. Calif. P 350/58–T36, 5139–1, 1958; see pl. 10)	6–7 m wide and 3–4 m deep; winding through pampa; kept open by Canichanas in 1916
5. R. Huachananoca at Nicalapo (S of San Ramón) E to the R. Chanana; 15 km	Nordenskiold (1916:146)	2 m wide
6. R. Chanana at Abuca E to the R. San Juan; 5 km	Nordenskiold (1916:146); Walter Herron[a] from the air ?	2 m wide
7. R. San Juan E to R. Itonama below Magdalena; 50 m (?)	Nordenskiold (1916:146)	5 m wide
8. R. Lopez (tributary of R. Itonama) near Huacaraje to R. Blanco above Baures; 10 km	Walter Herron; Nordenskiold (1916:146)	No details; cleaned and used by Walter Herron in 1954
9. Connecting R. Itonama and R. San Miguel at SE end of Lago San Luis; 3–4 km	Denevan from the air; Walter Herron	Last cleaned during World War II; an old means of by-passing *yomomo*-filled Lago San Luis

TABLE 3—*Continued*

...cation and length	Source	Remarks
...km NE of Magda-...a in pampa between Itonama and R. ...ures; 5 km	Walter Herron	No details
...necting R. Yacu- and one of its ...thern tributaries ...° 8′ S, 66° 37′ W); ... km	Aerial photo (Bol. Shell 05 20-064, 1960)	In pampa; very straight; right-angle juncture
...necting 2 streams ...out 80 km N of San ...nacio; 2-3 km	Denevan from the air	In pampa; right-angle juncture
...necting Lag. Mau- ...nd Lag. Isireri SW San Ignacio; 3 km	Denevan; aerial photo (Bol. Calif. P 350/58-35, 4933-101, 1958)	Built-up embankments 2-3 ft; winding; partly natural; 2-3 ft of water; 15-25 ft wide; in area of causeways, drained fields, and artificial *islas*
...nnecting R. Tico ...ributary of R. Ibare), ...ear Loreto to the R. ...moré; 10 km	Reported by people in Loreto	Last cleaned and used in 1956

...lter Herron was a longtime missionary pilot in Magdalena who was killed in a crash in 1964.

...an-made; however, unusually straight and nonoriented channels are ...ably artificial canals and not structural when they connect two differ- ...vers. On the ground, canals can be verified as artificial if there are ...up embankments on both sides.

...inder cut-off canals.—In addition to canals between bodies of water, ...der necks often have been cut through intentionally to create canoe ... cuts (*cortes*) that usually soon become the main course of the river ...rned. Generally the river is about to make the break without aid, ...metimes necks of several hundred yards are cut through. A number ...ople told me about this practice, and I saw two such artificial cuts ...e Río Negro near Baures. One, which was dug about 50 years ago, ... 25 meters across and cut off a meander bend about two kilometers

long. My guide told of helping to dig a corte on the Río Negro in 1960 that was 100 meters across, and there is said to be an artificial corte one and a half kilometers long some ten kilometers north of Baures on the Río Negro. Nordenskiöld (1916:147) related how his boatmen frequently discussed the possibilities of cutting through this or that bend of a river and thereby reducing travel time; sometimes they dragged their boat across a neck thus starting a canal that they might improve on each succeeding trip.

Nordenskiöld (1916:147), always concerned about origins, believed that the Indians of the Beni may have gotten the idea of building canals from seeing rivers cut through meander bends. However, he also suggested that the idea may have come with migrating Arawak Indians from the Orinoco and lower Amazon areas, where he said artificial canals are common. Nordenskiöld (1916:153) quoted a letter from the explorer Koch-Grünberg that suggested the possibility that certain channels in the Río Casiquiare region, including part of the Casiquiare bifurcation, may actually be artificial canals. To my knowledge, however, no one has verified the existence of artificial canals or cortes anywhere in the Orinoco and Amazon basins other than in Mojos.

Watercraft (see Métraux, 1942:66).—There are many references to the Mojo using canoes, presumably dugouts, but there are no early descriptions. Modern dugouts have pointed bows and flat sterns. Movima dugouts were 30 feet long and 16 to 18 inches wide (Métraux, 1942:82). Some dugouts today are propelled by the "fish-tail" paddle in the stern (*remando con cola*), but this innovation was probably introduced by the Spanish. Likewise the large *piraguas,* with shelters and crews of 16 or more paddlers, used in the nineteenth century were also probably European inventions (Orbigny, 1958:781). The Chácobo were using bark canoes when visited by Nordenskiöld (1924*b*:178). The only boatless tribe in Mojos was the Sirionó.

Padre Eder (1888:36–38) described some of the eighteenth-century devices used to ferry goods and peoples across rivers. Sometimes a simple dry log with vines wrapped around it for hand holds was mounted and paddled precariously across a stream; as a safety device several logs might be joined together. The *pelota* or bull boat was also used in Eder's time but may have been introduced by the Spaniards (the European coracle). The hide of an ox was stretched across a frame of bamboo, and then the

sides were turned up six inches. Up to 200 pounds of cargo were transported in this boat which was paddled across river or towed by a swimmer. Floats were also made by blowing air into animal skins, an ancient but now extinct trait in South America best known from the coast of Chile and southern Peru (Edwards, 1965:17–20).

Eder (1888:37–38) mentions reed crafts with upturned prows and sterns in which long trips were taken, even against the current. These rafts were made of the reed called *totora* which is now used by the Movima for making mats. The species is unidentified but may be the same as the *totora* reed (*Scirpus tatora*) of the Altiplano used for making the "balsa rafts" of Lake Titicaca. The reed rafts of Mojos seem to have been very similar to those of Titicaca, and a direct connection, either early or late, is strongly supported by the use of the same name *totora* for the reeds used in constructing the rafts in both areas. I found no evidence of bull boats or reed rafts being used in Mojos at the present time, nor is the true balsawood raft common although it is still frequently in use in the Andean foothills on rough rivers such as the Alto Beni.

The Mojo also built crude bridges over narrow streams by bending palms or bamboos over a stream from both sides, securing them, and then attaching ladder-like sticks over the arch (Eder, 1888:37).

While the Mojo were renowned boatmen, much in demand during the rubber era, and spent considerable time in their canoes traveling, fishing, and hunting, most of their boat life was seasonal; and they always preferred to spend nights and prepare meals in a shelter of some kind rather than in their boats. This is in marked contrast to true aquatic tribes such as the Guató of the upper Río Paraguay and the Mura of the lower Rio Madeira who lived most of their lives in their canoes.

Causeways

Causeways (*terraplenes, calzadas*) are found throughout the Llanos de Mojos from the Río Sécure north to Lago Rogoaguado and from the Río Beni to east of Baures nearly to the Rio Guaporé. They also occur in the large savannas between the Río Beni and Río Madre de Dios. The Mojos causeways are raised earthen roads built across low ground subject to flooding and also occasionally on high ground. These features have been known since the first explorers, but no one was aware of how numerous they were until the availability of aerial photographs. I estimate that there

are at least 1,000 miles of causeways in northeastern Bolivia. Most of the causeways are pre-Spanish, but they have continued to be built to the present time. Elsewhere in lowland South America a few similar causeways have been reported in the Orinoco llanos and in the Paressí Indian area of the upper Río Paraguay (see chap. X).

Several of the members of the Solís Holguín expedition of 1617 mentioned seeing calzadas connecting or entering Mojo villages (Lizarazu, 1906:134, 136, 170, 188, 200). Diego Felipe de Alcaya mentioned "clean roads 15 feet wide" and a calzada ten *brazos*[2] long connecting two plazas. Juan de Limpias told of "entering a village on a street or *calzada* which divided the fields and on which three men could ride side by side." Juan Antonio Justiniano reported using a "wide road" leading to the villages. According to Alonzo Soleto Pernia there were "roads so straight and so wide that they were almost wider than a [Spanish] street; and these roads were so swept up and clean, that it is certain we have never seen such a thing before." There is no doubt, then, that causeways were being used and maintained in conjunction with villages in the area of southeastern Mojos visited by the expedition.

There are also Jesuit references to Indian causeways in various parts of Mojos. Altamirano (1891:103) mentioned wide and well-cared-for Baures roads. Eder (1888:36) described calzadas built by Indians at an earlier date that were large enough for two carts and that stood above water even during the highest floods.[3] The Mojos causeways were subsequently seen and described by many travelers, including Alcides d'Orbigny (1958:758) between Magdalena and Baures; Ciro Bayo (1911:358, 359) southeast of Loreto and in the Pantano de Sayuba between Rurrenabaque and Ixiamas west of the Río Beni; Erland Nordenskiöld (1913:225) in southeastern Mojos; and more recently by oil company personnel in southwestern Mojos (Plafker, 1963). The causeways are well known by the Beniano who recognize them as roads built either by the Indians or by the Jesuits. According to Nordenskiöld (1916:148) the terraplenes were always mentioned when people "were asked about the curiosities of the region."

I have seen causeways on the ground near San Ignacio, La Esperanza, Caimanes, and Baures and from the air in all parts of the Mojos savanna. The densest concentration is between the Río Mamoré, Río Yacuma, and

[2] A *brazo* measures approximately two and a half feet.

[3] Also: "Con este penoso trabajo, . . . consequían tránsito seguro en medio de las aguas que todo lo inundaban . . ." (Eder, 1888:36).

the town of San Lorenzo (pl. 11). In one area of about 1,500 square miles near San Ignacio (fig. 4, chap V), I counted on aerial photographs and mosaics 564 causeways totaling 314 miles in length.[4] Most of these causeways are less than one mile long, but one, 50 kilometers west-northwest of San Ignacio, the longest I know of in the Beni, measures 8.2 miles (fig. 6). There is a causeway about 7 miles long 55 kilometers northwest of San Borja (14° 28′ S, 66° 22′ W). Few causeways have been measured east of the Río Mamoré, but Orbigny (1958:756) mentions one between Magdalena and Baures being 8 kilometers long, and I saw one between Baures and the Río Blanco said to be 12 kilometers long. There are also long causeways in the Caimanes area, including a discontinuous one extending east from Caimanes to Yaguarú and another between Caimanes and Tajibo. Thus the Mojos causeways are numerous and some are fairly long; however, I know of none that "continue[s] uninterrupted for tens of miles" as is claimed by Plafker (1963:377).

Causeways were constructed of available earth material, mainly alluvial clays and silts. Most of the causeways that I saw on the ground were from 2 to 4 feet high, with a few as much as 5 feet high (pl. 14*a*). Widths averaged from 6 to 15 feet. The wide causeway on plate 17, however, is between 20 and 25 feet wide. Some of the causeways in the vicinity of Caimanes are about 20 feet wide. Plafker (1963:377) gives an average of 18 to 30 inches for the height of causeways, but I saw few that were less than 2 feet high. Nordenskiöld (1913:225) saw several causeways that were about 3 meters wide and one-half meter high. Undoubtedly all the aboriginal causeways in Mojos have been reduced in height by erosion.

Most causeways have sufficient height to stand above flood waters, and because of good drainage they are invariably lined with trees. Because of abrupt relief, vegetation is somewhat protected from fire, and this could be an important factor in tree growth. Common plants include the *totai* and *motacú* palms, cacti, and thorny species of *Mimosa.* The causeways are unusually straight (pls. 12, 13; fig. 6) except for a few that are smoothly curved. Because of their straightness and tree cover, causeways can be identified easily in open pampa from the air and on aerial photographs, and they are also obvious features on the ground. Even when covered only by grass, causeways stand out clearly due to a relatively lighter color in

[4] This is a correction of figures I have given previously for the same area of 548 causeways totaling 333 miles (Denevan, 1963:542). Even the larger figures are too low since field experience showed that I had failed to identify many causeways on the aerial photographs.

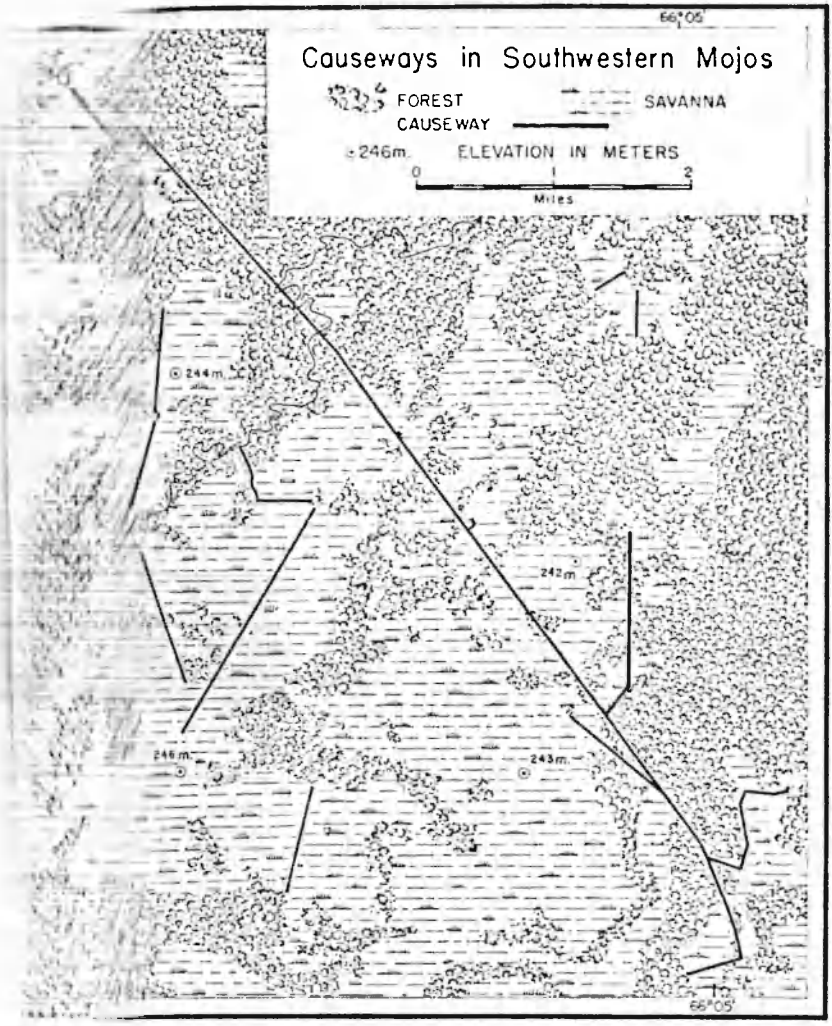
comparison with surrounding grasses. Causeways in forest can sometimes be picked out from the air because the trees on them stand slightly higher than adjacent trees and thereby cast a longer shadow.

It is fairly clear that the aboriginal causeways were built to connect settlements with one another, with areas of cultivation, with ceremonial and burial sites, and with rivers. Causeways occur in conjunction with habitation sites, artificial mounds, canals, and drained fields. The basic purpose of the causeways was not for cross-country travel but for local movement across stretches of low-lying ground subject to flooding (pl. 13). However, some of the causeways, especially the longer and probably more important ones, continue across both high and low ground (for example, in the Caimanes area). The building of raised roads on high ground where there is no drainage problem is probably indicative of the importance that causeways came to have for some of the savanna tribes and is one of many examples of cultures retaining traits in situations where they are no longer utilitarian.

The straightness of most of the causeways is impressive. When they branch off or change direction the angles are sharp, indicating either intentional change in direction or later additions. While the engineering needed to maintain a straight road in flat, open terrain is relatively simple, building a long straight road to a destination that cannot be seen is not easy. The jogs appearing in many causeways (fig. 6) are probably compensations for the inaccurate determination of an intended direct line between two points. Causeways frequently continue on the same course after crossing rivers. The long causeway shown on figure 6 also crosses the bends of two meanders, and undoubtedly the meanders cut across the causeway after the causeway was built.

There are no references to the Jesuits building causeways; however, there are causeways leading to mission sites, and undoubtedly some of them were built under the leadership of the padres following the aboriginal examples. The Franciscan padres of the Guarayos missions clearly did build causeways across local bajios. Padre José Cardús (1886:221–222) mentioned terraplenes between Ascensión and Yaguarú, between Ascensión and Urubichá ("a *curiche* over 1 kilometer long across which the Urubichá converts have built a solid *terraplene*"), and between Urabichá and Yaguarú ("a *terraplene* about 2 leagues[5] long built by the Francis-

[5] A Spanish league is a variable unit of measure but is usually about 5 kilometers (3.1 miles).



ways in southwestern Mojos about 50 kilometers west-northwest of San Ignacio. way trending northwest-southeast measures 8.2 miles. Source: Sheet 18CC, Planimétricas, Bolivia California Petroleum Company, 1958.

ie Zacharias Ducci (1895:80, 82) also mentions terraplenes e Franciscans in the same area, one across a *gran curiche* near nd another two leagues long between Urubichá and Yaguarú. here are postconquest causeways in or near many of the old

mission towns of Mojos, including some built in recent years. There is a causeway 250 yards long, 3 to 4 feet high, and 20 to 25 feet wide from the Magdalena plaza to the Río Itonama (pl. 14*a*); another 3 kilometers long, 3 to 4 feet high, and 15 to 20 feet wide from Santa Ana to an arroyo that enters the Río Yacuma; and another 2 feet high and 15 feet wide from Exaltación to the nearby graveyard. From the Reyes Experimental Ranch a raised truck road was built in 1960 20 kilometers to the port of Fombeni on the Río Beni. The road is 1 to 4 feet high and about 15 feet wide and has excavated drainage ditches on both sides. A similar and long causeway was under construction in 1962 from Reyes northeast to the ranch of Santa Rosa. While causeways are a logical means of providing usable roads and trails during flooding, the idea for their construction cannot be divorced from a tradition in Mojos which is many hundreds of years old.

Despite the Reyes truck causeways and other exceptions, the general attitude in the Beni today is that causeways are too much work and too expensive to be justified. Most roads on the Beni plains are not elevated and are unimproved. They are easily torn up by cattle, oxcarts, and flooding, the usual remedy being the creation of a new trail adjacent to the old one. As a result, modern trails and roads are seasonal and are constantly changing, and in comparison with the aboriginal causeways they are anything but straight.

Because old causeways are usually short and tend not to lead in directions desired by present travelers, they are seldom utilized by major trails, although local people may use some of them to get across bajios during flooding. Since the introduction of horses, oxen, and oxcarts capable of traversing wet ground, causeways have not had the utility and value, considering the labor involved in building them, that they undoubtedly had in aboriginal times.

VII. AGRICULTURE

agriculture in the Llanos de Mojos consists of shifting cultivation lash-and-burn techniques and is confined to forest areas. There is ence of savanna cultivation since the conquest, nor are there many es of savanna farming anywhere in the Americas. Beniano hoe and foreign agronomists give the following reasons for not farm- Mojos savannas: low fertility, poor drainage, clay pans, and grass tion. Nevertheless, the savannas were once farmed, as is indicated still visible remnants of tens of thousands of drained fields.

Drained Fields[1]

os there are four main types of savanna fields that undoubtedly were d for cultivation: (1) raised fields where earth was piled up to ow, rectangular platforms; (2) narrow, ridged fields; (3) furrow- elds in which ditches were dug to provide drainage; and (4) fields ting of regularly spaced small mounds. Less common are fields d in rectangular or gridiron patterns. The different types of fields lly do not occur in the same area. Apparently all or almost all of features are located between the Río Beni and the Río Mamoré; er, I had a few brief glimpses from planes of what may have been vanna fields east of the Río Mamoré between Magdalena and Trini- The main area of drained fields, about 30,000 square miles, is shown gure 4; this is a modification of the distribution shown by Plafker : fig. 3).

pite their numbers and significance the drained fields on the Mojos nas have received almost no attention from travelers and scholars. fields are usually indistinct and unimpressive on the ground, and his reason and because they are away from the commercial flight they remained unnoticed and unreported, except briefly by Erland denskiöld, until the recent availability of aerial photographs and the nd and aerial operations associated with oil exploration.

rdenskiöld (1916:149–150) wrote: "In some parts of Mojos people attempted to make seasonally flooded soils useful by drainage. In cular, it was brought to my attention that between San Borja and

[1] orge Plafker (1963:372) refers to all the linear drained fields as "furrow-ridge fields"; ver, "furrow" incorrectly implies plowing. Terms that sometimes are used in the Beni *erraдos*, *tablones*, and *huertas antiguas* (old gardens).

San Ignacio there are drainage works consisting of trenches which are often parallel and which were probably excavated." Whether Nordenskiöld saw these trenches is not clear, but he goes on to say, "I have seen remains of drainage works in the region of San Ramón." These are the only mentions of drainage features I know of in Nordenskiöld's many writings on Mojos, and apparently he had not seen many drained fields and was not too impressed.

A better-known but equally brief statement is that of Alfred Métraux (1942:19): "In the region inhabited today by the Chiman Indians, especially between San Borja and San Ignacio, there are remains of large canals, dikes, and raised earth platforms built to drain the vast marshes and to convert them into fields. These elaborate structures were made either by a large and industrious population which preceded the Chiman or else by the original stock from which the modern Chiman are descended." Métraux did not give a source for this information (probably Nordenskiöld), and he did not do any field work in Mojos himself.

Recently the Mojos drainage features have been described in some detail by George Plafker (1963) of the Bolivia California Oil Company, by Denevan (1962, 1963*a*), and in an unpublished manuscript by Mary Key (1961) of the Summer Institute of Linguistics in Riberalta. Plafker's study is based on air photo interpretation and sketchy reports from geophysical crews operating out of San Lorenzo, San Ignacio, El Perú, and La Esperanza. My own work is based on aerial photos, ground studies at Santiago, La Esperanza, and the San Ignacio area, and reconnaissance flights in light planes in the areas of San Lorenzo, San Ignacio, La Esperanza, Santiago, Exaltación, the Río Iruyani, Lago Rogoaguado, and Lago Yachaja. Mary Key flew several times over the fields between the Río Yacuma and Lago Rogoaguado.

Raised fields.—The most spectacular of the drained fields are the large raised fields or platforms found from just south of the Río Yacuma to just north of Lago Rogoaguado and from the Río Mamoré at Exaltación west to about 67° W (fig. 4, chap. V). These fields average 30 to 80 feet in width and some are over 1,000 feet long (pls. 14*b*, 15). A few cover as much as two acres. They are spaced anywhere from 10 or 20 to several hundred feet apart and occur in clusters of up to several hundred; some are in parallel alignments and others angle off obliquely. The height of those I saw on the ground at Santiago northwest of Exaltación ranged from 6 to 24

inches, which is sufficient to place them above normal flood waters for most of the year (pl. 22); however, some years there may be three or four feet of standing water on the savannas. Although the raised fields, and other earthworks, are constructed of clay soils that resist erosion, heights have been reduced by the actions of precipitation and flooding and by the accumulation of sediment between fields at a rate of possibly several inches a century.[2]

On U.S. Army trimetrogon photos I have counted about 2,600 large raised fields; and Bolivia Shell Oil Co. photos west of Lago Rogoaguado plus reconnaissance flights beyond the areas of photo coverage revealed a total of at least 5,000 large raised fields in the northwestern Beni.

Mary Key (1961) has described the large raised fields as follows:

> They were oblong in shape with somewhat of an appearance of cultivated plots lying parallel to each other . . . as few as four and as many as twenty. . . . Then another series would angle off obliquely or at right angles, and another series off from that, and so on. They seemed to completely cover the area, though some patches were obliterated or covered with water so deep that the pattern was lost. . . . These formations are of uniform width and the usual length is from three to five times as long as the width. We noted that the channels or narrow strips between them were usually green, . . . definitely deeper, and at this time of the year were filled with water. The reflection in the water gave back the sun's rays. The oblong shapes were higher and drier. . . . We estimated that each oblong was about 10 meters wide.

The raised fields stand out clearly from the air because of their light color, a result of exposed earth under a sparse grass cover, in contrast to the darkness of the dense and usually more verdant grass cover of the surrounding lower ground. At Santiago in December I found a few inches of water in the swales while the platforms were dry (pl. 15*b*). The break between the fields and the swales was quite abrupt. The grass on the platforms was *paja cerda* (*Sporobolus indicus*) and that in the swales was *gañotillo* (probably a *Panicum*). On the fields the surface soil was a light-gray clay loam (pH 5.5), but below three inches the subsoil was a very hard, yellowish mottled, white clay (pH 6.1). The soil in the swales was a deep, gray clay loam with no mottling (pH 4.9). There was a fairly high organic content in the topsoils of the swales but very little in that

[2] Assuming only Pleistocene and recent sediments above basement rock (Plafker, 1964:507) and assuming a beginning of the Pleistocene one million years ago, the average rate of accumulation for 1,000 feet of sediment would be .1 foot every 100 years. The depth of sediment in the main areas of causeways and drained fields is 2,000 to 5,000 feet, for which there would have been a deposition rate of .2 to .5 foot per century or .8 to 2.0 feet in 400 years.

of the fields. The difference in the two soils probably reflects the poor drainage and the young alluvial nature of the swale soils in contrast to the field soils that have received little deposition and are old enough to have experienced some leaching, mottling, and hardpan formation. The poorness of the grass cover on the fields and the presence of trees mainly on the edges of the fields are probably related to these soil differences; however, there are also great differences in drainage between fields and swales, and the fields are heavily trampled and grazed by cattle. At present, the field soils are poorer than the swale soils, but this was not necessarily true when the raised fields were first constructed.

Most of the raised fields are in pampa (pl. 14*b*), but those at Santiago are in open arboleda with scattered *chaaco* trees and some *tajibo* (pl. 15*a*). Most of the trees are on the better-drained ground of the fields, but some grow in the swales. Much of this scrub has invaded the area since the decline in the number of cattle beginning about 1950.

Many raised fields are lined with small, round termite mounds (pl. 14*b*). The termites obviously prefer the better drained ground of the fields.

The vaqueros at Santiago were oblivious to the existence of artificially raised platforms, although they were aware of slight differences of vegetation, relief, and drainage. Two men who were given an opportunity to see the fields from the air were quite amazed by the rectangles that covered the area where they had lived most of their lives. Thus it is not surprising that these large raised fields were not mentioned by the Jesuits or later travelers. Cayuvava families living at Santiago and nearby Exaltación also said they knew nothing of the fields and have no legends of their ancestors farming the savannas.

Ridged fields.—South of the Río Yacuma narrow, raised fields are separated by ditches, and the general pattern is one of alternating furrows and flat-topped ridges. These fields are found in areas with causeways, artificial islas, large mounds, ditched fields, and mound fields, but not the large, wide, raised fields that only occur further north.

The variety of the shapes and sizes of the ridged fields can be seen in plates 16 and 17. The fields range from 20 to 1,000 feet in length and average 5 to 20 feet in width. The ditches between fields also average 5 to 20 feet in width. The only ridged fields that I saw on the ground were a group of ten about three miles south of San Ignacio; they were 1 to 2 feet high and 4 to 5 feet wide, while the ditches were about a foot deep

.de. Oil company personnel who drove swamp buggies over
aid that the ditches averaged between 1 and 2 feet in depth
:376). The fields are not always straight, and there is no
ntation with respect to slope or natural drainage features.
ems to have been to keep the water off the fields, but not
rplus water out of the area of cultivation. The fields occur
ich are sometimes surrounded by sinuous ridges that may
ed as dikes (Plafker, 1963: fig. 4), but there is no clear evi-
r control for irrigation purposes.[3]

fields occur in scattered but dense concentrations. In an
west of El Perú, there are several thousand ridged fields
g about 100 acres including an abandoned stream meander
er, 1963: fig. 4).

ds.—There are a large number of drained fields in which
was accomplished mainly by digging closely spaced ditches
y raising ridges.[4] These furrow-like fields are very common
les of the Río Apere from 30 miles north of San Ignacio to
1 (pls. 18, 19, 20). They also occur west of San Ignacio near
. Air photos (pl. 21) show about 12,000 ditched fields almost
rea of about eight square miles in the vicinity of La Esper-
least this number elsewhere along the Río Apere. The ditches
distinguish from the air and on the ground unless the grass
n burned off.

s at La Esperanza are 6 to 12 inches deep and range in length
o feet, but average about 400 feet. They are 2 to 4 feet wide
d 5 to 25 feet apart (pl. 20). The close, furrow-like spacing
gives the appearance of ploughed fields.

ranza there are only a few scattered trees (*totai* palms and
he area of the fields. The common grasses are *gramalote*
and *paja cerda*. The soils of both fields and furrows are
no mottling within the upper 10 to 12 inches. The topsoil
fields was a grayish-brown loam with a pH of 6.0, while that
t ditch was a light-gray loam with a pH of 4.9. The entire
l when the Apere overflows, but most of the water drains

(1916:150) did mention seeing a dam near San Borja which he thought
r irrigation purposes, but he gave no details.
n fields in central New Guinea, "shallow groove drains may be dug, the
being slightly ridged" (Brookfield, 1962:247).

off rapidly into bajios some distance from the river (pl. 21). Most of the fields are on the gentle slope between the natural levees and the bajios. The heavier silt is deposited on the fields and the finer clays in the bajios. There are a few large ditches leading to the bajios, which may be intentional drainage canals (pl. 18), but many of the ditches run parallel to these canals rather than leading to them.

Mound fields.—Regularly spaced, small mounds, sometimes referred to as *montones,* were observed by George Plafker (1963:376) and by myself from the air and on photos but not on the ground. Plafker (1963: fig. 8) shows a group of oblong mounds that are about 4 to 5 feet long and 2 to 3 feet wide and are spaced a few feet apart. Most of the mounds, however, are circular, 10 to 20 feet apart, and about 5 feet in diameter. The heights are unknown but are probably no more than 1 to 3 feet. The mounds are evenly spaced in straight or nearly straight lines that form orchard-like blocks. From high altitudes it is easy to confuse fields of artificial mounds with termite mounds built on parallel raised fields; however, termite mounds are not evenly spaced.

Mound fields that are definitely artificial are not found in the areas of the other types of drained fields, but are found in open pampa far from large islas or gallery forests. Plafker (1963:376 and figs. 7, 8) saw mound fields "in a roughly elliptical area from about 65 to 125 miles northeast of Rurrenabaque." Figure 4 shows the main location of groups of mound fields between Santa Ana and Lago Rogagua. Presumably these "mound orchards" were built to provide drainage for crops. Their location far from rivers and large islas and their proximity to small, possibly artificial islas suggest that they may have been constructed by the people of small villages who were forced by population pressures into open pampa subject to deep flooding. Small mounds may have been built for crops instead of large raised fields because of the lack of manpower to build raised fields, while ditched fields were not practical because of deep flooding.

Gridiron fields.—Another, but apparently rare, type of old-field pattern in Mojos consists of what might be called gridiron fields. The term is taken from Harold Brookfield's (1962:248) New Guinea study where he described drained fields in which "the soil is ditched in a gridiron pattern, the spoil from the ditches being thrown onto the untilled intervening beds." The Mojos gridiron fields consists of rectangles enclosed on three or four

sides by ditches. About 85 kilometers west of Santa Ana (13° 12′ S, 66° 22′ W), aerial photographs show ditches which are 200 to 400 feet long, and there is very little apparent mounding or ridging between them. In the same area there are mound fields and small round islas that may be artificial. From the air I saw what seemed to be gridiron patterns near the northeast side of Lago Rogoaguado, about 10 kilometers east of Magdalena, and just north of San Joaquín. Bill Key, a Summer Institute of Linguistics pilot, saw similar patterns between San Joaquín and Magdalena and near Benecito on the Río Benecito west of the Río Yata. I tried to locate the gridiron fields near Magdalena on the ground, but was hopelessly confused by a maze of deep cattle paths through the pampa soil.

Plafker (1963:376) notes that "widely spaced ridges or dikes enclose large subrectangular flat areas resembling rice paddies" around 14° S, southwest of Santa Ana. Possibly the "dikes" are gridiron ditches, since it is often difficult to distinguish between ridges and ditches from high elevations and on aerial photographs.

Numbers of fields.—I have seen from the air or on aerial photographs about 5,000 large raised fields, 6,000 ridged fields, and 24,000 ditched fields for a total of 35,000 individual drained fields, not to mention a dozen mound fields each containing hundreds of mounds. The total area covered by these fields, not including the ditches, is about 6,500 acres. The numbers of fields are based both on counts and group estimates, and the area is based on the average size of each type of field. I only flew over a small portion of the region having fields; and identifying fields on aerial photographs is difficult, even when the exact location of the fields is known. Consequently there are undoubtedly many more drained fields than represented by the above figures. A total of 100,000 linear drained fields occupying 15,000 acres (23.4 square miles) spread unevenly over an area of 30,000 square miles in the western Beni would not seem to be an excessive minimum estimate. There could well be several hundred thousand fields which may occupy as many as 50,000 acres.

Cultivation of drained fields.—There are no eyewitness accounts of the drained fields of Mojos being built or cultivated. Nevertheless, the only logical explanation of them is that they are artificial features constructed to drain the savannas and to elevate platforms above flood waters for the purpose of cultivation.[5] Remarkably similar features that do have an agri-

[5] Linear vegetation patterns are sometimes produced by natural factors, as in Somaliland

cultural function are found elsewhere in the world (see chap. X). There is little likelihod that the ditches were cultivated rather than the fields, since this would have required dry-season irrigation or the use of aquatic crops during the wet season, and there is no evidence for either. The fields are not oriented to the slope in such a way as to facilitate irrigation nor are there obvious canals. Nevertheless, on available photos of ancient ridged fileds in the New World, the pattern most closely resembling field patterns in Mojos is that of rectangular plots and irrigation ditches in the Pisco Valley on the south Peruvian coast (Bennett, 1944: pl. 23).

All the drained fields that I have seen are on terrain subject to flooding. The only definite exception I know of is at Nuevo Mundo, south-southeast of San Borja in dense forest where a seismic crew reported seeing "furrow-ridge" fields (Plafker, 1963:375). Ridged fields have been reported but not verified between the Río Chapare and the Río Sécure, and some may be in forest (Ray Henkel, University of Wisconsin, personal communication). These forest fields may represent the persistence in a dry habitat of a cultural trait that originated in a wet savanna habitat; or the forest site may once have been in savanna; or the forest site may be poorly drained itself. Indians of the Chimane tribe are found at Nuevo Mundo as well as in the southwestern area of the savanna fields, but the location of the tribe in the sixteenth century is uncertain.

Nothing is known about the techniques, tools, or rotations used in savanna cultivation in Mojos. Savanna farmers in west Africa use hoes, and those in central New Guinea use wooden digging sticks with flattened ends for piling up mounds and ridges, for tillage, and for weeding, but there is no evidence of any Mojos tribe using any tool for cultivation other than a digging stick.[6] However, the Taino of Hispaniola were able to heap up their montones using only a digging stick; weeding was done without hoes, and the collection of manioc and sweet potato tubers growing in the mounds was done with digging sticks (Sturtevant, 1961:73).

Fiber mats and baskets were probably used by the Mojos tribes to move earth. Some idea of the manpower and time required to build a large raised field is provided by the recent construction of an airfield on low ground at

(MacFayden, 1950) and in the Rupununi savannas of British Guinea (Theo H. Hills, McGill University, personal communication). The Mojos patterns, however, are too irregular to be explained by structure, winds, or drainage.

[6] Nordenskiold (1924*b*:37, 65) said the Moseten in the Andean foothills used "digging spades" or "simple digging clubs," but he gave no details. Spade-shaped, wooden digging sticks were used for grassland cultivation and ridging in the Andes and in the Orinoco llanos.

Baures. A field 1,200 feet long, 75 feet wide, and 3 to 4 feet high was built by six men, led by missionary pilot Walter Herron of Magdalena, working steadily for six weeks. The work was done without machinery but with shovels, picks, and wheelbarrows. The use of only baskets and digging sticks to build a similar-sized raised field would certainly have required more workers or a longer period of time.

The raising of mounds, platforms, and ridges has several functions besides drainage. Heavy soil is loosened, thereby making it possible for crop roots to penetrate more readily. At the same time aeration is greatly improved, resulting in more rapid decomposition of the organic matter present and consequently faster availability of nitrogen. Also, the normally thin layer of humus can be concentrated in a mound or ridge, and weeds are destroyed at least temporarily. In Mojos, drainage was essential for savanna cultivation, since flooding occurs during the growing (rainy) season, and no techniques were developed for irrigation during the nonflooded dry season. Good drainage would also make possible the long preservation of unharvested tubers.

The reasons given today for not cultivating the Mojos savannas are poor drainage, clay pans, grass competition, and low fertility. These conditions all can be alleviated somewhat by mounding or ridging, as is presently true in savannas in New Guinea and west Africa. What is especially critical is the maintenance of fertility. While the mineral content of the savanna and forest soils of Mojos is similar, both being low in phosphorus and calcium and moderate in potash, the organic level of the topsoil under savanna is considerably lower than under forest. The ash nutrients provided by burning are much less under grass than under forest. Nye and Greenland (1960: 125) found that in west African savannas there was a serious shortage of nitrogen after the first year of cropping and of phosphate after one to two years; nevertheless, these grasslands are cropped, usually for three years at a time.

It has recently been pointed out by T. Cochrane of the British Tropical Agriculture Mission to Bolivia (unpublished report on the soils of the Bolivian piedmont region, La Paz, 1966) that in southwestern Mojos the fertility of the pampa soils is actually greater in and below the impervious claypan layer due to reduced leaching. Consequently, the construction of agricultural ridges probably had the important function of exposing superior subsoils and burying the poorer topsoil.

The fertility of the soils of mounds and ridges can be stretched, as well as improved initially, by various means of fertilization. For example, in central New Guinea a grass mulch is composted into mounded garden beds, a fallow tree crop of nitrogen-fixing casuarina is often planted, and in one instance peat was burned to produce potash to fertilize mounds (Brookfield, 1962:247–8). Organic mud is thrown up from adjacent canals onto the *chinampas* in Mexico, thereby improving fertility and also increasing the height (Coe, 1964:93). On Hispaniola, Taino women fertilized montones with urine and with ash from burnt trees (Rouse, 1948:522—no source). The soil of the cultivated *era* ridges or *camellones* of the upper Cauca Valley area of Colombia has vegetable matter mixed with it to improve fertility (West, 1959:281). On the other hand, only a few savanna tribes in Africa apply manure or compost to their raised fields (Nye and Greenland, 1960:4); one exception is in Ghana where a mulch often is placed on top of high yam mounds (Wills, 1962: pl. 1a). The Mojos tribes, of course, did not have significant quantities of animal manure available.

The relation between numbers of drained fields and population size in Mojos cannot be determined when nothing is known about the length of time the different types of fields were used or the time period during which they were built.[7] The fields may have been cultivated for only a year or two, or possibly for several years with the aid of fertility improvement and weeding; or short periods of cultivation may have alternated with long periods of fallow. The effort required to build the fields would seem to indicate that they were used for more than a year or two. Because of relatively good drainage, raised fields and mound fields were probably invaded by brush and trees soon after they were abandoned,[8] and a form of shifting, bush-fallow cultivation may have been possible. In west Africa, savanna woodlands are cultivated in rotation with a bush fallow,[9] but shifting cultivation is not usually successful on pure grassland. A form of composting

[7] Robert Carneiro (1960:231) has estimated for the Kuikuru of the Rio Xingu that an average of .7 acres of manioc (includes allowance for losses) is required to support an average person for one year. For the Mojos tribes, who derived a larger portion of their diet from fish and game than did the Kuikuru, an average of .5 acres probably was sufficient. If only one-fifth, or 1,000 acres, of the 5,000 acres of ditched fields partly shown on plate 21 was cultivated in manioc, a population of about 2,000 people could have been supported.

[8] The height of raised fields has been reduced by erosion and alluvial deposition, and the fields are now usually subject to sufficient flooding to inhibit the growth of trees. Causeways, which were built higher than were the fields, are still high enough to be flood free and usually are covered with trees.

[9] "In savanna the amounts of nutrients released on burning are very much less than in forest, and largely depend on the density of the woodland and the thoroughness with which it is burned" (Nye and Greenland, 1960:69).

such as used in New Guinea may have permitted longer use of mounds and raised fields in Mojos.

Invasion of fields by savanna grasses may be just as much a reason for abandonment as loss of fertility. In San Ignacio I talked with a man who once planted rice, corn, melons, and sweet potatoes early in the rainy season on pampa. Most of his crops matured before flooding, but he said he had to weed frequently, and the grass was so bad the second year that he gave up. The native grasses of Mojos are not as aggressive and troublesome as the *Imperata* grasses of the African and southeast Asian savannas, but weeding was undoubtedly necessary. Padre Castillo (1906:309) did note that the Mojo Indians carefully weeded their manioc patches.

Cultivation of grassland unquestionably involves more work than forest cultivation, but it can be done using only simple tools. In New Caledonia dense grassland turf is turned over with long digging sticks by several men walking side by side, and then the clods of turf are broken up with clubs (Carneiro, 1961:59). The Quechua cultivate grasslands in the same way using the *taclla* (digging stick with foot rest) (Cook, 1920).

The main crop grown on the drained fields of Mojos was probably manioc, which was the staple in Mojos in the seventeenth century; maize and sweet potatoes are other possibilities. The Taino planted manioc and sweet potatoes in their montones but not maize. The main crop on the New Guinea mound fields is the sweet potato, and in Africa manioc is grown on ridges and mounds. The reasons why maize is seldom planted on ridges and mounds in savanna are unclear; however, maize does require more nitrogenous soils than does manioc.

While the building of mounds and ridges on savanna for cultivation purposes is a good means of providing drainage where drainage is poor and represents a more complex form of tropical agriculture than shifting forest cultivation, there is no evidence that it is more productive or more permanent than shifting forest cultivation. Because of lower soil fertility, savanna farming is usually less productive and less permanent than forest farming.

Reasons for farming savannas.—There are several possible explanations why the Mojos savannas were farmed when apparently there was adequate forest available within the savanna region for slash-and-burn agriculture. Stone tools were very rare in Mojos, since stone had to be brought from long distances. Until metal tools were introduced by the Spanish, it may have been easier to build up earth platforms in the savanna than it was to

clear forests. Of relevance is the fact that in eastern Mojos, where there are a number of rock outcrops of the Brazilian Shield, there are very few drained fields, although there are large numbers of mounds, causeways, and canals. On the other hand, population may have become so dense that there was not enough forest available to support successful shifting cultivation based on a long fallow. This is becoming the situation in west Africa, where population is increasing, more and more forest is being converted into savanna, and there is increasing savanna cultivation. Again, tribal territorial claims may have prevented migration and thereby necessitated intensive cultivation of whatever land was available locally. All of these possibilities were eliminated by the Spanish conquest which introduced metal tools for clearing forests, drastically reduced the population, and established new groupings of the Indians. These events began taking place long before the first missions were established and probably even before the first explorers reached Mojos.

Antiquity of savanna farming.—The drained fields of the Llanos de Mojos are all aboriginal. There is no conclusive evidence concerning when they were first built or whether they were still being built at the time of the Spanish conquest. Since the people who built large mounds and causeways did not always drain fields for savanna cultivation, the fields are not necessarily contemporary with the Upper Velarde-Hernmarck mound-and-causeway culture. That the fields are not extremely old is indicated by the fact that they have not been completely destroyed by erosion and alluvial deposition.

More interesting than the date of origin is the date the construction and use of drained fields was abandoned. Was this abandonment a result of natural or social factors long preceding the Spaniards or was it an indirect result of the Spanish conquest? This question is of some significance in view of claims that certain seasonally flooded savannas in South America cannot continuously support advanced aboriginal cultures (Meggers and Evans, 1957:30–32; and Leeds, 1961:26).

The early explorers and the Jesuits never mentioned drained fields or savanna farming,[10] so fields probably were not still being drained in the latter part of the seventeenth century. That the Jesuits did not even notice abandoned fields is not surprising since subsequent travelers did not notice them either. The first Jesuits in Mojos, however, did not get into the main

[10] Padre Eder (1888.31) wrote that the ashes of burnt grasses provided good fertility, but, nevertheless, "the *campos* can not be cultivated because of the waters which flood them."

as of fields and these areas were not described until much later when the missions of San Ignacio (1689), and San José[11] (1691), and San Borja (1693), and Exaltación (1704) were founded. In the period intervening between the first Spanish exploration and the founding of the missions there were only a few expeditions and no colonization in Mojos. Nevertheless, there was sufficient direct contact between Spaniards and savanna Indians, both in Mojos and in Santa Cruz, and indirect contact through other tribes to disrupt the savanna tribes numerically, socially, and technically by (1) introducing disease and thereby considerably reducing a population that may have once numbered several hundred thousand; (2) slave raiding activities which brought about tribal displacements and breakdowns throughout the interior of South America; and (3) the introduction of metal tools and other implements, initially through Mojo traders who came to Santa Cruz.[12] As already pointed out, these factors eliminated the most likely reasons for savanna cultivation. Thus there may still have been savanna farming well into the seventeenth century. Unfortunately, there are no early descriptions by Spanish explorers of the regions where the savanna fields occur.

Shifting Cultivation

The people who drained fields in order to farm savannas probably also practiced agriculture in isla and gallery forests. All of the savanna tribes and most of the forest tribes of the Beni were practicing shifting cultivation in forests at the time they were first contacted by Europeans. Slash-and-burn fields were called *chacras* (or *chácaras*) during the colonial period and are now referred to as *chacos*. Abandoned chacos are called *barbechos*.

There are many early references to forest cultivation but few details. Several of the descriptions of Mojos by members of the Solís Holguín expedition mention chácaras: "*chácaras* in carefully cleared *montaña*"; and "great *chácaras* of maize and other vegetables" (Lizarazu, 1906:149, 195). Altamirano (1891:30) wrote that the Mojo first felled the trees and rooted out the useless weeds and grasses. Coronel Aymerich, Governor of Mojos from 1768 to 1772, wrote that because of flooding, crops were grown in the forests on *alturas* next to the rivers (gallery forests on natural levees), from where transport was easy to villages that were sometimes two or three days

[11] The mission of San José, abandoned by 1764, was located southwest of San Borja.

[12] Alfred Métraux (1943:2) pointed out the likelihood of a pre-Jesuit and even precontact population decline in Mojos from epidemics of European diseases and a general cultural upheaval due to shifting of tribes in the interior South America as a result of peripheral European pressures.

away (René-Moreno, 1888:68). Padre Eder (1888:31) said that the campos could not be cultivated because of flooding and they were less fertile than the forests, where the ashes of burnt vegetation provided excellent fertility.

The process of clearing forests for fields in aboriginal Mojos has been described by Alfred Métraux (1942:59—based on Eder, 1888:30):

> The Mojo and Baure cleared fields in the forests, which were not flooded during the rainy season. At the end of August they first destroyed the underbrush, then cut the base of large trees by alternately charring and hammering the wood with stone axes. They waited until a strong wind blew down the undermined trees, or else felled selected trees, which knocked down all the others. The dry trunks were burned and their charred remains left on the field to protect young maize stalks. The Spaniards who penetrated the country with Solís Holguín were amazed at the size of the Mojo fields, which were crossed by wide roads.

The Mojo and Baure used digging sticks for planting, and presumably so did the other tribes of Mojos. Long pointed digging sticks (*punzones*) are still used, but some have metal points. Hoes were apparently unknown in South America outside the Andes.

Stone axes were used by the Mojo to clear forest. Alonzo Soleto Pernia, a member of the Solís Holguín expedition, said that "we found trees cut, as if by stone axes; they have mines where they obtain stone for axes for cutting trees, and their edges are like iron" (Lizarazu, 1906:211). Rock outcrops may not have been far from the area visited by the expedition; however, in the central savannas most stone tools were obtained in trade and were a valuable commodity. Possibly in much of Mojos there were not enough axes to clear sufficient forest to support large numbers of people. The Mojo had cutting and sawing tools made from bone, teeth, and chonta palm wood, but these would not be very effective for clearing mature forest. Girdling large trees by cutting through the cambium layers probably was practiced. The change to metal tools undoubtedly had revolutionary effects for shifting cultivation. By 1676, and probably much earlier, Mojo Indians were traveling to Santa Cruz to trade cotton goods for "machetes to cut and clear their *chacras*" (Márban, 1898:148). The Jesuits used axes and machetes as major gift items in gaining the friendship of the natives.

There are no reports of any form of fertilization by the Mojo and Baure. The neighboring Moré, however, applied a deep layer of ashes to their manioc plantings (Métraux, 1942:88). Furthermore, the More fields were semigardens with a large variety of intercropped plants (manioc, maize, sweet potatoes, and yams) and scattered cotton and banana trees, pineapple

ants and *urucu* (*Bixa orellana*) shrubs. Such fields are continuously yielding and help protect the soil and maintain fertility. Today most of the Savanna Indians maintain gardens of varying size and complexity, but these are usually small, permanent house gardens, while most food production is in large fields of manioc, maize, upland rice, and plantains.

Nothing is known about original practices of intercropping, crop rotation, the number of consecutive years chacos were cropped, or the length of fallow in scrub monte or forest. Today Trinitario and Ignaciano Indians farm isla chacos for three to five years and then abandon them because of infestations of weeds and grasses. Chacos cut in tall forest at Lago Huachi near El Cármen are used for five to seven years with good yields. I visited one chaco where the bush fallow was only three years and another where it was five to six years. There is an abundance of forest available, however, and much longer fallows are possible. Plate 21 shows chaco clearings within gallery forest.

In the early seventeenth century the Indians of southeastern Mojos had large farms producing great quantities of food. This is indicated by the reports of the members of the Solís Holguín expedition of 1617. The relation of Juan de Limpias (Lizarazu, 1906:170) states that a Captain Diego Hernández Vexarano saw a large number of *percheles* of maize and other legumes and told Juan and another soldier to count them. Juan counted over 30 percheles in one group. There seemed to be 20 to 30 *fanegas* (30–45 bushels) of food in each *perchel,* and the men were much impressed. The other soldier counted over 400 percheles in a group. Captain Gregorio Jiménez said that Captain Diego Hernández Vejarano reported seeing a *cacicara* with over 500 percheles of maize, which formed one of the tribe's granaries (Lizarazu, 1906:158).

Métraux (1942:59) translates percheles from these accounts as "probably the forked sticks used to support maize." This usage is apparently based on one meaning of *percha* as perch or pole and *perchonar* meaning to leave shoots on a vine stock. However, it would be impossible for a single "forked stick" to support a crop of 32 to 48 bushels of maize. A unit of land is a possibility, but most likely perchel refers to a maize crib on pilings for protection against flooding and animals (the term has been so used in Portugal). Such cribs were still being built by the Chácobo when visited by Nordenskiöld (1920:3). Seven hundred percheles each holding 30 to 45 bushels of corn would total 21,000 to 31,500 bushels—a sizable amount for what was presumably one village.

Crops

The Mojos savannas tribes cultivated a wide variety of crops, including both seed plants and tubers propagated by vegetative reproduction. The most complete pre-mission period list was that given by Padre Castillo (1906:309–310) which includes the following plants: manioc (*yuca* in Bolivia) (*Manihot esculenta*); maize (*Zea mays*); beans, probably the kidney bean (*Phaseolus vulgaris*); *zapallo* or squash (*Cucurbita*); *camote* or sweet potato (*Ipomoea batatas*); *maní* or peanut (*Arachis hypogaea*); *papaya* (*Carica papaya* probably); *ají* or red pepper (*Capsicum*); cotton (*Gossypium barbadense*); *arrachacha,* an edible tuber common in the lower Andes (*Arracacia xanthorrhiza*); tobacco (*Nicotiana tabacum* probably); and the plantain or cooking banana (*Musa paradisiaca normalis*). Most of these plants were also mentioned by members of the Solís Holguín expedition. Additional South American crops that are cultivated in Mojos today and are probably pre-Spanish in the region are: *urucú,* a red dye plant (*Bixa orrellana*); *guayaba* (*Psidium guajava*); *totuma* or calabash tree (*Crescentia cujete*); pineapple (*Ananas comosus*); and gourds (*Lagenaria*).

Manioc or yuca.—The staple food crop for most of the tribes in northeastern Bolivia was manioc, while maize was only a secondary crop. Manioc is given prominent attention in all the early accounts. Padre Marbán (1898: 139) wrote that "*yuca* is the common bread of the land," and Padre Orellana (1906:13) said that "*yuca* is their principal food."

Manioc was planted in September or October with three or four stem cuttings, each about six inches long, placed in separate holes. In February[13] some of the tubers were harvested and eaten, but others were left in the ground where they continued to grow and were safe for as long as two years (Eder, 1888:48–49). Some of the varieties grown were very large, and the Movima still produce tubers up to three feet long.

Padre Eder (1888:48–49) described both sweet and bitter (poisonous) types of manioc. The sweet manioc was boiled or roasted in ashes after being dried in the sun. The bitter manioc was more useful and more common. It was pressed, sliced or grated, and dried in the sun, and the flour was toasted as bread in a clay pan. Castillo (1906:310) said that the Mojo also made *chicha* from manioc. At the present time the only poisonous

[13] From September to February seems to be too short a growth period for manioc, most varieties of which take eight to 24 months and average 16 months to mature and produce maximum yields.

manioc that I have heard of in the Beni is said to be grown north of Riberalta.

The Movima process their sweet manioc in a manner characteristic of the usual treatment of bitter manioc. First, they grate the manioc root either over a metal plate with holes or on a wooden wheel, and then they pulverize the flesh with a stone. The finer flour (*almidón*) is sifted out with a straining mat and baked into a bread. Water is added to the coarser flour, and the mixture is allowed to ferment for several days in a hollow log. Then it is dried in the sun, pulverized once more, and is toasted in a large clay bowl. The end result (*chive*) is similar to Brazilian *farinha*, but chivé is fermented and is made from sweet rather than bitter manioc.[14] The Movima treatment of sweet manioc may reflect the former use of bitter manioc, but it is possible that the Movima never used bitter manioc.[15]

Maize.—The descriptions of large maize fields, whether chacos or drained fields, by the members of the Holguín expedition may mean that maize was a major crop for some tribes. In the reports of the expedition, maize is mentioned ten times and manioc only twice. The Jesuits, however, said that maize was grown mainly for making chicha. Padre Castillo (1906:310) wrote that "some maize is used for food and for special *chicha* as well as for the *chicha* served guests," while Padre Marbán (1898:138) said that "there is not much maize because these Indians do not use it for *chicha*, except once in a while."

The Mojo planted 10 to 14 grains of maize in holes made one *vara* (about 33 inches) apart with digging sticks. They planted in early October and reportedly harvested the crop only two months later when "a man on horseback could not touch the top of the highest stalks" (Eder, 1791:30). The Ignacianos still plant their maize in early October and harvest it in late November and December before the start of heavy and prolonged rains, and they usually plant a second crop near the end of the wet season. Marbán (1898:138) said that some varieties of maize had very large ears with over 450 kernels each. Alonso Soleto Pernia (Lizarazu, 1906:211) said that the maize kernels were thick, large, and soft (probably

[14] See Dole (1960) for a discussion of techniques of preparing manioc flour in South America.

[15] Donald Lathrap (1962:510–516) argues that sweet manioc is older than bitter manioc in South America, mainly on the evidence of sweet manioc's wider distribution. Lathrap believes that bitter manioc was introduced into Amazonia from Venezuela between 1,500 BC and AD 500, mainly by migrations of Arawak-speaking tribes, and that it then replaced sweet manioc as the main staple crop except in peripheral areas such as eastern Peru and Bolivia.

a soft "flour" corn). Most of the maize varieties grown in the Beni today have been introduced recently. Rows of maize are often intercropped with manioc, and individual maize plants may be slightly mounded.

Not much is known about the preparation of maize for food and drink. Castillo (1906:327) said that the ears of maize were roasted. Pernia spoke of *vatanes* for the grinding of maize (Lizarazu, 1906:209), and these may have been the same as the large wooden mortar (*tacú*) used for grinding maize in the Beni at the present time. Nordenskiöld (1924*b*: map 16) believed that the grooved clay bowls that he found in southeastern Mojos were used for grinding maize; however, Rydén (1964:266–267) has recently pointed out that the bowls were more likely used as graters for manioc or that they had a double use as both manioc graters and maize grinders.[16]

The Ignacianos, Movimas, and Chácobos store their maize in canoes kept inside their houses; in event of flooding the canoes float and the maize is not damaged. This is probably an old practice. The maize cribs on pilings of the Chácobo and seventeenth-century Mojo have been mentioned already.

Other crops.—Peanuts and sweet potatoes are the crops most frequently mentioned after manioc and maize in the seventeenth-century accounts. Neither peanuts nor sweet potatoes are common in Mojos today, but peanuts are still an important crop in the Guarayos region. In Mojos peanuts usually were planted during the dry season on the sandy playas of the rivers. Beans are almost never eaten in Bolivia today, and the only area where I saw beans cultivated was at Baures where the entire production is sold to Brazil. Tobacco was used as a medicine and not smoked except by the Guarayo.

Cotton was an important crop among all the aboriginal savanna tribes and later in the Jesuit missions. The Baure and Mojo were noted for their cotton garments and hammocks. Castillo (1906:310) wrote that cotton was cultivated and does not mention wild cotton. Eder (1888:48) described the cultivated cotton as being a tree of medium height with numerous branches that had to be pruned after four years in order to maintain good yields. He said that the Mojo raised cotton of two colors—white and *mollado*. The cotton of the ceiba or mapacho tree was known but was

[16] Implements for preparing and consuming food in Mojos are discussed and mapped by Nordenskiöld (1924*b*).

dered of too poor a quality to be spun. The perennial, woody cotton ntly grown in house gardens in the Beni is a variety of *Gossypium dense*.

he Chimane are reported to have cultivated eight varieties of reeds rrow shafts and a creeper for drugging fish (Métraux, 1942:19). In arly twentieth century the Chácobo cultivated a type of arrow grass *erium saccharoides*) for arrow shafts according to Nordenskiöld *b*:5, 114).

oduced crops.—The Jesuits are known to have introduced the Old ld crops of coffee, upland rice, and various fruit trees including the rind (*Tamarindus indica*) and several varieties of oranges and lem- Plantains and sugar cane, however, were pre-mission introductions. f these crops were being grown at the end of the Jesuit period (Eder, :38–52).

he Jesuits probably also introduced cacao (*Theobroma cacao*) to s. There are no mentions of pre-mission or early mission cacao culti- n by the Indians; however, Eder said that during the later mission d wild cacao was common in mature forests and was cultivated in ations in the missions. There are many subsequent reports of wild . Cacao, which apparently was aboriginally cultivated only in Middle rica, may have escaped into the forests of Mojos after having been duced in the missions by the Jesuits. The seeds are spread readily nonkeys and other animals. The present wild and cultivated cacaos e Beni are said to be identical, but no botanical studies have been e. Nordenskiöld (1924*b*:34) noted that the cacao raised by Indians Mojos was mainly for selling to the whites, and the same is true today. dre Castillo (1906:310) said that the Mojo grew sugar cane (*caña e*), and this may have been the cultivated *uba* cane reported by the Europeans in Brazil and Argentina. The plantain is also pre-Jesuit. illo (1906:310) said plantains were cultivated in 1677, and Eder (1888: later mentioned three varieties (*guineo, Dominicano,* and *harta bel-*). Carl Sauer (1950:527) has suggested that the plantain may even re-Columbian in South America, and if not, then it spread rapidly ng the tropical forest tribes in the sixteenth century. Neither sugar nor plantains were mentioned by the members of the Solís Holguín dition or in the accounts of other early expeditions to Mojos.

hile the use of Indian terms for Old World crops is not necessarily

indicative of pre-Columbian possession, such usage usually does indicate early post-Columbian possession as result of rapid diffusion through other tribes rather than from direct European contact. Word lists for the Movima (Judy, 1962) and the Ignaciano (Willis Ott, personal communication) show a consistent use of native terms for South American crops and animals and Spanish or Spanish-derived terms for crops and animals introduced by the Jesuits. For example, maize is *cuajtaa* in Movima and *sipane* in Ignaciano. *Cafe* (coffee), however, is *cape* in Movima and *cajue* in Ignaciano; *arroz* (rice) is *aroso* in Movima and *arusu* in Ignaciano; and *vaca* (cow) is *huaca* in Movima and *waca* in Ignaciano. Both the plantain and sugar cane, however, have native names and were pre-mission in Mojos. Sugar cane is *charaye* in Movima and *acutene* in Ignaciano; plantain is *pere* in Movima and *cáerena* in Ignaciano; and *guineo* (a variety of plantain) is *apu* in Ignaciano and *talumo* in Movima.

Taro (*Colocasia esculenta*), and aroid tuber from the Pacific Islands, is a minor garden crop among many of the Beni tribes, including the Ignaciano, Chácobo, Chimane, Yuracaré, and Moseten. The date of introduction may have been late, as it was not mentioned in any of the missionary accounts. It is generally known in Peru and Bolivia as *gualusa* but as *papa china* in Ecuador.

Padre Eder (1888:31) said that rice produced as many as five crops a year, and that harvesting was done in canoes, which suggests that the Jesuits may have grown wet rice on the savannas. All rice production today in the Beni, as well as in most of the Amazon Basin, is with dry "upland" varieties.

VIII. OTHER SUBSISTENCE ACTIVITIES

In the Mojos savannas and islas, edible wild plants and animals are abundant and are more concentrated and easier to obtain than in adjacent forests. Certain plants, animals, fish, and birds were major sources of foods and, at the same time, provided useful materials for all the aboriginal savanna tribes. Quantity and availability varied considerably with the seasons, as did methods of hunting and gathering. Animal protein was a regular part of the diet; however, the pre-Spanish sources were mostly wild animals and fish rather than domesticated animals. Undoubtedly, the former large concentration of Indians on the Mojos savannas was partly made possible by the relative abundance of game and fish.

Gathering

Descriptions of some of the noncultivated plants used by the Mojo Indians were given by Padre Castillo and Padre Eder. Most important were the palms, of which there are numerous species and numerous potential economic uses. The *cachi* palm (probably the *cusi, Orbignya phalerata,* which is common on the islas east of the Río Mamoré) was valued for its edible fruit and nuts, and the oil from the nuts was used for making a soap (Castillo, 1906:303). Several other palms have edible fruits: the *motacú* (*Attalea princeps*) bears fruit year round; the *sumaque* (*Cocos batrifora*?), *assai* (*Euterpe*), and *totai* or wine palm (*Acrocomia totai*) bear from July through September; and the *chonta* (*Guilielma insignis*) bears from February through March. Palm heart or cabbage was also eaten, especially that of the *cusi* and *motacú* although most of the other palms of the Beni also have edible hearts. *Chonta* palm wood was used for bows, arrow tips, knives, and other items requiring very hard wood. Palm fronds were used for building temporary shelters; however, most of the tribes roofed their houses with grass rather than palm fronds.

Many trees other than palms have edible fruits, including the *pácay* (*Inga edulis*), *paquío* (*Hymenea courbaril*), *coquino* (*Ardisia*), and *ambaibo* (*Cecropia*); most trees bear fruit from February through April. Eder (1888:38–52) listed a number of trees that were sources of medicines, dyes, insect repellants, and aromatics. Vanilla (*Vanilla*) served as a medicine and aromatic. Wild *canela* (unidentified) had a cinnamon-like bark. During the Jesuit period the bark of quinine (*Cinchona*) was used by

both Indians and Jesuits for treating malaria fevers. The genus *Cinchona* seldom grows below 1,000 feet, and so it may have been obtained from outside Mojos. Eder also mentioned a high *almendra* tree with 30 nuts to a pod which was probably the Brazil nut tree (*Bertholletia excelsa*). The Jesuits pressed the white milklike fluid out of the nuts and mixed it with rice to make a tasty meal, which, however, often led to indigestion. Among Tacanan tribes near the Río Beni, Brazil nuts were a major source of food (Métraux, 1942:35). The *exomoboco* tree (unidentified) and the *bibosi* (*Ficus*) were sources of bark for clothing. The bark was stripped off in sheets and pounded until soft and pliable. When salt was not available, the ashes of a certain plant were mixed with *ají* (chile pepper) and used as a condiment (Eder, 1888:151).

All of the Beni tribes gathered turtle and caiman eggs on the river playas during the dry season, and the savanna tribes collected the eggs of the rhea (*Rhea americana*, the South American ostrich) (Eder, 1888:71). The Mojo ate both ants and worms which were squashed and boiled and sometimes mixed together as an ant-worm mush (Eder, 1888:150). Bee's honey and wax were collected in the forests. The presence of shell middens in many of the mounds and islas in Mojos indicated that various mollusks and mussels were collected and eaten; shells were possibly used for tools. Shells collected by Rydén (1941:137) from an artificial mound near Casarabe were identified as *Ampullaria*. Willis Ott of San Ignacio (personal communication) says the Ignacianos once ate a black-shelled snail found in the marshes but ignored the brown and white land snails.

Today the savanna tribes know a large number of useful plants, but the gathering of wild foods is not very important. However, wild fruits and nuts, palm heart, and honey are still major food sources for the Sirionó Indians of the forests (Holmberg, 1960:28).

Hunting

The savanna tribes hunted a variety of animals and birds in open savanna as well as in gallery and isla forests. The types of game, methods of hunting, and weapons used were described in detail by Padre Eder (1888:52–79, 135–142), and this information was partly summarized by Alfred Métraux (1942:59–60).

The major game animals include: *ciervo* or swamp deer (*Blastoceros dichotomus*); other deer (*Ozotoceros, Bezoarticus*); tapir or *anta* (*Tapirus*

terrestris); *capybara* (*Hydrochoerus hydrochaeris*); jaguar or *tigre* (*Panthera onca*); peccary or *jabali* (*Tayassu tajacu*); rabbits (*Sylvilagus*); monkeys (*Alouatta, Ateles, Saimiri*); *borochi* or "giant swamp fox" (*Chrysocyon brachyurus?*); anteaters (*Myrmecophaga, Tamandua*); and *agouti* (*Dasyprocta*).

Hunting was facilitated during the height of the dry season by concentrations of game near water holes, lakes, and rivers and during flooding by concentrations of game on islas surrounded by water. High prolonged floods, however, were disastrous, for they greatly diminished valuable wild game, especially deer and peccary (Orellana, 1906:19).

The hunting of game on islas has been well described by Métraux (1942: 59–60; based on Eder, 1888:137–138):

> During the floods a very profitable Mojo hunting method was to surround an island on which game had taken refuge. A few hunters took vantage positions on high places while others surrounded the island in canoes. Groups of Indians with trumpets, drums, and packs of dogs invaded the island from several sides making as much noise as possible. The panic-stricken animals, especially deer, ran to the shore to escape by swimming, but were killed by the boatmen, who struck them with sticks, lassoed them, stabbed them, or jumped on their backs and drowned them.

Single major hunts of this nature resulted in the killing of up to 40 deer and 200 peccary, plus rheas, anteaters, tapir, jaguars, and lesser game.

Deer in particular were hunted in the pampa, often for a week at a time by large groups led by a chief (Castillo, 1906:333). Well-trained dogs were used to drive game toward ambushes, and grass fires were lit for the same purpose. Deer ran in large herds, and up to 30 were killed in a few hours. Deer were also stalked by Mojo hunters wearing birdlike costumes (white shirts and masks) and imitating bird whistles until close enough to fire with arrows or blowguns. The hunters also lay in the grass and raised an arm or leg, which attracted the attention of the curious deer.

The jaguar was the basis of an important religious cult among the Mojo (Métraux, 1942:74–75), and as such was the most important animal hunted:

> The Mojo attacked jaguars either with two spears or with bows and arrows, which they shot in rapid succession until the animals fell. The killing of a jaguar brought unusual honors to the hunter and was celebrated with dancing, drum beating, and other ceremonies. The safest means of taking a jaguar was to lure him to the river bank or into the water by imitating his call with a calabash megaphone, and then to shower him with arrows from a canoe. They also treed jaguars with dogs and shot them with the blowgun. After acquiring iron, a lone

hunter with two iron spears would not hesitate to attack a jaguar (Métraux, 1942:60; based on Eder, 1888:55).

Jaguars have become very numerous since the introduction of cattle and are now a constant potential danger to man and his livestock.

Peccary was sometimes hunted by first capturing a young one and placing it on a tree branch where its cries attracted the herd, which was readily dispatched with arrows and spears. Smaller wild pigs (unidentified) in herds of as many as a thousand were chased by dogs into holes in the ground or in trees; then the holes were closed with stakes, and the animals were suffocated with smoke. Rabbits were forced into their burrows by grass fires and then dug out; however, the Indians had to be wary of snakes which also took refuge in the holes.

Monkeys were hunted in the forests both for food and because they did considerable damage to crops, "carrying away ears of maize in their arms to the trees to eat, and then returning to completely destroy a *chacra* within an hour" (Eder, 1888:61). The tapir also did great damage to crops; they were pursued to the water and shot when they came up for air. Capybara were killed in the same way.

During the northern hemisphere winter, when Mojos is flooded, millions of migratory birds, as well as the local tropical birds, swam over the llanos and feast on the fish. Ducks of several varieties were hunted for food, and various birds, including the rhea, were hunted for their plumage The Mojo built blinds in the areas where birds roosted and then avoided the blinds until the birds were accustomed to them. Later the hunters entered the blinds when the birds were gone and shot them one by one with blowguns as they returned. Ducks were sometimes captured by Indians who entered the water hiding beneath large gourds. The ducks were approached slowly, grabbed by the feet, pulled under water, and their necks were twisted. The other ducks, used to one another ducking under water, were not at all alarmed and soon met the same fate.

Hunting weapons included the bow and arrow, bolas, blowguns, slings, and spear throwers with short spears.[1] Long spears or lances probably were introduced by the Spaniards. Eder said that the Mojo were so skillful with the bow and arrow that up to 20 arrows could be fired in a minute; that targets could be hit at 70 paces; and that arrows were fired with sufficient

[1] Many of the hunting weapons used by the Mojos tribes were described and their distribution discussed by Nordenskiold (1924*b*:44–85).

to penetrate the side of a canoe. Both bows and arrows were the length an. The bows were decorated with feathers and colored-thread wrap- The arrows were feathered and had a shaft of bamboo that was d with a cemented-on point of bamboo, bone, or the spike of a sting- To terrify the enemy, war arrows often had hollow nuts attached that led in the air.

he eighteenth century the Mojo blowgun was a long bamboo tube was heated over a fire, possibly for straightening. The darts were palm splinters with the bases wrapped in cotton. The darts were d in a quick-acting poison made from the *coropi* vine (unidentified). coropi was crushed and moistened with hot water; then the liquid was d through cotton, boiled until thick, dried in the sun, and moistened tobacco juice before being spread on darts and arrows (Eder, 1888: 25). Nordenskiöld (1924*b*:58–59) believed this poison to be curare *chnos*); however, there is no evidence that curare was used in this of South America before the eighteenth century. Eder also mentioned poisons, one so effective that it killed trees and others used in warfare caused both fast and slow deaths.

he spear thrower still was being used in Eder's time by the Tiboita raux, 1942: pl. 5), but had been given up by the Mojo. The Canichana Itonama were using slings when visited by Nordenskiöld (1924*b*:65). Mojo slings described by Eder used clay pellets studded with poisoned s. The Mojo bolas probably originally contained clay centers, but lead used in the eighteenth century. Nordenskiöld (1924*b*:65) believed that and bolas may have been introduced into Mojos in postconquest ; however, both weapons and the spear thrower (*estolica*) were seen embers of the Solís Holguín expedition (Lizarazu, 1906:147, 164–165). erious types of traps, snares, and pitfalls were also used by the Mojo but not described by Eder. They may have been similar to the Caviña ayo, and Moseten traps described and sketched by Nordenskiöld 24*b*:65–74).

Fishing

much of the year fishing was as important, if not more important, hunting. During the retreat of flood waters in April, May, and June, t numbers of fish were stranded in the mud or concentrated in small where they were easily killed with clubs and spears as well as with and arrows; and leaping fish often landed in the Indian canoes. At

such times the stench of rotting dead fish and the associated carrion birds gave the llanos an unpleasant aspect which was compounded by mosquitoes and the difficulty of travel by any means. Fish were also hunted and trapped in the rivers and lakes.

The more common food fish include: *pacú* (*Myletes*); *surubí* (*Platystoma*), weighing up to 400 pounds; *piratinga* (*Arapaima gigas?*), weighing up to 300 pounds; *bagre* (*Pimelodon*); *sabalo* (*Prochilodus*); *dorado* (*Salminus*); *corbina* (unidentified); and *anguila* (unidentified). *Caiman* and river turtles (*Podocnemis expansa*) were also hunted for food. The pink fresh-water porpoise (*Sotalia pallida*) is common; however, there are no reports of the manatee (*Trichechus inunguis*). Fishing, hunting animals in the water, and aquatic activity in general were sometimes dangerous because of the presence of piranhas or *palometas* (*Serrasalmus*), stingrays (*Potamotrygon*), electric eels (*Electrophorus electricus*), anacondas or *sicurí* (*Eunectes murinus*) which were reported to exceed ten meters in length, *caiman* (*Caiman*), and *lagarto* (*Melanosuchus* or *Paleosuchus*). Most of these fish and amphibians and methods of fishing by the Mojo were described in some detail by Padre Eder (1888:142–146, 79–95).

There is no record of any of the aboriginal savanna tribes using fish hooks. Instead they relied on arrows and spears, including a trident or fishgig, for catching individual fish. At night fish were attracted by torches and then speared. The modern Ignaciano fish with arrows propelled by hand catapults, but this is probably a postconquest technique.

Eder described a number of methods of catching large numbers of fish at one time. Fish were drugged with the *coropi* vine, which was crushed, shredded, and thrown into calm lake waters. The plant used may have been different from the *coropi* used for arrow poisons. Keller (1875:100) identified the fish poison used along the Río Mamoré as *Paullinia pinnata*. A plant currently used for fish poison is *ochoho* (*Hura crepitans*), and *barbasco* (*Lonchocarpus*) has also been reported. Nets were not used until introduced by the Jesuits; however, the Mojo did use a bottomless basket device called the *covo* to intercept swarms of migrating fish in shallow water (Keller, 1875; pl. on p. 100). Nordenskiöld (1924*b*:90, map 11) saw the Cayuvava using a similar basket, which they threw over fish in swampy places. The Mojo sometimes built weirs across the outlets of lagoons and placed baskets or traps (not described) in a few openings. Also, large barriers of weeds and brush were pushed toward lake shores where trapped fish were captured by hand.

Another unusual method of fishing consisted of attaching a hide above one side of a canoe in a shallow, quiet place where fish were abundant and then beating the water and the canoe bottom with flat sticks. The resting fish leaped out of the water, hit the hide, and fell into the canoe in large numbers.

Caiman were sometimes killed after baiting them with a dog tied to a tree, or a duck on a line in the water, or with a piece of meat. *Caiman* were a favorite food of the Canichana who passed a noose over their necks or thrust a sharp stick in their mouth and then killed them with an ax or a spear. According to Eder, land turtles were not eaten, and there were no river turtles. However, turtles are now hunted far up the Río Mamoré. Either Eder was wrong or the river turtles have recently sought spawning beaches farther up river than they did in the eighteenth century.

Domesticated Animals

Domesticated animals were of little importance to the preconquest tribes. The only exception is the hunting dog, and it may have been introduced by the Spanish. The resemblance of the Mojo dog to the Spanish greyhound suggested to Métraux (1942:62) that it had been obtained at an early date during trading trips to Santa Cruz. Nordenskiöld (1924*b*:114) noted that many tribes of the region did not have dogs and that those dogs present were either not of the Indian breed or had been considerably crossed with dogs introduced by the whites. The members of the Solís Holguín expedition of 1617 did not mention Indian dogs.

The Mojo were keeping ducks when first contacted, and this may have been the domesticated muscovy duck (*Cairina Moschata*), which, however, was apparently rare among tropical forest tribes of the Amazon. In 1564 Alemán (1897:198) reported seeing chickens with double chins near the Río Beni; however, Captain Francisco Sanchez Gregorio said that in 1617 the Toros (Mojo) had many ducks but no chickens or other "domesticated" fowls (Lizarazu, 1906:195). The Indians have native names for chickens, so the introduction was probably quite early and is certainly pre-Jesuit.[2]

[2] Nordenskiöld believed the early and widespread presence of chickens in South America was the result of introduction and rapid dispersal in the early sixteenth century. Sauer (1952: 57–60), on the other hand, has suggested that chickens may be a pre-Columbian introduction, as was claimed by Ricardo Latcham for the Araucanian chicken that lays blue and olive-green eggs. Light-blue eggs are laid by some chickens (often black with gold speckled breasts) throughout the Beni and also in Santa Cruz.

Honey and beeswax were collected by the Mojos tribes, but bees were not domesticated. According to Nordenskiöld (1930*b*:208) there was true bee-keeping by the Arawakan Paressí tribe east of Mojos. Guinea pigs, an Andean domesticate, are found in many Indian huts today in the Beni, but there is no evidence that Guinea pigs existed in the area in pre-Jesuit times. Cattle and horses were readily adopted by the mission Indians but not by unacculturated savanna groups. Cattle were treated as wild game by many Indians until recent years.

The savanna tribes used both domestic fowl and wild animals in religious ceremonies and for sacrifice. Francisco del Rosario (1682:836–837) said the Mojo sacrificed a duck to a carved post diety in their temples. Offerings of meat were made to the jaguar spirit (Métraux, 1942:74). Padre Equiluz (1884:35) reported that Padre Zapáta entered a Cayuvava village where sacrifices of rabbits, rheas, and deer were being made before a perpetual fire.

IX. POPULATION

A strong, although not conclusive, argument can be made for a larger population in the Llanos de Mojos when the Spaniards first arrived than exists today. The evidence consists of (1) numerous pre-1700 estimates of population and villages for individual tribes, groups of tribes, and for Mojos as a whole; (2) enumerations of mission Indians in the early eighteenth century long after the savanna tribes had been decimated by epidemic disease; and (3) the indirect evidence of large numbers of earthworks.

Individual Tribes

Mojo.—When first described, the Mojo had unusually large villages. Juan de Limpias reported that on the Solís Holguín expedition of 1617 he visited a village with 400 houses, 90 kitchens, and nine drinking places (Lizarazu, 1906:170). This would give a population of 2,000 if each house averaged five persons. Of 11 villages, the next largest seen by Limpias had 60 or 66 houses each. Other enumerations of the villages, houses, and people of the province of the Toros or Torocosis (Mojo) by members of the same expedition, all recorded 21 years later in 1638, varied as follows: They were told that there were 44 villages in the province, the largest having 700 people with a *barrio* of 100 more, and the other villages averaging 300 people each. They saw six villages with such large populations that they estimated there were over 30,000 Indians. The first village had 280 houses plus kitchens and drinking places. Over 3,000 Indians were seen after entering only one league into the province. There were 36 chiefs in all the province. Traveling one and a half leagues into the savanna they saw seven villages, the largest having 350 houses, 50 kitchens, and 20 drinking places (Lizarazu, 1906: 149, 163–4, 165, 195). In an earlier (1621) account of the expedition Diego Hernández Bejarano (Vejarano) said that only seven villages were seen, with the number of houses indicating about 800 Indians (Finot, 1939:280). Whether he meant 800 in one village or in all seven is not clear. He said that only 50 or fewer Indians actually were seen, but later indicates that all these were in one village. Taking into account faulty memories and reliance on poorly understood Indian informants, it appears that the expedition penetrated only a league or two into the savannas from the east; saw seven or eight villages within this distance, the largest with several hundred houses; saw several thousand Indians, or evidence thereof; and learned

that there were several dozen villages or subtribes under chiefs and a large number of people in the Province of the Mojo.

Sixty years after the Solís Holguín expedition Padre Marbán (1898:132) wrote that the Mojo villages only had 20 to 100 houses each with just a few villages having over 200. He and Padre Castillo (1906:294) both estimated before the first missions were founded that there were only 6,000 Mojo Indians in over 70 villages; one or both of these padres may have made a rough count of villages and people during their travels among the Mojo. Altimirano in 1700 (1891:25) and Eguiluz in 1696 (1884:6) both reported 4,000 Mojo Indians in over 50 villages, their source probably being Padre Orellana (1906:7) who said the same thing in 1687. These figures seem very low for the Mojo in view of (1) the frequent mention of the numerical and cultural importance of the Mojo; (2) the fact that these same padres reported much large populations for other tribes such as the Baure, Movima, and Cayuvava; (3) the earlier reports of large villages and numerous people; and (4) the presence of 19,759 Indians in 1696 in the first six missions founded (Eguiluz, 1884:62), over half of which were Mojo speaking. Undoubtedly, the Mojo Indians, being the first major savanna tribe encountered by the Spaniards, had been reduced considerably by disease and by slave raiding between 1617 and 1687. There was no Spanish settlement in Mojos during this period, and there are few descriptions by exploratory, slave, and missionary expeditions. Until the missions were founded, beginning in 1682, most of the direct contact between the Mojo Indians and the Spanish was in Santa Cruz, where the Mojo brought slaves, cotton textiles, and other products for trading.

A fair minimum estimate of the total Mojo Indian population in the 1690's would be about 15,000: 10,000 in the missions (the majority of the population of Loreto, Trinidad, San Javier, and part of that of San Ignacio); 4,000 known in villages; and probably at least another 1,000 uncounted village Indians. Of the total of 17,500 Indians in eight missions in 1712 Nordenskiöld (1924*b*:17) estimated that "more than 12,000 were probably Mojo." In 1767 there were only 4,000 Mojo Indians in four missions (Hervás, 1800:247). In 1830 there were 8,212 Mojo in the mission towns (Orbigny, 1946:321), and today there are about 5,000. Harold and Mary Key 1961:53–54) estimate that there are now 2,500 Mojo-speaking people in San Ignacio, 50 in San Javier, and an unknown number (probably over 2,000) elsewhere including Trinidad and upper Mamoré tributaries.

Baure.—In 1692 Padre Eguiluz (1884:22) wrote that Padre Barrace had previously counted 75 Baure villages during his travels. In 1712 Altamirano (1891:106) said that there were 124 Baure villages with enough people to support 20 *reducciones* with 2,000 Indians each. This adds up to 40,000 Indians and an average of 322 in each village. Altamirano (1891:124) commented that, despite the difficulties of getting the Baure to leave their villages, the missions of Concepción de Baures, San Joaquín, and San Martín had about 2,000 Indians each in 1708 soon after they were founded. In 1830 Orbigny (1946:321) recorded a total of 5,178 Baure Indians. There are presently from 3,000 to 4,000 Baure-speaking Indians in the Beni (Key, 1961:53) including a large group at the present site of San Joaquín on the Río Machupo.

Cayuvava.—On his first visit to the Cayuvava in 1693 Padre Agustín Zapata was reported to have seen seven villages averaging 1,800 people each, except for one with over 2,000 people. In 1695 Zapata again visited the Cayuvava. He heard news of "la infinidad de gente que habitaba la tierra adentro" (probably also Cayuvava), investigated, and encountered "muchos y muy numerosos pueblos" with more than 1,500 people in each. He reported that many reducciones could be established with over 10,000 or 12,000 people (each?) with less difficulty from flooding than in the other mission areas. All of this was related by Padre Eguiluz in 1696 (1884: 33–6). In Zapata's (1906:25–26) own account in a letter written in 1695 giving "noticias del Paititi," he said that there were five villages within a distance of three leagues, the largest being called the Paititi; that there were 4,000 or 5,000 people in the five villages; and that there were many large villages nearby which he did not visit.

There were 1,400 Cayuvava Indians in Exaltación in 1713 (Maurtua, 1906*b:* map 18); about 3,000 in 1749 (Gonçalves da Fonseca, 1826:82); and 970 in 1832 (Orbigny, 1946:324). Today there are only about 50 Cayuvava (Key, 1961:53), mostly in or near Exaltación, and the tribe is nearly extinct.

Movima.—In the early 1700's Padre Altamirano (1891:150) stated that there were 20,000 Movima in 80 villages. There were only 200 Movima in Santa Ana in 1713 (Maurtua, 1906*b:* map 18), but there were several thousand in other missions. In 1767 there were 2,000 Movima in Santa Ana, 1,200 at San Borja, and 1,200 at Reyes (Métraux, 1942:82—no source). Orbigny (1946:328) in 1830 reported only 1,238 Movima in Santa Ana and none in other missions. Today there are about 2,000 Movima (Key, 1961:

53). There are several hundred Movima living permanently in Santa Ana, and many of those elsewhere consider Santa Ana home and have a second house there. A sketch map made by Robert Judy (1962:75), who is studying the Movima language, shows over 50 sites between San Ignacio and Lago Yachaja that have Movima people.

Canichana.—Padre Zapata visited the Canichana in 1693 and reported finding 48 villages along the Mamoré, with others inland, making a total of 72 villages. He estimated a total of 4,000 to 5,000 people (Eguiluz, 1884: 33). A mission was established at San Pedro in 1695 with 1,200 Canichana Indians, and in 1797 there were 2,544 Indians in the mission (René-Moreno, 1888:495). Today there are only about 50 Canichana (Key, 1961:53), and the tribe is on the verge of dying out.

Itonama.—The Itonama were first described in 1704 by Padre Lorenzo Legrarda, who reported 6,000 of them in 23 villages extending from 20 leagues of San Pedro to 6 leagues of the Baure Indians (Altamirano, 1891: 99). The tribe originally was settled in the mission of Magdalena in 1720 shortly after 2,000 members had been captured by a slave-raiding expedition from Santa Cruz. In 1790 Magdalena had 6,023 Itonama (Chávez Suárez, 1944:401), and in 1792 part of the surplus was moved to San Ramón. Orbigny (1946:328) reported 4,815 Itonama in 1831 in the two mission towns, and at present there are about 3,000 (Key, 1961:53). Thus the Itonama is one tribe that was not drastically reduced in size following Jesuit contact. However, the number of Itonama may well have been greater than the 6,000 reported in 1704.

Other tribes.—There are very few early estimates of population for any other savanna tribes or for the marginal savanna tribes. Padre Zapata reported 7,000 Indians belonging to several pampas nations, which he did not identify, seen on his journeys to the Cayuvava (Eguiluz, 1884:34). The now extinct Tapacura Indians, who were situated just east of Mojos, were mentioned frequently as being a very large tribe. Padre Eguiluz (1884:22) said that Padre Barrace encountered 52 Tapacura villages, and Orbigny (1946:326) much later reported 1,350 Tapacura, of which 300 lived in the forests of the upper Río Blanco and the rest in Cármen de Mojos and Concepción de Chiquitos. Present-day populations of other Beni tribes include approximately 600 Sirionó, 100 Moré, 130 Chácabo, 1,000 Maropa, 5,000 Guarayo, and a fairly large but unknown number of Chimane (Key, 1961:53). The Guarayo are probably now the largest tribe in northeastern Bolivia and are rapidly expanding numerically and regionally.

Total Savanna Population in the 1690's

Table 4 shows a total Indian population for Mojos in the 1690's of 112,259 in over 362 villages, including six missions. These figures are based on Jesuit counts and estimates of varying reliability.

There are three seventeenth-century estimates of the total population of Mojos, but none is for the entire llanos. Based on Indian informants, one of the members of the Solís Holguín expedition of 1617 stated that there

TABLE 4

The Aboriginal Population of Mojos Reported in the 1690's

Population reported	Villages	Tribes	Date	Source
19,759	6	Missions[a]	1696	Eguiluz, 1884:62
4,000[b]	50	Mojo	1687	Orellana, 1906:7
4,500 (4,000–5,000)	72	Canichana	1693	Eguiluz, 1884:33
11,000 (10,000–12,000)	7 plus	Cayuvava	1695	Eguiluz, 1884:36
20,000	80	Movima	1700	Altamirano, 1891:150
40,000	124	Baure	1700	Altamirano, 1891:106
6,000	23	Itonama	1700	Altamirano, 1891:99
7,000[c]	?	Other Savanna Tribes	1694	Eguiluz, 1884:34
112,259 reported.	362 plus		1687–1700	

[a] Loreto, Trinidad, San Ignacio, San Javier, San José, and San Borja. Over half of the mission Indians spoke Mojo or a Mojo dialect.
[b] Combined village and mission Mojo Indians probably totaled at least 15,000 in the early 1690's.
[c] This figure was given by Padre Zapata based on other unnamed pampas nations seen on his journeys to the Cayuvava.

were 30,000 people in the "provincia de los Toros o Paretis" (Mojo) (Lizarazu, 1906:164). Padre Castillo writing about 1677 stated that the Mojo and immediately adjacent tribes totaled over 50,000,[1] not including the Cayuvava ("el gran Paititi"), and possibly neither the Baure, Movima, nor Itonama. Padre Eguiluz (1884:63) in 1696 said that in addition to the 19,759 Indians in the missions there were "70,000 other friendly Indians" who wished to be christianized; this gives a total of nearly 90,000 and presumably there were additional unfriendly Indians.

I would estimate that there were at least 100,000 Indians living in over 400 villages in the Llanos de Mojos in 1690. Several factors have been taken

[1] ". . . son los Mojos y sus provincias confinantes mas de 50,000 almas y muchas más las que con estas se van encadenando" (Castilla, 1906:302).

into consideration. First, the Jesuit figures for the Baure and possibly the Movima may well be excessive. On the other hand, the total for the Itonama is probably too low in view of the later mission figures. Most of the reported population figures apparently are based on village-by-village counts and estimates, and undoubtedly some villages were missed. The Cayuvava figure, in particular, may be low for this reason. The marginal and extinct savanna tribes have not been included in the total reported or even estimated since there are few early population figures for them, and what portion of these people actually lived in the llanos is not known.

Taking the Jesuit figures in Table 4 at face value, allowing for uncounted people and for a decrease after 1690 in the populations of the tribes reported in 1693, 1694, 1695, and 1700, there would have been at least 150,000 Indians in the llanos in 1690. However, in view of the possibility of some exaggeration by the Jesuits, a minimum figure of 100,000 seems a reasonable estimate. This figure is considerably greater than the figures of less than 20,000 Indians in Mojos given by most modern writers for the end of the seventeenth century (Métraux, 1942:55; Steward and Faron, 1959:254; Plafker, 1963:373). These low figures are based on early counts of mission Indians only.

Enumerations after 1696

Since 1696 there have been a number of reasonably reliable counts of the Indians in the various missions; however, there has been little information on nonmission Indians until recent years. Government census data is available for the entire Beni only for the years 1900 and 1950.

In 1696 there were 19,759 Indians in six missions (Eguiluz, 1884:62). In 1713 there were 24,914 baptized Indians in 16 missions (Maurtua, 1906*b*: map 18). In 1737 there were 35,250 Indians in 21 missions (Argamoza, 1906:50). In 1742 there were 30,000 Indians in the Mojos missions (Hervás, 1800, 1:247). In 1767 there were 18,535 Indians in 15 missions (René-Moreno, 1888:17). In 1780 there were 18,295 Indians in 11 missions (Chávez Suárez, 1944:378—no source). In 1831 there were 22,972 Indians in the seven savanna tribes, including both mission and village Indians (Orbigny, 1946:328).

In 1900 there were only 32,000 people reported in the entire Beni (Bolivia, 1902), a figure that is probably too low. In 1950 there were 119,770 people in the Beni, at least three-fourths of whom, or about 90,000, were located in the Llanos de Mojos (Bolivia, 1955). For 1960 the Dirección General de

Estadística in La Paz gave an estimate of 158,000 people in the Beni (Bolivia, 1961), but this may be too high in view of the large number of people who have left the Beni since 1950. I estimate that in 1961 about 120,000 people were located within the boundaries of the Llanos de Mojos for a density of 1.7 per square mile. In 1961 the Summer Institute of Linguistics estimated that the six savanna tribes of Mojos totaled about 13,600 (Key, 1961:53–54).

The increase of mission Indians from 19,759 in 1696 to 35,250 in 1737 and the reports of many deaths from disease in the intervening period indicates that the Jesuits had gathered only a small portion of the savanna Indians into missions by 1696. The Jesuits were still gathering up Indians at the end of the mission period according to Padre Eder (1888:126–131), who wrote a long description of the methods used to round up the *bárbaros*. I therefore estimate that at least 15,000 nonmission Indians can be added to the 1737 figure, giving a total of 50,000.

The population estimates for the Llanos de Mojos in the 1690's (90,000—Eguiluz; 100,000—Denevan; 112,000—Table 4) approximate the present population; however, the precontact population of the sixteenth century undoubtedly was considerably larger than the population of the 1690's.

Epidemic Disease and Population Decline

There was a very rapid population decline in most of the New World during the sixteenth century, a decline resulting more from introduced European diseases than from slavery and outright killing. Epidemics were especially ravaging where Indians were congregated in large towns or villages. One of the most striking examples of this depopulation was in central Mexico, for which Borah and Cook (1963:4, 88) have documented a decline from 25.2 million in 1519 to 2.65 million in 1568 to 1.075 million in 1605.

The Mojos tribes were first definitely exposed[2] to Spaniards who probably carried alien diseases during the *entrada* of the Figueroa expedition of 1580 and other expeditions of the late sixteenth century. The Indians continued to be periodically exposed to new diseases by explorers and missionaries and during Mojo trade expeditions to Santa Cruz until the first Jesuit mission was established at Loreto in 1682, after which contact was

[2] Although there is little evidence, epidemic diseases undoubtedly preceded Europeans in the interior of South America long before there was direct contact.

continuous. Marked population decline from disease and other effects of the Spanish conquest of the Bolivan Oriente was probably well under way in the early seventeenth century, if not earlier, was most severe during the early mission years, and continued throughout the eighteenth century. Since 1831 the population of the savanna tribes has been roughly stabilized at between 10,000 and 20,000, with the low point probably being reached during the height of the rubber boom at the end of the nineteenth century.

There are numerous references in the early Jesuit accounts to the disastrous effects of disease and poor health on the Indian population of Mojos. Epidemics of common European diseases, to which the Indians had no immunity, were especially destructive. In 1687 Padre Orellana (1906:23) said that there had been many deaths from a smallpox epidemic that already had lasted seven years; "all that remained of many villages was their name," and others had been greatly reduced in size. Orellana also said that just before Padre Julian Aller left Mojos (probably in 1670) an epidemic of smallpox killed 1,000 Indians plus an additional undetermined number after his departure, so that the number of Indians reported by Aller (no figure given) was greatly reduced by the time other Jesuits arrived in 1675 and after.

In 1676 Padre Marbán (1898:136) noted that the Indians suffered from many diseases and did not live very long. Padre Zapata (1906:26) in 1695 said there was continuous sickness among the tribes of the lower Mamoré. Padre Altamirano (1891:46) wrote in 1712 that the Indians of Mojos seldom lived to the age of 60 due to diseases such as smallpox, measles, and "fevers" (malaria). Padre Eder (1888:167) said that smallpox had been introduced by the Spaniards and that it almost wiped out several villages. The ailments most often mentioned in the later accounts are measles, smallpox, influenza, malaria, tuberculosis, dysentery, and helminthic diseases.[3] Epidemics of Old World diseases still periodically kill many Indians in the Beni. In 1961–1962 measles killed several Sirionó Indians at Eviata, and an epidemic of whooping cough in Ascensión killed over 50 Guarayo children.[4] Malaria, however, has now been greatly reduced in eastern Bolivia.

[3] Measles and smallpox are post-Columbian in the New World, and malaria and yellow fever probably are.

[4] Indigenous diseases are also ravaging. Between 1961 and 1963 hemorrhagic fever, known as "bleeding fever" and as the "Black Typhus of the Beni," killed over 200 people in the towns of San Joaquín and Orobayaya.

Estimated Pre-Spanish Population

The estimated minimum figure of 100,000 Indians in Mojos in 1690 is not excessive, and is more likely low, in view of the 35,000 to 50,000 Indians still present in 1737 after 30 to 50 years of concentration within missions. Assuming at least 100,000 in 1690 and recognizing a marked decline since the first direct Spanish contact in 1580, it seems likely that there were several hundred thousand Indians in Mojos in the late sixteenth century and possibly as many as half a million.

A postulated population decline from 500,000 in 1580 to 50,000 in 1737, or 90 percent in 157 years, compares with a 90 percent drop in the population of central Mexico in only 49 years (1519–1568). The Mexican Indians, however, were subjected to much more intensive pressures and exposures to disease. Woodrow Borah (1964:382) has estimated that the post-Columbian decline of population in the New World averaged about 90 percent within the first 100 years of European contact. A similar decline in 157 years in Mojos would not seem unreasonable in view of the small amount of contact for the first 100 years. Henry Dobyns (1966) has suggested an average New World depopulation ratio of 20 to 1 from immediately prior to discovery to the start of population recovery. The low point for the Mojos tribes of about 10,000 would provide a discovery figure of 200,000; however, this figure seems too low in view of the 100,000 figure for the 1690's. I suggest a compromise figure between 200,000 and 500,000 of 350,000, or an average precontact population density of five per square mile for 70,000 square miles.

The presence of tens of thousands of drained fields and hundreds of miles of causeways and canals supports a claim for the existence of very large and locally very dense pre-Spanish populations. Although the population estimates given here are indeed tenuous, it can be said with some certainty that the population of Mojos in the sixteenth century greatly exceeded the present population.

X. ABORIGINAL EARTHWORKS ELSEWHERE

In several of the periodically flooded regions of tropical America, other than the Llanos de Mojos, aboriginal people raised mounds, crop rows or montones, and causeways to provide dry ground for settlement, agriculture, and roads. In this chapter a brief review is presented of these other drainage works in South America, along with a few significant examples from North and Central America and from the Old World. This review will serve not only to indicate possible sources of origin for the Mojos features but also to provide insight into the possible technology and purpose of these structures.

Ridge and Mound Cultivation

Poorly drained land may be farmed in several ways: (1) by cultivating paddy rice; (2) by irrigating in the dry season; (3) by cropping at the start or end of the wet period when flooding is not serious; (4) by constructing dikes and drainage ditches; (5) by mounding and ridging. In the tropics, paddy rice cultivation is the most common practice, but is limited mainly to Asia. In the large, seasonally flooded savannas of South America the only major example of any type of cultivation today is at Calabozo in the State of Guarico in the Venezuela llanos, where wet rice is grown during the dry season using irrigation and intensive fertilization. Mounding and ridging were and still are practiced in several areas of wet savanna in the tropics, and there are a number of examples of both in South America in addition to the spectacular crop platforms in the Llanos de Mojos. Ridge and mound fields are also found in well-drained grasslands, semideserts, and forests in both temperate and tropical latitudes, and consequently such agricultural landforms were not necessarily constructed because of poor drainage conditions. They are also produced by certain methods of irrigation, plowing, and other techniques of soil management.

Montones or mound fields.—Regularly spaced mounds, larger than the common maize mounds of the Americas, were piled up for crops on Hispaniola, in northwestern Argentina, in Colombia, in Mojos, and are currently common in central Africa.

On Hispaniola the Tiano Indians used digging sticks to heap up what

the Spaniards called "montones."[1] Each montón was about 9 to 12 feet in circumference, about 3 feet high, and flat on top. They were arranged in rows and were about 2 or 3 feet apart. Six to ten cuttings of manioc or five or six cuttings of sweet potatoes were planted in rows along the top of each montón. The possible functions of such mounding include easier collection of the mature tubers, concentration of topsoil, loosening of the soil, weed control, longer preservation of unharvested manioc tubers, and improvement of drainage (Sturtevant, 1961:73). Many of the mounds were apparently on forest sites, but Bartholome de las Casas (1909:12) noticed that savannas also were cultivated. Casas (1909:28) mentioned fields that measured 20,000–30,000 by 5,000–10,000 montones, which, even if an exaggeration, is suggestive of large numbers of montones and a large amount of food production.

At Pucará in the Lerma Valley of Salta (Argentina) members of the 1901–1902 Erland Nordenskiöld expedition to South America found a field of about 1,000 small circular mounds laid out in an orchard pattern. Eric Boman (1908:1:279–293), who later found two other groups in the same area, was at a loss to explain them and suggested that they might be ceremonial. On the basis of subsequently seeing similar mounds in Rhodesia, Eric von Rosen (1924) believed those at Pucará were built for crops on poorly drained ground. The mounds were one-half meter in height and 2.0 to 2.7 meters in diameter. Around each mound there was a single or double ring of stones which may have served to reduce erosion. One of the groups was encircled by a ditch and embankment, and nearby at a slightly lower elevation were what seemed to be canals and reservoirs for irrigation. The site is at an elevation of 1,250 meters, is flat, receives 500–600 mm of precipitation, has a scrub and short grass vegetation, has sandy soils, and is periodically flooded during the short rainy season.

In the Colombian highlands rows of crop mounds were built by the Muiscas and are still built on poorly drained grassy plains such as the Sabana de Bogotá and on grassy slopes with heavy clay soils. The mounds are about 30 cm high and one meter in diameter (Eidt, 1959:386, figs. 7, 8).

In Africa mounding is practiced in many areas on grasslands that may or may not be poorly drained. In Ghana high mounds on "derived" savannas are planted with yams; fertility is improved by a vegetation

[1] See Casas (1909:28); Oviedo (1851:1:269–274); and also Sturtevant, (1961) for discussion and additional sources.

mulch on top of each mound (Wills, 1962: pl. 1a). In west African savannas, as noted by Nye and Greenland (1960:3), the general practice is to hoe up two-foot-high mounds for yams, and then destroy the mounds and form low ridges for maize and sorghum the following year. On grassland in the former Belgian Congo small mounds called *matuka* are heaped up for manioc and other crops (Gourou, 1953: pl. 23). On Rhodesian grasslands large manioc mounds about 2 feet high and 8 to 10 feet in diameter and flat on top with lumps of clay around the bases to reduce erosion were observed by Eric von Rosen (1924: fig. 3).

Mounding serves to protect seeds and young plants from being washed away during heavy downpours and temporary flooding and breaks up grassland sod and hardpans. Even on forest soils slight mounding of individual plants is practiced throughout the tropics and was characteristic of the Indian maize-beans-squash complex of eastern North America. Rows of mounds (montones) built up around maize plants are still conspicuous on the slopes of the western Guatemalan highlands (McBride, 1942:261, fig. 9).

Raised, ridged, and ditched fields.—Fields consisting of long, parallel ridges or flat-topped platforms and separated by ditches have been built in various parts of the tropics for drainage and for improving the cultivability of grassland soils.

In the Andes crop ridges or *eras* are found from Colombia to Bolivia, usually on grass-covered fields both on the slopes and on the flat (West, 1959). In Peru and Bolivia ridges are associated with potato cultivation on the *puna* mainly above 10,000 feet. In Colombia ridges are used at similar and lower elevations for potatoes, *oca, ullucu, arracacha,* maize, and manioc. Furrows are cut in grassland with the *taclla* or footplow in Peru and Bolivia and with the *chuzo* (a type of hoe) in Colombia. The blocks of sod are placed grass down and crushed with clubs on an interfurrow strip to form planting ridges two to three feet wide and up to a foot in height. Usually the eras are cropped for one or two years and are fallowed for two or three years, and then after several cycles they are abandoned.

Robert West (1959:280–281) and James Parsons (1949:34–35) report large numbers of old, possibly pre-Columbian, ridges at elevations of 5,000 to 10,000 feet in the area of Popayán, the Quindío, and the Sabana de Bogotá. Some of these ridges were described in the sixteenth century by

Spaniards who called them *camellones*. They are five to six feet wide and are divided into blocks or planting beds by transverse ditches. Both old and modern ridges are built parallel to the slope, but they experience little erosion, probably because of the resistance of heavy clays in the ditches. The ridging seems to be done to improve drainage and to break up the heavy sod soils. West suggests that the mixing of the soil with plant material improves the fertility. Remnants of numerous and large ridged fields of apparently pre-Columbian origin are found on flat, poorly drained land along the west side of Lake Titicaca; some of the field patterns are remarkably similar to those in western Mojos only 150 miles to the east (Smith, Hamilton, and Denevan, n.d.).

In the lowlands of South America numerous remains of linear drained fields are found in Colombia, and there are historical reports of such fields in Venezuela. Remnants of ridged fields also have been reported in savannas in Surinam; however, almost nothing is known about them (T. Van der Hammen, Geological Institute of Leiden, personal communication).

In the northern lowlands of Colombia there are thousands of ridged fields in the seasonally flooded plain of the lower Río San Jorge, a tributary of the Río Cauca, near the towns of Ayapel and San Marcos. These fields have only recently been described by Parsons and Bowen (1966), who estimate that they total at least 80,000 acres spread over an area twice as large. The Mojos fields, in contrast, are much more dispersed. The San Jorge field patterns do resemble some of those in Mojos; however, there are also significant differences. The San Jorge fields consist of three main distinctive types: ridges and swales on natural levees arranged at right angles to the stream channels; checkerboard patterns of blocks of short parallel ridges; and clusterings of loosely parallel ridges without orientation to natural levees. The fields vary in length from a few yards to nearly a mile, average about 20 feet in width, and vary from a few inches to six feet in height. The fields were never mentioned by the first Spaniards in the area nor by later settlers, and Parsons and Bowen believe the fields are therefore preconquest in origin.

In the Orinoco llanos, Castellanos (1955:1:539) in the sixteenth century said there were *labranzas viejos camellones* in association with causeways. No remains of such fields have been found; however, they may yet be revealed by careful study of air photos. Padre Gumilla (1945:430–431) in

the eighteenth century observed tribes of the Orinoco llanos cultivating savanna using *macanas* (spades or wide-ended digging sticks) to throw up earth on both sides of a trench in wet places. The grass was covered up with the excavated earth and then maize, manioc, other tubers, and peppers were planted.[2] Yields were much smaller than those on forest sites. Gumilla (1945:432) also said that the Otomaco Indians between the Orinoco and Río Apure planted crops on the grassy margins of lagoons as the lagoons dried up.

A unique form of wet-land cultivation has been practiced in the Valley of Mexico from possibly the first century A.D. up to the present (Coe, 1964). This is the system of *chinampas* (also called "camellones") or "floating gardens" of lakes Chalco and Xochimilco. A chinampa is a platform or garden bed up to about 300 feet long and 30 feet wide consisting of layers of mud and aquatic plants built out into the lake but anchored by trees and stakes to the lake bottom. Plants were transplanted from seed beds and crop production was nearly continuous. Chinampa villages by the lakes were able to supply large amounts of food to the urban centers of the Valley of Mexico. Aerial photographs and an Aztec map of chinampas (Coe, 1964:92–93) show patterns of uniform parallel fields similar to some of the Mojos field patterns.

The most interesting raised fields in the Old World tropics are those of Oceania.[3] In areas of lowland swamps and grassy slopes in New Guinea and New Caledonia, gardens of yams, taro, manioc, and other crops are arranged in long parallel ridges divided by drainage ditches. In the New Guinea highlands, between 5,000 and 10,000 feet above sea level, raised gardens are made for sweet potatoes, the staple crop, on both slopes and in wet, level grasslands. In the Wissel Lakes District and the Baliem Valley, drainage ditches up to three feet deep surround platforms six to ten feet square, and a deeper ditch usually drains each group of fields. Before digging begins, tall grass is uprooted and placed in piles at the site of each ridge. While this compost is decomposing a second growth of

[2] "Los bárbaros que vivían y los que aún viven en campos limpios, como no tienen el embarazo de las arboledas y bosques, consiguen sus frutos, aunque en menor cantidad, con menos trabajo; porque con las palas de macana que dije levantan la tierra en los sitios húmedos de uno y otro lado del surco, tapando la paja y el heno con la tierra extraída del uno y del otro lado, y luego siembran su maíz, yuca o manioca y otras raíces, y en todas partes gran cantidad de pimiento. . . ." (Gumilla, 1945:430–431).

[3] See Barrau (1958), Brookfield (1962), and Brookfield and Brown (1963:41–54) for descriptions of raised gardens in Melanesia and New Guinea, as well as photos, sketches, and additional sources. Originally, the only implements used were simple wooden digging sticks.

grass is grown, cleared, and added to the pile. Ditches are then dug around each pile and the earth is thrown on the rotting straw. Periodically the organic mud in the ditches and additional grass compost are placed on top of the gardens. Cultivation is continuous for several years. The resulting fields are small, closely spaced, and either square or rectangular, but the aerial pattern is somewhat similar to that of the ridged fields of Mojos shown on plate 19 (Barrau, 1958: fig. 17a). Large population concentrations were and still are sustained in New Guinea using such intensive systems of cultivation. In the Baliem Valley there were 60,000 people with a density of over 100 per square mile in 1941, and in part of the Wahgi Valley there is a density of at least 450 persons per square mile (Carneiro, 1961:59). In Africa, savanna fields are sometimes ridged, especially for manioc and yams (Wills, 1962: pl. 1a); however, mounding seems to be more common.

Some of the drained fields of Mojos closely resemble the "ridge-and-furrow" fields of medieval England, remnants of which can still be seen, especially in the Midlands, where the parched grass on former ridges stands out in the dry season.[4] These old ridges were the result of the method of plowing employed and were not intended to improve drainage. Elsewhere in Europe, however, fields were ridged for drainage. The Celtic "lazy-bed" system of crop ridging, for example, was used in poorly drained areas of Ireland. Since the eighteenth century lazy beds in Scotland and Ireland have been used for potato cultivation; the raised planting beds are formed by taking sod from the furrows and placing it grass down on a layer of manure (Salaman, 1949:232–234). Groups of long, straight or curved ridged Indian fields ("garden beds") also have been described in the grasslands and woodlands of North America, but very little is known about their age or how they were constructed or used. At least 180 garden bed sites have been reported in Wisconsin and Michigan (Fox, 1959).

It has often been assumed that the grasslands of the world were not settled and cultivated until the plow became available for breaking up the grassland sod. Grasslands were cultivated, however, without plows in the Andes, Mojos, lowland Colombia, Africa, New Guinea, Ireland, and elsewhere as pointed out above. Furthermore, seasonally flooded or poorly

[4] Compare plate 18 of Mojos fields with the aerial photos of old "ridge-and-furrow" fields in England in Beresford and St. Joseph (1958:21–49).

drained grasslands were cultivated without complete drainage or protective diking. The means employed, still in use in some areas, generally involved cutting, turning, and breaking up the sod and heavy soil with digging sticks or hoes, piling the earth up into mounds or ridges, and mixing vegetable compost into or on top of the raised earth. The methods used to construct and cultivate these fields are indicative of possible aboriginal practices in the Llanos de Mojos, where old drained fields are common but were never observed by Europeans being constructed or being used.

Causeways

Causeways or elevated roads of either earth or stone are found in several parts of Latin America, mainly where drainage is poor. The best-known causeways are in the Andes, the Maya lowlands, and in the Orinoco and Mojos savannas.

Andes.—In the Peruvian and Bolivian Andes, causeways were part of the Inca road system (Rowe, 1946:230; and Tschopik, 1946:531). Rowe reported (1946:230) that, "in marshy places or in areas subject to innundation, it [the highland road] ran on a causeway build up of sod blocks. The causeways were 15 to 22 feet (5 to 7 m) wide and 3 to 6 feet (1–2 m) high. They were sometimes paved with flat stones, and at intervals had culverts roofed with stone slabs." There is a good example of an Inca causeway crossing the marshes of the plain of Anta near Cuzco, which is ten kilometers long, one meter high, and seven meters wide (Cieza de León, 1959:135, footnote by Von Hagen).

Maya lowlands.—Many of the Maya roads (*sacbeob*) were raised causeways constructed of limestone blocks with limestone gravel on top. They were 2 to 8 feet high, about 15 feet wide, and varied in length from less than one mile to the 62-mile-long road from Coba in Quintana Roo to Yaxuna in Yucatán (Morley, 1956:309). They pass through both forest and swamp and are very straight except for slight changes in direction in order to pass through villages. Sixteen major roads were reported by Morley, and these and others were mapped by Von Hagen (1960:186–187). The Maya causeways show up clearly on aerial photographs (Morley, 1956: pl. 37b), and future photo studies will undoubtedly turn up additional causeways in Yucatán, Campeche, Quintana Roo, Petén, and Honduras.

Llanos del Orinoco.—The causeways of the Orinoco llanos, recently de-

Cruxent (1952:280–286), have long been known. They ... to those of Mojos, those of both areas being made of earth ... arable ... flooded savanna lands. The sixteenth-century writer Juan ... ably ... said that the Sedeño expedition of 1536 encountered "a ... llanos ... which was over 100 leagues long and had vestiges of old ... *calzada*, ... ridges of former fields."[5] Fray Jacinto de Carvajal wrote ... its an... er Miguel de Ochogavia told him that on his expedition ... explo... untered Caquetío Indians fleeing from Coro who had built ... the enc... ks in the llanos.[6]

... earthw... 2:285) doubts that the tribes first encountered in the llanos ... nt (1... ds were responsible for the calzadas and other earthworks; ... Spanis... subsisted mainly by hunting, gathering, and fishing and ... Indians ... low cultural level, therefore scarcely capable of the organ... ... a ver... ssary to build these causeways." However, the llanos tribes ... (Jir... , and others) in the sixteenth century were engaged in ... , Ca... ive struggles against one another, and their true socio... ... disrup... ion is not known.

... ic sit... on Humboldt (1852:2:96) during his journey through the ... antler... in 1800 observed causeways near Barinas: "A fine road ... llan... d near Hato de la Calzada, between Varinas and Canagua, ... discov... ng, made before the conquest, in the remote times, by the ... ques ... causeway of earth fifteen feet high, crossing a plain often ... It is ... d nations farther advanced in civilization descend from the ... d. ... Truxillo and Merida to the plains of the Río Apure?"

... ains of ... ants of causeways are found in the llanos states of Barinas, ... ay ren... nd Apure. Four causeways in Barinas are described by ... sa, ...) as follows: (a) Calzada de los Mochuelos near Torunos, ... nt (19 ... ng, 7 to 8 meters wide, and a maximum height of one-half ... meters ... alzada de Paez near Hato de la Calzada and the Río

(b) ... n de su jornada
... mas andadera,
... guas anegada
... en su manera,
... na calbada,
... ien leguas duradera,
... uas poblaciones
... camellones."
... 1955:1:539)

... adas como empinadas çeyuas y hobos, constituydos estos y aquellas en unas ... manos compussieron las troppas inmenssas de yndios caquetios que se ... llanos cuando la venida de los espanoles primeros tomaron tierra en ... al, 1956:117.)

Tocoporo, 5 kilometers long, 13 to 25 meters wide, and 1 to 2 meters high; (c) Calzada del Chaparral near Caño del Oso, four branches with lengths of 2,000, 1,500, 80, and 60 meters, an average width of 10 meters, and 1.5 to 2 meters high; (d) Calzada de Ojo de Agua between Pedraza and Hato de la Calzada, about 200 meters long, 1.8 meters maximum height, and an irregular width. These causeways are on the higher parts of gently rolling ground subject to flooding, and some have excavated trenches beside them. They are comparable in length and height to those of Mojos but are significantly wider than the Mojos causeways, which seldom exceed eight meters. Causeways are not nearly as numerous in the Orinoco llanos as in the Mojos llanos.

Cruxent believes the Barinas causeways were built because of the seasonal flooding and may have served (1) for roads; (2) for settlement sites, as is indicated by the remarks of Castellanos and by the presence of potsherds; (3) for cultivation, as is suggested by the mention of crop ridges (camellones) by Castellanos; however, these ridges may not have been on top of causeways; and (4) for hunting preserves, since game seeking refuge on the high causeways during floods could be easily hunted at a time when game was scarce.

Elsewhere.—Causeways were built by Indians in areas immediately adjacent to Mojos. There are causeways in the large savannas west of the Río Beni (east-northeast of Ixiamas and in the area of 67° 30′ W, 13° 05′ S); through both forest and savanna in the Guarayos Indian area of the upper Río Blanco between Mojos and Chiquitos; and in the Paressí Indian area in the savannas between the upper Rio Guaporé and the Serra dos Parecís in Mato Grosso. Few details are available for these causeways. Those of the Paressí, an Arawak tribe that had a dense population and impressive farms, were wide and straight and connected villages (Métraux, 1942:164). Some of the causeways west of the Río Beni are over a mile in length, as measured on aerial photographs. In Guarayos many of the causeways were built by Franciscan missionaries in the nineteenth century.

In a summary section of the *Handbook of South American Indians* (1949:54), Wendell Bennett said that the Warrau Indians of the Orinoco delta built "banked roads," but this fact is not mentioned in descriptions of the Warrau elsewhere. According to Friar Gaspar de Carvajal, the Orellana expedition down the Amazon in 1541 encountered "many roads

and fine highways . . . more like royal highways and wider. . . ." (Toribio Medina, 1934:202). Parsons and Bowen (1966) mention reports of a few causeways in the Río San Jorge region of northern Colombia. Various tribes elsewhere in the tropical lowlands of South America built roads, and undoubtedly some sections were raised as causeways.

The evidence is insufficient to postulate a diffusion of causeway building to Mojos and nearby areas from either the Andes or the Orinoco llanos. On the other hand, the apparent rarity of causeways in the Old World tropics suggests that they are not an "obvious" independent invention in poorly drained regions, and this fact supports the likelihood of diffusion of causeway building from one part of the Americas to another.

Habitation Mounds

Most of the past and present peoples living in the poorly drained lowlands of tropical America have sought locations for their houses and villages on naturally high ground that is seldom or never under water. Some tribes, however, placed their houses on pilings and, in a few instances, on large artificial mounds.

Artificial earthen mounds are found throughout the Americas. Thousands of them are found in the Ohio and Mississippi valleys and the southeastern United States, and others are scattered through Middle and South America. Most of these mounds were built for burial purposes or for temples and were not associated with poor drainage. Others are accumulations of settlement refuse. Mounds were raised specifically for habitation sites in areas of "wet" savanna on Marajó Island at the mouth of the Amazon, in Venezuela, and in the Llanos de Mojos in Bolivia.

Marajo Island.—The archaeology of the mounds of Marajó Island has been studied by Betty Meggers and Clifford Evans (1957). Over 100 artificial mounds are known to exist on the island, the majority being habitation sites and the remainder cemeteries. All occur within a circular area about 100 kilometers in diameter centered on Lago Arari in the eastern part of the island, a region of campo (grassy savanna) and seasonal flooding. All the mounds have artifacts belonging to what Meggers and Evans have designated the Marajoara culture. This culture, which is noted for its elaborate pottery, apparently migrated to Marajó from up river, possibly from the montaña of Colombia-Ecuador where somewhat similar ceramics have been found, several hundred years before the arrival of

Europeans. Most of the mounds are located near rivers or lakes. The habitation mounds range in size up to 250 feet in width, 300 feet in length, and 20 feet in height, while the cemetery mounds are considerably longer and are as much as 35 feet high. The habitation mounds are oblong in shape, were increased in size while in use, and probably supported large communal houses with dirt floors.

Venezuela.[7]—In the Orinoco llanos in the area of the causeways near Caño del Oso in Barinas there are several artificial mounds containing pottery. One is 7 to 8 meters high and about 100 meters in diameter. Smaller mounds occur near Cazorla in Guarico and elsewhere in the llanos. In the Lake Valencia area there are numerous mounds ranging in size up to 3 meters in height, 30 meters in width, and 100 meters in length. The llanos mounds ordinarily do not contain burials, but those of Valencia were used both for cemeteries and for dwellings. All the sites are or were subject to inundation. Those of Valencia are on what was once part of the lake bed and consist of both refuse accumulation (possibly under pile dwellings) and intentional mounding of layers of clay and humus.

Elsewhere.—The Guató Indians, an aquatic tribe with little agriculture, which inhabited the seasonally flooded savannas at the divide between the upper Río Paraguay and the upper Rio Guaporé, built large mounds (*aterrados*) on which were grown groves of acuri (*Attalea*), a palm with edible fruit and nuts. Two Guató mounds near the Caracara river excavated by Max Schmidt (1914) measured 140 meters by 76 meters and 52 meters by 45 meters; both were about 2 meters high. They were relatively free from flooding and formed forest islas surrounded by grassland. The mounds contained simple pottery, and their main function may have been for settlement sites. Artificial Indian mounds in the Brazilian Pantanal were mentioned without details by Herbert Wilhelmy (1958:65). There are large numbers of artificial earth mounds, either settlement sites or graves, in the San Jorge floodplain, some covering several acres in area and raising as much as 25 feet (Parsons and Bowen, 1966).

Mound dwelling is not known elsewhere in areas subject to flooding in South America; however, there were and still are other means of adapting, such as pile dwellings, which are especially common in Colombia and Venezuela and are also built by the Shipibo, Conibo, and Piro Indians in eastern Peru. The Warrau of the Orinoco delta used pile dwell-

[7] See Cruxent and Rouse (1958:1:183–201) and Kidder (1948:419–421).

ings in the sixteenth century, but in the nineteenth century they were building house platforms consisting of two layers of tree trunks and an additional layer of clay (Kirchhoff, 1948:872). In the Atrato Valley of Colombia pile dwellings were used, but the Toro tribe there was reported to have built houses in trees during flooding (Hernández de Alba, 1948: 315).

XI. CONCLUSIONS

Origin and Fate of the Savanna Chiefdoms

Some of the peoples of Mojos built flood-free sites for settlement, communication, and cultivation and had elaborate crafts, methods of farming seasonally flooded grasslands, and relatively dense populations and large villages. At the time of Spanish contact three savanna tribes—the Mojo, Baure, and Cayuvava—could be classed as "chiefdoms"; that is, intermediate in social development between tropical-forest villagers and Andean civilizations. These and possibly other savanna chiefdoms were responsible for the various types of earthworks and for savanna cultivation. However, there is insufficient evidence for determining the origins and affinities of the archaeological and historical cultures of Mojos, or to indicate whether the ideas and technology for building the earthworks were developed locally or were introduced directly or indirectly from elsewhere. Diffusion certainly is suggested by the existence of features similar to those in Mojos in both the Andes and in the northern South American lowlands. Quite possibly, Arawak-speaking tribes migrating from Venezuela played a major role.

Origins.—It is not known for certain who the savanna farmers of Mojos were. Of the tribes encountered by the Spaniards, the three chiefdoms seemed most capable of building numerous and large earthworks and draining savanna fields. The Spaniards observed the Mojo and Baure using causeways and the Baure using mounds for settlement, but they did not report savanna cultivation anywhere in Mojos. Of the chiefdoms only the Cayuvava were found in an area of residual savanna fields. The Arawakan Mojo were found on the margin of the fields in southwestern Mojos, but they may have moved out of the main area of fields before the arrival of the Jesuits there in the late seventeenth century. On the other hand, savanna farming in western Mojos may be quite old and the work of tribes that deteriorated, were wiped out, or were displaced by the historical tribes either before or during the sixteenth century.

To summarize the problem of cultural origins in Mojos, there are several sets of contrasting features that can be only partly associated with one another: (a) three main ceramic styles: Lower Velarde-Chimay, with modeling and incision and monochrome painting; Upper Velarde-Hern-

marck, with polychrome painting; and Masicito, with fine-line incision and punctation; (b) an emphasis on sweet manioc, an emphasis on bitter manioc, and a possible emphasis on maize; (c) simple farming people with small villages and chiefdoms with large farms and large villages; (d) late-arriving Arawak-speaking tribes and older tribes speaking unclassified languages; (e) a variety of earthworks spread throughout the llanos but with drained savanna fields mainly west of the Río Mamoré. Once these features within Mojos are correlated, it will be easier to seek origins of traits and tribes outside Mojos.

Decline—It is not yet possible to say whether the engineering and food-producing achievements of the savanna tribes of Mojos and elsewhere were terminated by an inability to cope with the environment, by the appearance of Europeans, or because of other factors such as warfare.[1] Consequently, any "ecological" explanations are premature. Arguments can be made for both pre-Spanish and post-Spanish abandonment of the earthworks and savanna farming in Mojos. George Plafker (1963:377) believes that the earthworks are even older than the tribes originally found in Mojos by the Spaniards and that they were built by some unknown people that disappeared. He reasons as follows:

> (1) They [the earthworks] are far too extensive to have been made by the small number of Indians found by the Spanish conquerors; (2) they represent a much more advanced type of agriculture than the "slash and burn" technique in use by these Indians since the conquest; (3) they occur in areas distant from most of the main tribal centers of population; (4) the present Indians, as far as is known, have no knowledge of who made them or how old they are; and (5) at least some of them antedate much of the forest that now covers large tracts of formerly open land.

Each of Plafker's points deserves further comment. (1) There were many more Indians at the time of conquest than "less than 20,000" (Plafker, 1963:373), a figure obtained from Métraux, who in turn based it on the Eguiluz figure of 19,759 Indians in six of the missions in 1696. (2) While the types of drained-field cultivation employed were more complex than slash-and-burn agriculture, the techniques used are or were known to numerous groups of aboriginal people in the humid tropics, including South America. (3) The main tribal centers in Mojos in the sixteenth

[1] In the Orinoco llanos the decline of advanced savanna cultures could well have resulted from the warfare between Carib, Arawak, and other tribes (Cruxent, 1955:85). The demise of the mound builders of the Marajó Island savannas has been attributed to environmental limitations by Meggers and Evans (1954), but this is not an entirely satisfactory explanation.

century are not known with certainty. (4) It is true that remnants of the Mojos tribes know nothing of the earthworks, but these tribes have few legends or oral traditions that antedate the Jesuits. (5) The Nuevo Mundo fields in all probability preceded forest, but this does not necessarily indicate great age.

Plafker goes on to suggest that a climatic change could have resulted in greater flooding and thereby terminated the cultivation of savanna fields. There is no evidence, however, that there has been a significant change in climate or in the amount of flooding in Mojos since the various earthworks were built (see chap. I). Nevertheless, several successive years with high floods of a magnitude that still periodically occurs could prevent savanna farming and result in starvation, population decline, and cultural displacements and deterioration. Such disasters probably did occur,[2] but to state with certainty what the permanent effects were on the Indians is not possible.

Finally, we know that in the seventeenth century, causeways, canals, and mounds and possibly drained fields still were being used and that the Mojo, Baure, and Cayuvava were probably capable of building such works. What is not known, however, is whether these savanna cultures were declining at the time of contact or if they had been preceded by other causeway and mound builders and savanna farmers. Archaeology, hopefully, will someday provide answers to these questions.

Summing up the evidence, we can say that some types of earthworks were still being constructed and used in the seventeenth century, although their "golden age" may have been earlier; that earthworks were built by the tribes found by the Spaniards, although other tribes may have been responsible for older earthworks; and that earthworks and possibly savanna farming were abandoned because of the effects of the Spanish conquest (although earthworks undoubtedly were also abandoned earlier for various reasons.

Modification of the Physical Environment

The aboriginal savanna tribes of Mojos left a lasting imprint on the landscape that is much more conspicuous than that of native peoples else-

[2] High floods also inundate forest farms and destroy crops. This was one of the biggest problems of the 1947 Trinidad flood. Gallery-forest farms are always in danger of ruin from flooding. Padre Orellana (1906:18) wrote that "floods enter the *chacras* destroying the *yuca* . . . which cannot be replanted until the floods recede—a great disaster."

where in the tropical lowlands of South America. Although nothing remains of conventional structures, the results of burning and clearing, the building of earthworks, and the digging of canals have left many visible scars and subtle influences on the natural habitat.

Vegetation.—The Mojos savannas undoubtedly were increased in size as a result of Indian activities. The clearing of forests for farming and frequent burning to drive game and for other reasons converted much forest into scrub savanna; however, most of the grassy savannas seem to be the natural result of seasonally alternating flooding and desiccation. After the Jesuit conquest there was less pressure on the forests because of a smaller Indian population, but artificial savannas were maintained by the continuation of burning. On the other hand, earthworks of all types provided sites with sufficient drainage and some fire protection to permit the invasion of woody vegetation where previously there was only grass. Frequently the shapes of patches of trees identify the configuration of mounds, artificial islas, raised fields, and causeways.

Relief.—Although only a few feet or less in height, the old earthworks provide relief features that are often clearly recognizable both on the ground and from the air, especially during flooding when surrounded by water. These features were and still are important because they are mostly free from flooding, and therefore, they are of value to man and his livestock and have different vegetation, soils, and wildlife than terrain subject to flooding.

Soils.—In general the soils of artificially raised features subject to little or no flooding show some profile development in contrast to sites subject to flooding and deposition, which have young alluvial soils without profiles. If a raised feature is forested the soils are usually deep and have a good organic topsoil, but if grass-covered, the soils may now be mottled with a hardpan near the surface and a low humus content. The fertility of the soils on mounds that served as settlement sites may well have been improved by the accumulation of ash and organic refuse. No soil samples were taken of such sites; however, six of the nine artificial mounds that I observed had crops growing on top of them or at their edges (see table 2).

Wildlife.—Raised earthworks not only differ from low ground in soils and vegetation, but also in wildlife of all types because of the different vegetation and because such sites provide refuge during flooding.

Drainage.—Drainage was and remains modified locally by causeways,

mounds, and drained fields and has been changed regionally by the digging of canals beside causeways, connecting streams, and through meander bends.

Impact on Subsequent Settlement

The features of the cultural landscape of the Mojos savannas became relics after the arrival of the Jesuits and have had little influence on subsequent settlement. Individual traits, of course, survived with the village remnants of the Indians, and many of these traits were adopted by whites and mestizos not only in the Beni, but also throughout the wet tropics of the Americas (crops, slash-and-burn agriculture, the dugout canoe, the hammock, and so forth). For the most part, however, the location and form of settlement; the building of mounds, causeways, canals, and drained fields; and the cultivation of savannas were not continued by the Jesuits and their successors or by the posteonquest Indians.

The Jesuits founded the towns and established settlement features that have persisted to the present time. Indian villages usually were built where there was enough high ground not too distant from major rivers. The Jesuits sought similar sites for their missions; but when a mission was built for convenience where there was already a village, a new town was designed around the church. The Mojo and Baure are reported to have had plazas, but the plaza was a mission fixture before the conquest of Mojos and not a borrowed trait. The Jesuits probably introduced rectangular houses to Mojos; however, daub and wattle construction was a native practice. Most of the artificial mounds and islas are too small for towns, but ranch houses, corrals, and huts have been built on them from time to time. In general, there has been little continuity of settlement sites of any type in either the aboriginal or European periods.

While the building of mounds and drained fields terminated with the Spanish conquest, a few causeways and canals continued to be built during the Jesuit period and afterward. Causeways and canals are undoubtedly carry-overs of Indian practices rather than being Spanish reintroductions. Both occur but are rare elsewhere in the seasonally flooded savannas of South America, even though they are fairly obvious adaptations to flooding and drought. In eastern Bolivia, causeways and canals were built by the Jesuits, Franciscans, and by civil administrators in the vicinity of several towns. Very few of the aboriginal causeways continued to be used, but some of the old canals probably were maintained and a few may have

been kept in use up to the present century. Causeways are still being built and do represent a tradition dating back to the savanna chiefdoms.

Work To Be Done

Only a beginning has been made toward an understanding of aboriginal earthworks and savanna cultivation in the Llanos de Mojos. The main concern here has been to describe the remnants of these features, to discuss their construction and functions, and to try to place them in a geographical, historical, and cultural context. Still to be established are the identity of the people who were first responsible for the different earthworks, when the earthworks were first constructed, when most of them were abandoned, and how the drained fields were farmed. Several lines of further investigation need pursuing:

1. *Archaeology.* The need for further archaeological work is obvious in view of what little has been done; to date, only the studies of Nordenskiöld in southeastern Mojos have been of any significance. Systematic excavations should be made in several areas, especially in southwestern Mojos where causeways and drained fields are most numerous, in northwestern Mojos where there are large raised fields, and in the Baures region of northeastern Mojos. While few artifacts have survived other than pottery, the pottery alone is potentially indicative not only of cultural affinities but also of settlement size, duration, and form and of sociopolitical, religious, and economic development.

2. *Dating.* In addition to relative dating of cultural horizons, hopefully objects will be recovered that can be dated with some precision. Datable carbonized materials seldom survive in the tropics, but charred bones or vegetable matter might be found in association with sherds; also, pottery tempered with siliceous bark or sponges can be dated by C-14 analysis. Methods other than C-14 might be employed for dating bones and some types of potsherds.

3. *Pollen analysis* should be possible in the Beni, and if so, something could be learned of vegetation changes and thereby possible changes in climatic or drainage conditions that may have affected human activities.

4. *Linguistic analysis* of the savanna languages, most of which have been recorded, may provide clues concerning when different tribes arrived in the Beni and to whom they are most closely related outside the Beni. Native terms for different types of earthworks may give some indication of origin.

5. *Archival research.* I have only been able to use primary historical source materials that have been published or exist in Bolivia. By far the greatest volume of documents from the Jesuit period are in the archives of Spain and the Vatican. Some of these have been utilized in still unpublished studies by Professor Leandro Tormo Sanz of the Instituto de Cultura Hispánica in Madrid, and he reports (personal communication) seeing a number of references to causeways and other earthworks. Undoubtedly there is much documentary archival material of value on the Indians.

6. *Drained fields and cultivation.* Closer examination of the different types of drained fields; further analysis of the soils of the fields, the ditches between fields, and undisturbed soils near the fields; and experiments with draining and cultivating savanna fields will provide insights into how the Indians farmed the savannas, as well as how the savannas might be farmed profitably today.

7. *Comparative studies of other seasonally flooded savannas.* The geography, cultures, and land utilization of the other tropical American savannas are only slightly better known than those of Mojos.

8. *Further description and location of earthworks in the Llanos de Mojos and adjacent savannas and a more thorough study of the savannas themselves.* The information presented here has been only an introduction to a hitherto neglected environment and man's use of it.

Observations on the Cultural Ecology of Mojos

Adaptation to Inundation.—One of the major objectives of this study has been to examine the various ways the aboriginal people of Mojos have adapted their cultural landscape and economic activities to seasonal inundation. Sites with dry ground for settlement, transportation, and cultivation were artificially created in Mojos, and special subsistence activities were undertaken during the flood season. Probably none of these features and activities are unique to Mojos; all can be found in some form elsewhere in South America. Furthermore, in Mojos these features and activities were apparently characteristic of several linguistic and cultural groups over a long period of time. It might be argued that adapting to flooding by building earthworks is a natural response to a seasonally inundated environment. However, many tribes in Mojos did not build earthworks, nor did tribes in other seasonally flooded savannas in South

America. Also, while the forms of the Mojos earthworks are often unique, it is not certain that they are entirely local developments.

The Mojos earthworks probably reflect the interreactions of diverse cultures plus political and economic pressures in a cul-de-sac in the interior of South America where the habitat is unfavorable but by no means extremely limiting. In Mojos, increasing population pressure on the available arable land (only the forest patches, if traditional methods were used) may have forced people to intensify agriculture, develop more sophisticated techniques, and to cultivate savannas. This transition may have been associated with warfare over land and an increase in size of political units or the formation of loose alliances among related linguistic groups. In addition there may have been an organization of labor, including prisoners, to build earthworks and in particular to drain fields in order to increase productivity. Possibly, then, both the cultivation of savanna and sociopolitical development in Mojos were associated with a shortage of arable, forested land in an open region easily occupied by large numbers of people and rich in wild game and fish.

Although the cultivation of savanna in Mojos made possible the support of larger populations, such cultivation was not necessarily initially a response to population pressure. The idea may have been introduced from elsewhere, have been within the cultural tradition, or have been the result of experimentation. The practice may have been adopted because of convenience—because adequate forest was distant, or because it was easier to drain savanna than to clear forest without stone or metal tools. If population pressure was initially involved, it was probably local and possibly the result of tribal territorial restrictions.[3]

[3] The present cultivation of dry savannas in Africa and wet savannas in Melanesia is probably directly related to dense populations and insufficient forest for shifting cultivation. In discussing Melanesian savanna cultivation, Robert Carneiro (1961:59) pointed out how such agriculture might develop because of population pressure:

"Shifting cultivation in its typical extensive form can be practiced only so long as sizable reserves of forest are available from which new plots can be cleared as old ones are abandoned. However, in any region of shifting cultivation where the population increases at a significant rate, a reduction in the available forest reserves necessarily occurs. Ultimately, with continued increase in population, the forest disappears, either virtually or completely. When this happens, no choice is left to the horticulturists but to till the only form of land available to them, namely grassland. No longer can fallowed land be allowed to revert to secondary forest as was the custom before. Now necessity dictates that it be cleared and planted after a very few years under grass. Unquestionably, cultivating the grasslands is more tedious and time-consuming than cultivating the forest. But it is not as impossible as primitive swidden farmers, blessed with ample forest reserves, are inclined to believe. It can be done and done successfully, even with no better tools than the digging stick or the hoe."

Earthworks and social organization.—The building of causeways, mounds, and drained fields suggests but does not necessarily in itself prove the presence of central authority, or a complex social organization with well-organized labor, or the existence of an incipient state. As pointed out by Ralph Beals (1955:54) and Richard Woodbury (1961:556–557) in regard to hydraulic civilizations and Hohokam Indian irrigation, the managerial functions in irrigation may have been performed through patterns of community cooperation rather than through a central authority; and the same could have been true for the builders of the Mojos earthworks. The historical Mojo and Baure did have strong headmen, but there is no conclusive evidence that villages were firmly united under single chiefs or that villages joined together in building earthworks or for warfare. All the major earthworks are of such a nature that they could be built by simple rule-of-thumb procedures without the management of engineering specialists. Nor would unusually large numbers of laborers be required. If one man moved a cubic meter of earth a day, 20 men could build a causeway one meter high, two meters wide, and one kilometer long in only 100 days.

Subsistence patterns and population density.—Savanna cultivation and the associated technological development did not necessarily mean that there was more food production or larger surplus production than from shifting cultivation in forest. For subsistence economies, differences in population concentration probably are less related to differences in food production per unit of land or unit of labor or in richness of soil fertility than to the degree to which the amount of arable land is increased by techniques such as irrigation, terracing, fertilization, forest clearing, and drainage.[4]

An argument has been presented for the preconquest presence of large numbers of Indians in the Llanos de Mojos, with a density significantly exceeding that of present-day Mojos as well as most of aboriginal Amazonia. Such a density was undoubtedly associated with an extension of agricultural land by means of savanna cultivation. However, savanna soils are no more or are often less productive than forest soils, and both

[4] Carneiro (1961:53) points out that the Kuikuru farmer of central Brazil probably spends less time producing food than a forest farmer did producing the same amount of food. He also attempts to show that tropical forest cultures with slash-and-burn agriculture are technically capable of producing food surpluses and of supporting permanent villages with 2,000 people (Carneiro, 1960, 1961:52).

types can be improved with relatively equal facility by various types of technology. Most important, for aboriginal Amazonia the critical factor controlling population density was probably neither soil fertility nor the amount of arable land available or made available but rather the availability of protein in the form of wild game and fish (Lathrap, 1962:549–556; also Denevan, 1967). The staple crops of virtually all the Amazonian cultures were starchy tubers (sweet and bitter manioc and sweet potatoes) which provided a much less balanced diet than did the protein rich maize-beans-squash complex elsewhere in the New World; maize and protein-rich crops such as beans and peanuts were present but of relatively minor importance in most of Amazonia. Wildlife was consequently the main source of protein. In this respect the Llanos de Mojos and other seasonally flooded savannas must be considered optimum rather than marginal habitats. Fish, birds, and wild animals are abundant in the Llanos de Mojos and were a very important part of the Indian diet. There is an even greater subsistence potential along the major river courses, where fish and game are very plentiful and the young alluvial soils are superior to the generally older soils of the interfluve forests and savannas. Here were found the densest populations in the Amazon Basin.

The poorest subsistence potential for aboriginal people in Amazonia is in the forests where the soils can still be cultivated but where wildlife is scarce, and in the well-drained upland savannas such as the campos of the Guianas and central Brazil where the soils are very poor and there is little game and almost no aquatic life. Both situations have been characterized by very sparse populations of mainly seminomadic people. These relationships between habitat, subsistence, and population distribution might have been quite different had the maize-beans-squash complex penetrated Amazonia or had the Amazonian tribes made significant use of domesticated animals.

Habitat, subsistence, culture, and population in tropical savanna lands.— In 1954 Betty J. Meggers, an archaeologist, gave impetus to a revival of environmental determinism in an article entitled "Environmental Limitation on the Development of Culture." Based largely on her archaeological work on Marajó Island, where the mound-building Marajoara culture appeared suddenly from up river and apparently gradually deteriorated over a period of several hundred years, she formulated a law stating: "The level to which a culture can develop is dependent upon the agricultural potential of the

environment it occupies." (Meggers, 1954:822.) Thus, she argues, if th agricultural potential is limited, then the cultural "level" is limited. He prime example is the tropical forest where soils are poor but usable in a rotation system; her prime case study is Marajó Island.

Over the next ten years Meggers was subjected to a barrage of attacks. Geographers remained silent, with a few exceptions (for instance, Blaut, 1959), but the anthropologists needed no assistance. It was readily pointed out that "high" cultures did develop in the humid tropics,[5] that the agricultural potential of all habitats is improvable to a degree dependent on technology,[6] and that the decline of socially advanced Amazonian cultures can be explained as the result of large-scale intertribal warfare[7] or by the disruptive effects of the European conquest.[8]

During these discussions of environmental limitations, no one reexamined the habitat of Megger's case study, the Marajoara culture of Marajó Island. Although Meggers and Evans (1957:398) note that the Marajoara people lived in seasonally flooded campos, they fail to emphasize that this is not a typical tropical forest environment and that the soil resources are even poorer than those of most tropical forests and yet the campos still supported a substantial culture and population. For slash-and-burn farmers only a small portion of the Marajó campo region has cultivable forest soils, and the less fertile grassland soils require special techniques including fertilization and either dry-season irrigation or wet-season drainage. This is

[5] "It appears that we have underestimated the ability of human groups to attain great cultural achievements at times in spite of the natural surroundings in which they find themselves. Certainly the brilliant development of the Olmec-La Venta culture would caution us against viewing man merely as a function of environment" (Coe, 1957:609).

[6] "[A]gricultural potential, per se, is a culture's appraisal of its local environment in terms of its own knowledge, agricultural techniques, and tools. Furthermore, since this cultural inventory changes with time, due to invention and diffusion, the agricultural potential of the region may change in so far as these new additions to the cultural inventory concern the agricultural use of environment" (Ferdon, 1959:18).

[7] Donald Lathrap (1962:561-571) postulates an Invasionist Stage in Amazonian prehistory coming just before and during the conquest period, when less sedentary, warlike people such as the Caribs, Panoans, and Tupi Guaraní moved against more highly developed tribes. Lathrop suggests that the cultural decline evidenced by deteriorating ceramic styles on Marajó Island, at Yarinacocha, and elsewhere in the Amazon region may well have been the result of intensive warfare rather than an inability of advanced cultures to survive in a tropical rainforest environment as suggested by Meggers and Evans. It is not clear, however, whether the Guaraní and Chiquitoan tribes that were pushing toward the eastern and southern fringes of Mojos had any significant impact on the Mojos chiefdoms.

[8] The impact of European contact on the social organization of Amazonian tribes was the subject of a recent paper by Lathrap and Myers (1964), who conclude: "There was a marked breakdown of socio-political integration during the first 150 years of Spanish contact. In short, it appears that the level of socio-political integration typical of the Indians of the Peruvian Montaña from 1750 up to the ethnographic present was not an adaptation to the Tropical Forest Environment but to a high level of conflict between European and aboriginal culture."

true of most South American savannas, and savannas therefore might be considered more "limiting" in agricultural potential than tropical forest. Credence is lent to this supposition by the fact that modern agriculture is very rare in New World savannas, and savanna tribes actually do most or all of their farming in what forest there is available. Anthony Leeds (1961) has made a study of such a situation, the Yaruro of the Orinoco llanos, and he believes that because of limited forest (two percent of the tribal area) and the lack of a technology for farming the savannas, population growth, surplus production, and "sociocultural" evolution is impossible. Alfred Kidder II (1964:453) recently alleged that the grasslands east of the Andes had great agricultural potential, but that they could not be exploited by Indians with a simple technology.

Thus, of significance and in need of emphasis is the fact that some savannas in South America were once cultivated and supported aboriginal cultures with a sophisticated agriculture, some engineering ability, and relatively dense populations. Archaeology, historical descriptions, and remnants of fields and earthworks have indicated that this was true for the Llanos de Mojos, northern Colombia, and possibly for the Llanos del Orinoco and locally elsewhere. Even those seasonally flooded savannas that were not cultivated, such as Marajó Island, were often attractive to human settlement because of their superior game and fish resources and because the lack of forest facilitated movement and hunting.

In conclusion, it has become increasingly evident that many parts of the New World humid tropics, both forest and savanna, supported relatively dense populations before or at the time the first Europeans arrived. Such claims, of variable validity, have been made for eastern Panama, Darién, Hispaniola, the Amazon River Valley, Marajó Island, the Valle General of southwestern Costa Rica, lowland Maya and pre-Maya areas of eastern Meso-America from Vera Cruz to Honduras, the Cauca, San Jorge, and Sinú valleys of Colombia, the Pacific Coast of Nicaragua, and portions of the southwest coast of Mexico such as Colima. In these areas a density of archaeological sites in combination with early Spanish accounts suggest pre-Spanish populations that in many instances exceeded present populations. The Llanos de Mojos must now be added to the list.

Evidence has been presented that in the Mojos savannas in the sixteenth century there were several hundred thousand Indians and large villages

with palisades, moats, plazas, and streets; and there still can be seen at least 1,000 miles of causeways, several hundred thousand linear drained fields, and also numerous canals, large mounds, and small mound fields. Clearly, aboriginal Mojos is an outstanding example of (1) aboriginal man's ability to adapt to harsh conditions by modifying those conditions and (2) the fact that "agricultural potential" is a cultural appraisal. In a savanna environment with seemingly little opportunity for grassland cultivation because of flooding, drought, and low fertility, pre-Spanish people achieved a productivity and population density that have not been equaled since.

BIBLIOGRAPHY

Acosta, Josephi [José] de

1880. [1590] *The Natural and Moral History of the Indies.* Trans. Edward Gimston, 1604. London: printed for the Hakluyt Society. Vols. 60, 61.

Agustín Palacios, José

1944. [1875] Exploraciones de Don Jose Agustín Palacios realizadas en los ríos Beni, Mamoré y Madera y en el lago Rogoaguado, durante los años 1844 al 47: Descripción de la Provincia de Mojos. La Paz: Editorial del Estado. 91 pp.

Alemán, Diego

1897. "Entrada de Diego Alemán a los Mojos ó Mussus, 1564," *in* Marcos Jiménez de la Espada, ed., *Relaciones geográficas de Indias,* 4:196–200. Madrid: Tip. de M. G. Hernández.

Altamirano, Diego Francisco

1891. [ca. 1710] "Historia de la mision de los Mojos," *in* Manuel V. Ballivian, ed., *Documentos históricos de Bolivia: Historia de la mision de los Mojos.* La Paz: Imprenta de El Comercio. 184 pp.

Andión, Hierónimo de

1885. "Annua de la Compania de Jesús: Tucumán y Perú (1596)," *in* Marco Jiménez de la Espada, ed., *Relaciones geograficas de Indias,* 2:66–82. Madrid: Tip. de M. G. Hernández.

Anonymous (Probably Diego Francisco Altamirano)

1713. "Breve noticia del estado en que hallan el año de 1713 las misiones de infieles, que tiene á su cargo la Provincia del Perú, de la Compania de Jesús en las Provincias de los Mojos," *in Colección de documentos Bolivianos recojidos i ordenados por G. René-Moreno, Segunda Serie, Tomo 142: Historia y Biografía, 1713–1877.* Unpublished, Biblioteca Nacional, Sucre. 17 pp.

Anonymous

1743. [ca. 1703] "Extract of a Spanish Relation, Containing the Life and Death of Father Cyprian Baraze, of the Society of Jesus, Founder of the Mission of the Moxos in Peru," *in* John Lockman, *Travels of the Jesuits into Various Parts of the World,* 2:437–468. London: printed for John Noon. [Also a French version in *Lettres edifiantes et curieuses....* 1780–1783, 8:77–119.]

Anonymous (Probably Diego Francisco Altamirano)

1891. [ca. 1699] "Breve noticia de las misiones de infieles que tiene la Compañía de Jesús de esta Provincia del Perú, en las Provincias de los Mojos," *in* Manuel V. Ballivian, ed., *Documentos históricos de Bolivia: Historia de la mision de los Mojos.* La Paz: Imprenta de El Comercio. 11 pp.

Arce Pereira, Lucío

1961. "Informe del estudio de los suelos de la estación de mejoramiento ganadero de Trinidad (Beni)." Servicio Agricola Interamericano, La Paz. Typed, 7 pp. and map.

ARCE PERLIRA, Lucío, and others
1963. *Estudio exploratorio en el Río Mamoré y sus afluentes Chipiriri, Isi e Ichilo.* Servicio Agrícola Interamericano, La Paz. 191 pp.

ARCHIVO DE MOJOS
1778. El gobernador provisto para Mojos, Don Ignacio Flores . . . respecto las misiones de los llanos de Mojos a las cuales dichas fincas pertenece La Plata, julio 24 de 1778." Archivo de Mojos, 5:1, Biblioteca Nacion Sucre.

ARGAMOSA, MANUEL ANTONIO DE
1906. "Informe de Don Manuel Antonio de Argamosa, Governador de Sa Cruz de la Sierra, sobre el estado de las misiones de Mojos y Chiquit 6 de febrero de 1737," *in* Maurtua, 1906*a*, 10:49–56.

ARLET, STANISLAS
1781. "Lettre du Père Stanislas Arlet, de la Compagnie de Jesús, au Révére Père Général de la même Compagnie," *in Lettres edifiantes et curieus* . . . 1780–1783, 8:39–51.

ARMENTIA, NICOLÁS (supposed author)
1905. *Descripción del territorio de las misiones franciscanas de Apolobamb por otro nombre, Frontera de Caupolican.* La Paz: Editorial Ofic 238 pp.

BARRAU, JACQUES
1958. *Subsistence Agriculture in Melanesia.* Bishop Museum Bulletin 21 Honolulu. 111 pp.

BAYO, CIRO
1911. *El peregrino en Indias: En el corazón de la America del Sur.* Madri Librería de los Sucesores de Hernando. 443 pp.

BEALS, RALPH L.
1955. "Discussion: Symposium on Irrigation Civilizations," *in Irrigatio Civilizations: A Comparative Study,* Social Science Monographs [Pa American Union, Washington], I:53–57.

BEARD, J. S.
1953. "The Savanna Vegetation of Northern Tropical America," *Ecologic Monographs,* 23:149–215.

BENNETT, WENDELL C.
1936. *Excavations in Bolivia,* Anthropological Papers American Museum Natural History, 35 (Pt. 4):329–507.
1944. "The Archeology of the Central Andes," *in* Julian H. Steward, ed *Handbook of South American Indians,* Bulletin of the Bureau American Ethnology 143, 2:61–147.
1949. "A Cross-Cultural Survey of South American Indian Tribes: Archite ture and Engineering," *in* Julian H. Steward, ed., *Handbook of Sout American Indians,* Bulletin of the Bureau of American Ethnology 14 5:1–65.

BERESFORD, M. W., and J. K. S. ST. JOSEPH
1958. *Medieval England: An Aerial Survey.* London: Cambridge Universit Press. 275 pp.

Blaut, James M.
1959. "The Ecology of Tropical Farming Systems," *in Plantation Systems of the New World*, Social Science Monographs [Pan American Union, Washington], VII:83–97.

Bolívar, Gregorio de
1906. "Relación de la entrada del Padre fray Gregorio de Bolívar, en compania de Diego Ramírez de Carlos, á las provincias de indios Chunchos, en 1621," *in* Maurtua, 1906*a*, 8:205–237.

Bolivia. Oficina Nacional de Immigración
1902. *Censo general de la población de la República de Bolivia: Resultados generales (1900)*. La Paz: J. M. Gamarra. 2 vols.

———. Dirección General de Estadística y Censos
1955. *Censo demográfico 1950*. La Paz: Editorial Argote. 252 pp.

———. Dirección General de Meteorología
1960. *Anuario meteorológico, Ano 1958*. La Paz. 126 pp.

———. Dirección General de Estadística, Sección Demografia
1961. "Calculo de población por departamentos y provincias, Año 1950–1960." La Paz. Typed, 3 pp.

Boman, E.
1908. *Antiquités de la région andine de la République Argentine et du Désert d'Atacama*. Mission scientifique G. de Créqui Montfort et E. Sénéchal de la Grange. Paris: Imprimerie Nationale. 2 vols.

Borah, Woodrow
1964. "America as Model: The Demographic Impact of European Expansion Upon the Non-European World," *in XXXV Congreso Internacional de Americanistas: Actas y Memorias* [Mexico, 1962], 3:379–387. Mexico.

Borah, Woodrow, and S. F. Cook
1963. *The Aboriginal Population of Central Mexico on the Eve of the Spanish Conquest*, University of California Publications, Ibero Americana: 45. 157 pp.

Braun, Otto
1961. "Cultivo de pastos en el Beni," Servicio Agrícola Interamericano, Boletín Experimental No. 14. La Paz. 19 pp.

Brazil. Instituto Brasileiro de Geografia e Estatística
1960. *Carta do Brazil ao milionésimo*. Rio de Janeiro. 46 bound sheets.

Brookfield, Harold C.
1962. "Local Study and Comparative Method: An Example from Central New Guinea," *Annals Association American Geographers*, 52 :242–254.

Brookfield, Harold C., and Paula Brown
1963. *Struggle for Land: Agriculture and Group Territories Among the Chimbu of the New Guinea Highlands*. Melbourne: Oxford University Press. 193 pp.

Caballero, Lucas
1933. [1706] *Relación de las costumbres y religión de los indios manasicas, . . .* Manuel Serrano y Sanz, ed. Madrid: V. Suárez. 43 pp.

CÁRDENAS, MARTÍN

1945. "Aspecto general de la vegetación de Bolivia," *in* Frans Verdoorn, ed., *Plants and Plant Science in Latin America.* Waltham, Mass.: Chronica Botanica Co. Pp. 312–313.

1953. "Por las pampas del Yacuma y las playas del Beni," *Revista de Agricultura* [Cochabamba], 8:45–48.

CARDÚS, JOSÉ

1886. *Las misiones franciscanas entre los infieles de Bolivia: Descripción del estado de ellas en 1883 y 1884.* Barcelona: Librería de la Inmaculada Concepción. 429 pp.

CARNEIRO, ROBERT L.

1960. "Slash-and-Burn Agriculture: A Closer Look at Its Implications for Settlement Patterns," *in* Anthony F. C. Wallace, ed., *Men and Cultures: Selected Papers of the Fifth International Congress of Anthropological and Ethnological Sciences* [Philadelphia, 1956]. Philadelphia: University of Pennsylvania Press. Pp. 229–234.

1961. "Slash-and-Burn Cultivation Among the Kuikuru and Its Implications for Cultural Development in the Amazon Basin," *in* Johannes Wilbert, ed., *The Evolution of Horticultural Systems in Native South America, Causes and Consequences: A Symposium.* Caracas: Sociedad de Ciencias Naturales La Salle. Pp. 47–67.

CARVAJAL, JACINTO DE

1956. [1648] *Relación del descubrimiento del Río Apure hasta su ingreso en el Orinoco.* Caracas: Ediciones Edime. 306 pp.

CASAS, BARTOLOMÉ DE LAS

1909. [ca. 1527–1550] "Apologética historia de las Indias," *in* M. Serrano y Sanz, ed., *Historiadores de Indias,* Vol. 1, *Nueva biblioteca de autores españoles* 13. Madrid: Bailly, Bailliére e hijos.

CASTELLANOS, JUAN DE

1955. [1589] *Elegías de varones ilustres de Indias.* Bogotá: Editorial A B C. 4 vols.

CASTILLO, JOSEPH DE

1906. [ca. 1676] "Relación de la provincia de Mojos," *in* M. V. Ballivián, ed., *Documentos para la historia geográfica de la República de Bolivia,* Serie Primera: Epoca Colonial, Vol. 1: *Las provincias de Mojos y Chiquitos.* La Paz: J. M. Gamarra. Pp. 294–395.

CASTILLO, MARIUS DEL

1929. *El corazon de la América meridional.* Vol. 1: *Bolivia.* Barcelona.

CHÁVEZ SUÁREZ, JOSÉ

1936. "La traslación de Trinidad," *El Diario,* La Paz, March 4, 1936.

1944. *Historia de Moxos.* La Paz: Editorial Fénix. 510 pp.

1947. "La fundación de la ciudad de Trinidad," *La Razon,* La Paz, November 16, 1947.

CHURCH, GEORGE EARL

1877. *The Route to Bolivia via the River Amazon: A Report to the Governments of Bolivia and Brazil.* London: Waterlow and Sons, Ltd. 216 pp.

1898. "Argentine Geography and the Ancient Pampean Sea," *The Geographical Journal,* 12:386–401.

CIEZA DE LEON, PEDRO DE
1959. [1553] *The Incas of Pedro de Cieza de Leon*, V. W. Von Hagen, ed. Norman: University of Oklahoma Press. 397 pp.

COE, MICHAEL D.
1957. "Cycle 7 Monuments in Middle America: A Reconsideration," *American Anthropologist*, 59:597–611.
1964. "The Chinampas of Mexico," *Scientific American*, 211 (1):90–98.

COLLIER, DONALD
1958. "Comment" [on "Archeological Evidence of a Prehistoric Migration from the Río Napo to the Mouth of the Amazon," by Betty J. Meggers and Clifford Evans], *in* R. H. Thompson, ed., *Migrations in New World Culture History*. University of Arizona Press, Social Science Bulletin No. 27. Pp. 17–19.

COOK, O. F.
1920. "Foot-Plow Agriculture in Peru," *Annual Report, 1918*, Smithsonian Institution, Washington. Pp. 487–491.

CRUXENT, J. M.
1952. "Notes on Venezuelan Archeology," *in* Sol Tax, ed., *Selected Papers of the XXIXth International Congress of Americanists* [*New York, 1949*]: *Indian Tribes of Aboriginal America*, 3:280–294. Chicago: University of Chicago Press.

CRUXENT, J. M., and IRVING ROUSE
1958. *An Archeological Chronology of Venezuela*, Social Science Monographs VI [Pan American Union, Washington]. 2 vols.

DENEVAN, WILLIAM M.
1962. "Informe preliminar sobre la geografía de los Llanos de Mojos, nordeste de Bolivia," *Boletín de la Sociedad Geográfica e Histórica Sucre*, 47 (No. 446):91–113.
1963*a*. "Additional Comments on the Earthworks of Mojos in Northeastern Bolivia," *American Antiquity*, 28:540–545.
1963*b*. "Cattle Ranching in the Mojos Savannas of Northeastern Bolivia," *Yearbook of the Association of Pacific Coast Geographers*, 25:37–44.
1967. "A Cultural-Ecological View of Former Aboriginal Settlement in the Amazon Basin," *The Professional Geographer* (in press).

DIAZ DE GUZMÁN, RUI
1835. [1612] "Historia Argentina." Vol. 1 of Pedro de Angelis, ed., *Coleccion de obras y documentos relativos a la historia . . . del Río de la Plata*. Buenos Aires: Imprenta del Estado. 156 pp.

DOBYNS, HENRY F.
1966. "Estimating Aboriginal American Population: An Appraisal of Techniques With a New Hemispheric Estimate," *Current Anthropology* (in press).

DOLE, GERTRUDE E.
1960. "Techniques of Preparing Manioc Flour as a Key to Culture History in Tropical America," *in* Anthony F. C. Wallace, ed., *Men and Cultures: Selected Papers of the Fifth International Congress of Anthropological and Ethnological Sciences* [Philadelphia, 1956]. Philadelphia: University of Pennsylvania Press. Pp. 241–248.

1961 62. "A Preliminary Consideration of the Prehistory of the Upper Xingú Basin," *Revista do Museu Paulista* [São Paulo], 13:399–423.

Ducci, Zacarias

1895. *Diario de la visita a todas las misiones existentes en la república de Bolivia, America meridional, praticada por el R. P. Sebastian Pifferi.* Asis [Italy]. 185 pp.

Eder, Ferencz Xaver (Francisco Javier)

1791. *Descriptio provinciae Moxitarum in regno peruano....* Budapest. 383 pp., map, and plates.

1888. Descripción de la Provincia de los Mojos en el Reino del Perú. Trans. Nicolás Armentia from the 1791 Latin edition. La Paz: Imprenta de El Siglo Industrial. 179 pp.

Edwards, Clinton R.

1965. *Aboriginal Watercraft on the Pacific Coast of South America,* University of California Publications, Ibero-Americana: 47. 160 pp.

Eguiluz, Diego de

1884. [1696] *Historia de la Mision de Mojos.* Lima: Imprenta del Universo. 64 pp.

Eidt, Robert C.

1959. "Aboriginal Chibcha Settlement in Colombia," *Annals Association American Geographers,* 49:374–392.

Evans, Clifford

1964. "Lowland South America," *in* J. D. Jennings and Edward Norbeck, eds., *Prehistoric Man in the New World.* Chicago: University of Chicago Press. Pp. 419–450.

Farabee, William Curtis

1922. *Indian Tribes of Eastern Peru,* Papers of the Peabody Museum of American Archaeology and Ethnology, vol. 10. Cambridge: Peabody Museum. 194 pp.

Ferdon, Edwin N.

1959. "Agricultural Potential and the Development of Cultures," *Southwestern Journal of Anthropology,* 15:1–19.

Finot, Enrique

1939. *Historia de la conquista del Oriente boliviano.* Buenos Aires: Librería Cervantes. 405 pp.

Fox, George R.

1959. "The Prehistoric Garden Beds of Wisconsin and Michigan and the Fox Indians," *The Wisconsin Archaeologist,* 40:1–19.

Garcilaso de la Vega

1959. [1609, 1617] *Comentarios Reales de los Incas.* Lima: Librería Internacional del Peru. 3 vols.

Garriga, Antonio

1906. "Linderos de los pueblos de las misiones de Mojos, declarados y confirmados por el Padre Provincial Antonio Garriga en su visita de 10 de octubre de 1715," *in* Maurtua, 1906*a,* 10:34–42.

...NER
...*ration of the Valley of the Amazon*, part II [part I is by Wm. ... Herndon]. Washington: A. O. P. Nicholson, Public Printer. ...pp.

...FONSECA, JOSÉ
...*gação feita da cidade do Gran Para até a boca do Rio de Madeira ... anno de 1749*. Collecção de noticias para a historia e geografia ...nações ultramarinas que vivem nos dominios portuguezes ou que ...ão visinhas, 4(Pt. 1):1–141. Lisbon.

...RE
... *Tropical World*. London: Longmans, Green and Co. 156 pp.

...OSEPH H.
... General Classification of Central and South American Lan...ges," *in* Anthony F. C. Wallace, ed., *Men and Cultures: Selected ...rs of the Fifth International Congress of Anthropological and Eth...gical Sciences* [Philadelphia, 1956]. Philadelphia: University of ...nsylvania Press. Pp. 791–794.

...SÉ
...–15] *El Orinoco ilustrado*. Madrid: Tipografía Clásica Española. ...pp.

...DEUS [TADEO]
...9] "Los rios navegables que fluyen al Marañon, procedentes de las ...dilleras del Bajo y Alto Perú," *in* M. V. Ballivián and Pedro Kramer, ... *Tadeo Haenke: Escritos*, Série 1, pp. 75–96. La Paz: Imprenta y ...grafia de El Nacional de Isaac V. Vila.

...TOR W. VON
...*orld of the Maya*. New York: Mentor. 224 pp.

...NDA
...nige funde in Beni-Gebiet, Ostbolivien," *Archiv für Völkerkunde* ...ien], 12:136–143.

...C. M. G.
...nforme del Professor C. M. G. Harrison: Navegabilidad de los Rios ...amoré, Chapare, Ichilo y Río Grande; El ganado en los Departamen... del Beni y Santa Cruz; La agricultura en las zonas del Chapare y ... Ichilo," Instituto de Fomento, La. Paz. Typed, 48 pp.

...STEPHEN N.
...olivia: A Reconnaissance of the Río Mamoré and Tributaries," *Peru...n Times*, Lima, March 8, 15, 1963.

... DE ALBA, GREGORIO
...ub-Andean Tribes of the Cauca Valley," *in* Julian H. Steward, ed., ...*andbook of South American Indians*, Bulletin of the Bureau of Amer...n Ethnology 143, 4:297–327.

...NDURO, LORENZO
...*atálogo de las lenguas de las naciones conocidas, y numeración, divi...ón, y clases de estas según la diversidad de sus idiomas y dialectos*. ...adrid: Librería de Ranz. 6 vols. in 3.

HERZOG, THEODOR
1912. "Formaciones vegetables del este de Bolivia," *Boletín de la Sociedad Geográfica de La Paz,* Año 10 [Nos. 36, 37, 38]:159–190.

HILBERT, PETER PAUL
1962. "New Stratigraphic Evidence of Culture Change on the Middle Amazon (Solimões)," *in Akten des 34. Internationalen Amerikanistenkongresses* [Vienna, 1960]. Vienna: Ferdinand Berger, Horn. Pp. 471–476.

HOLMBERG, ALLAN R.
1960. [1950] *Nomads of the Long Bow: The Siriono of Eastern Bolivia.* Chicago: University of Chicago Press. 104 pp.

HOWARD, GEORGE D.
1947. *Prehistoric Ceramic Styles of Lowland South America, Their Distribution and History.* Yale University Publications in Anthropology, No. 37. New Haven. 95 pp.

HUGHES, RICHARD L.
1961. "Preliminary Study on Trinidad," Servicio Agrícola Interamericana, La Paz. Typed, 15 pp.

HUMBOLDT, ALEXANDER VON, and AIMÉ BONPLAND
1852. *Personal Narrative of Travels to the Equinoctial Regions of America During the Years 1799–1804.* London: George Routledge and Sons. 3 vols.

JUDY, ROBERT and JUDITH
1962. *Movima y Castellano.* Summer Institute of Linguistics, Cochabamba. 154 pp.

KELLER, FRANZ
1875. *The Amazon and Madeira Rivers.* London: Chapman and Hall. 210 pp.

KEY, HAROLD and MARY
1961. "Bolivian Indian Tribes: Bibliography and Map of Present Language Distribution." Summer Institute of Linguistics, Cochabamba. Mimeographed, 54 pp.

KEY, MARY
1961. "An Archaeologist's Mystery." Summer Institute of Linguistics, Riberalta. Typescript, 3 pp.

KIDDER, ALFRED, II
1948. "The Archaeology of Venezuela," *in* Julian H. Steward, ed., *Handbook of South American Indians,* Bulletin of the Bureau of American Ethnology 143, 4:413–438.
1964. "South American High Cultures," *in* J. D. Jennings and Edward Norbeck, eds., *Prehistoric Man in the New World.* Chicago: University of Chicago Press. Pp. 451–486.

KIRCHHOFF, PAUL
1948. "The Warrau," *in* Julian H. Steward, ed., *Handbook of South American Indians,* Bulletin of the Bureau of American Ethnology 143, 3: 869–881.

LATHRAP, DONALD W.
1958. "The Cultural Sequence at Yarinacocha, Eastern Peru," *American Antiquity,* 23:379–388.

1962. *Yarinacocha: Stratigraphic Excavations in the Peruvian Montana.* Unpublished Ph.D. dissertation, Harvard University. 2 vols.

1963. "Linguistic Relationship, Ceramic Tradition, and Problems of Population Movement in the Amazon Basin: The Arawak Case." MS of paper read to the American Anthropological Association, San Francisco, 1963. 4 pp. and 4 figures.

LATHRAP, DONALD W., and THOMAS P. MYERS

1964. "Precontact Patterns of Socio-Political Organization in the Peruvian Montaña: A Reappraisal." MS of paper read to the American Anthropological Association, Detroit, 1964. 12 pp. and 9 figures.

LEEDS, ANTHONY

1961. "Yaruro Incipient Tropical Forest Horticulture: Possibilities and Limits," *in* Johannes Wilbert, ed., *The Evolution of Horticultural Systems in Native South America, Causes and Consequences: A Symposium.* Caracas: Sociedad de Ciencias Naturales La Salle. Pp. 13–46.

LETTRES ÉDIFIANTES ET CURIEUSES ÉCRITES DES MISSIONS ÉTRANGÈRES

1780–1783. [1707–1743] Paris: J. G. Merigot. 26 vols.

LIMPIAS SAUCEDO, MANUEL

1942. *Los gobernadores de Mojos.* La Paz: Escuela Tipográfica Salesiana. 318 pp.

LINNÉ, SIGVALD

1925. *The Technique of South American Ceramics.* Göteborgs Kungl. Vetenskaps-Och Vitterhets-Samhälles Handlingar, Fjarde Följden, Band 29, N:O 5. 199 pp.

LIZARAZU, JUAN DE

1906. [1638] "Informaciones hechas por Don Juan de Lizarazu sobre el descubrimiento de los Mojos," *in* Maurtua, 1906*a*, 9:124–216.

MACFADYEN, W. A.

1950. "Vegetation Patterns in the Semi-Desert Plains of British Somaliland," *Geographical Journal,* 116:199–211.

McBRIDE, G. M. and M. A.

1942. "Highland Guatemala and its Maya Communities," *Geographical Review,* 32:252–268.

MANN F., GUILLERMO

1951. *Esquema ecológico de selva, sabana, y cordillera en Bolivia.* Publicación Num. 3 del Instituto de Geografía, Facultad de Filosofía, Universidad de Chile, Santiago. 236 pp.

MARBÁN, PEDRO

1898. [ca. 1676] "Relación de la provincia de la vírgen del Pilar de Mojos," *Boletín de la Sociedad Geográfica de La Paz,* 1:120–167.

MAURTUA, VÍCTOR M.

1906*a*. *Juicio de límites entre el Perú y Bolivia.* Madrid: Imprenta de los Hijos de M. G. Hernández. 12 vols.

1906*b*. *Juicio de límites entre el Perú y Bolivia: Cartas geográficas. Segunda Serie.* Barcelona: Tipolitografía de Henrich y Compañía. 58 plates.

McQUOWN, NORMAN A.

1955. "The Indigenous Languages of Latin America," *American Anthropologist,* 57:501–570.

MEGGERS, BETTY J.
1954. "Environmental Limitation on the Development of Culture," *American Anthropologist*, 56:801–824.

MEGGERS, BETTY J., and CLIFFORD EVANS
1957. *Archeological Investigations at the Mouth of the Amazon*. Bulletin of the Bureau of American Ethnology 167. 664 pp. and 112 plates.
1958. "Archaeological Evidence of a Prehistoric Migration from the Rio Napo to the Mouth of the Amazon," *in* R. H. Thompson, ed., *Migrations in New World Culture History*. University of Arizona, Social Science Bulletin No. 27. Pp. 9–16.
1961. "An Experimental Formulation of Horizon Styles in the Tropical Forest Area of South America," *in* S. K. Lothrop, ed., *Essays in Pre-Columbian Art and Archaeology*. Cambridge: Harvard University Press. Pp. 372–388.

MERLIN, MARCEL
1955. Le bassin hydrographique de l'Ichilo-Mamoré. United Nations, La Paz. Processed, 3 vols. and plates.

MÉTRAUX, ALFRED
1942. *The Native Tribes of Eastern Bolivia and Western Matto Grosso*. Bulletin of the Bureau of American Ethnology 134. 182 pp.
1943. "The Social Organization and Religion of the Mojo and Manasi," *Primitive Man*, 16:1–30.
1948. "Tribes of Eastern Bolivia and the Madeira Headwaters," *in* Julian H. Steward, ed., *Handbook of South American Indians*, Bulletin of the Bureau of American Ethnology 143, 3:381–454.

MORLEY, SYLVANUS
1956. [1946] *The Ancient Maya*, revised by George W. Brainerd. Palo Alto: Stanford University Press. 507 pp.

NEWSWEEK
1947. "Bolivia: Drowned City," March 17, 1947. P. 54.

NORDENSKIÖLD, ERLAND
1910. "Archäologische Forschungen im bolivianischen Flachland," *Zeitschrift fur Ethnologie* [Berlin], 42:806–822.
1911. "Die Siriono-Indianer in Ostbolivien," *Petermann's Mitteilungen* [Gotha], 57:16–17.
1913. "Urnengräber und Mounds im bolivianischen Flachlande," *Baessler Archiv*. [Leipzig and Berlin], 3:205–255.
1916. "Die Anpassung der Indianer an die Verhältnisse in den Uberschwemmungsgebieten in Südamerika," *Ymer* [Stockholm], 36:138–155.
1917. "Die östliche Ausbreitung der Tiahuanacokultur in Bolivien und ihr Verhältnis zur Aruakkultur in Mojos," *Zeitschrift für Ethnologie* [Berlin], 49:10–20.
1918. "Palisades and 'Noxious Gases' Among the South American Indians," *Ymer* [Stockholm], 38:220–243.
1920. *The Changes in the Material Culture of Two Indian Tribes Under the Influence of New Surroundings*. Comparative Ethnological Studies, No. 2 [Göteborg]. 245 pp.

1923. *Indianer und Weisse in Nordostbolivien.* Stuttgart: Strecker und Schröder. 222 pp.

1924*a*. *Forschungen und Abenteuer in Südamerika.* Stuttgart: Strecker und Schröder. 338 pp.

1924*b*. *The Ethnology of South America Seen from Mojos in Bolivia.* Comparative Ethnological Studies, No. 3 [Göteborg]. 254 pp.

1924*c*. "Finds of Graves and Old Dwelling Places on the Río Beni, Bolivia," *Ymer* [Stockholm], 44:229–237.

1930*a*. *L'archéologie du bassin de l'Amazone.* Paris: Les Editions G van Oest. 70 pp. plus 56 plates.

1930*b*. *Modifications in Indian Culture Through Inventions and Loans.* Comparative Ethnological Studies, No. 8 [Göteborg]. 256 pp.

NYE, P. H., and D. J. GREENLAND

1960. *The Soil Under Shifting Cultivation.* Commonwealth Bureau of Soils, Technical Communication No. 51. Farnham Royal [Eng.]: Commonwealth Agricultural Bureaux. 156 pp.

ORBIGNY, ALCIDES D'

1835–1847. *Voyage dans l'Amérique Méridionale.* Paris: Pitois-Levrault and P. Bertrand. 10 vols., including atlas and plates.

1946. [1845] *Descripción geográfica, histórica y estadística de Bolivia.* La Paz: Colegio Don Bosco. 426 pp.

1958. [1835–1847] *Viaje a la América meridional, in* Bibliotheca Indiana: Viajes y Viajeros, 3:15–920. Madrid: Aguilar.

1950. [1839] *El hombre americano.* Buenos Aires: Editorial Futuro. 423 pp.

O'LEARY, TIMOTHY J.

1963. *Ethnographic Bibliography of South America.* New Haven: Human Relations Area Files. 389 pp.

ORELLANA, ANTONIO DE

1906. "Carta del Padre Antonio de Orellana, sobre el origen de las misiones de Mojos, 18 octubre 1687," *in* Maurtua, 1906*a*, 10:1–24.

OSBORNE, HAROLD

1964. [1954] *Bolivia, A Land Divided.* London: Oxford University Press. 181 pp.

OVIEDO Y VALDÍS, GONZALO FERNÁNDEZ DE

1851–1855. [ca. 1520–1557] *Historia general y natural de las Indias, islas y tierra-firme del mar Océano,* José Amador de los Rios, ed. Madrid: Real Academia de la Historia. 4 vols.

PAN AMERICAN UNION, NATURAL RESOURCES UNIT

1964. *Bolivia: Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources.* Washington. 13 pp.

PARSONS, JAMES J.

1949. *Antioqueño Colonization in Western Colombia.* University of California Publications, Ibero-Americana: 32. 225 pp.

PARSONS, JAMES J., and WILLIAM A. BOWEN

1966. "Ancient Ridged Fields of the San Jorge River Floodplain, Colombia," *Geographical Review,* 56:317–343.

PEÑA, RAFAEL

1944. [1901] *Flora cruceña.* La Paz: Editorial del Estado. 475 pp.

PLAFKER, GEORGE
1963. "Observations on Archaeological Remains in Northeastern Bolivia," *American Antiquity*, 28:372–378.
1964. "Oriented Lakes and Lineaments of Northeastern Bolivia," *Geological Society of America Bulletin*, 75:503–522.

POSNANSKY, ARTURO
1928. "Breves noticias de una rama cultural Tihuanacu al noroeste de Bolivia," *in Annaes do XX Congresso Internacional de Americanistas* [Rio de Janeiro, 1922], 2:195–197. Rio de Janeiro: Imprensa Nacional.

REAL CÉDULA
1906. "Real Cédula de S. M. ordenando no se dé á persona alguna el descubrimiento de los Mojos, 22 de agosto de 1573," *in* Maurtua, 1906*a*, 9: 72–73.

RENÉ-MORENO, GABRIEL
1888. *Biblioteca boliviana: Catálogo del archivo de Mojos y Chiquitos*. Santiago: Imprenta Gutenberg. 628 pp.

RICHARDS, P. W.
1952. *The Tropical Rain Forest, An Ecological Study*. London: Cambridge University Press. 450 pp.

RIPPY, J. FRED, and J. T. NELSON
1936. *Crusaders of the Jungle*. Chapel Hill: University of North Carolina Press. 401 pp.

ROSARIO, FRANCISCO DEL
1682. "Carta de relación del Padre Fray Francisco del Rosario de todo lo sucedido en la conquista espiritual de los Andes del Perú, por la parte de Cochabamba," *in* Juan Meléndez, ed., *Tesoros verdaderos de las Indias*, 3:812–844. Rome: N. A. Tinassio.

ROSEN, ERIC VON
1924. "The Mounds of Pucará," *Ymer* [Stockholm], 44:181–191.

ROUSE, IRVING
1948. "The Arawak," *in* Julian H. Steward, ed., *Handbook of South American Indians*, Bulletin of the Bureau of American Ethnology 143, 4: 507–546.

ROWE, JOHN H.
1946. "Inca Culture at the Time of the Spanish Conquest," *in* Julian H. Steward, ed., *Handbook of South American Indians*, Bulletin of the Bureau of American Ethnology 143, 2:183–330.
1951. "Indian Tribes of South America" [Map, 1:8,000,000], Berkeley: Berkeley Blue Print Co.

RUSBY, H. H.
1927. "Descriptions of New Genera and Species of Plants Collected on the Mulford Biological Expedition to the Amazon Valley, 1921–1922," *Memoirs of the New York Botanical Garden*, 7:205–387.

RYDÉN, STIG
1941. *A Study of the Siriono Indians*. Göteborg: Elanders Boktryckeri Aktiebolag. 167 pp.

1964. "Tripod Ceramics and Grater Bowls from Mojos, Bolivia," *in* Hans Becher, ed., *Beitrage zur Völkerkunde Sudamerikas, Festgabe fur Herbert Baldus zum 65. Geburtstag,* Hanover, Des Niedersächsisches Landesmuseums Abteilung für Völkerkunde (Völkerkundliche Abhandlungen, Band I), pp. 261–270.

SALAMAN, R. N.
1949. *The History and Social Influence of the Potato.* London: Cambridge University Press. 685 pp.

SANABRIA FERNANDEZ, HERNANDO
1961. *Breve historia de Santa Cruz de la Sierra.* La Paz: Editorial Don Bosco. 51 pp.

SAUER, CARL O.
1950. "Cultivated Plants of South and Central America," *in* Julian H. Steward, ed., *Handbook of South American Indians,* Bulletin of the Bureau of American Ethnology 143. 6:487–543.
1952. *Agricultural Origins and Dispersals.* New York: American Geographical Society. 110 pp.

SCHMIDT, MAX
1914. "Die Guato und ihr Gebiet: Ethnologische und archäologische Ergebnisse der Expedition zum Caracara-Fluss in Matto Grosso," *Baessler Archiv.* [Leipzig and Berlin], 4:251–283.

SMITH, C. T., P. HAMILTON, and W. M. DENEVAN
n.d. "Ancient Ridge Cultivation in the Area of Lake Titicaca." Unpublished manuscript, 25 pp.

STEWARD, JULIAN H. (editor)
1946–1959. *Handbook of South American Indians,* Bulletin of the Bureau of American Ethnology 143. 7 vols.

STEWARD, JULIAN H., and LOUIS C. FARON
1959. *Native Peoples of South America.* New York: McGraw Hill Book Co. 481 pp.

STORIE, R. EARL
1953. "Preliminary Study of Bolivian Soils," *Soil Science Proceedings,* 17: 128–131.

STURTEVANT, WILLIAM C.
1961. "Taino Agriculture," *in* Johannes Wilbert, ed., *The Evolution of Horticultural Systems in Native South America, Causes and Consequences: A Symposium.* Caracas: Sociedad de Ciencias Naturales La Salle. Pp. 69–82.

TORIBIO MEDINA, JOSÉ (editor)
1934. *The Discovery of the Amazon According to the Account of Friar Gaspar de Carvajal and Other Documents.* American Geographical Society, Special Publication No. 17. New York. 407 pp.

TORMO SANZ, LEANDRO
1962. "La campaña de Moxos contra los Portugueses del Brasil," *"Revista de la Universidad Autonoma Gabriel Rene Moreno."* 18 (Año IX):6–30.

TROLL, CARL
1936. "Termiten-savannen," *in Länderkundliche Forschung. Festschrift für Norbert Krebs* [Stuttgart]. Pp. 275–312.

Tschopik, Harry, Jr.
1946. "The Aymara," *in* Julian H. Steward, ed., *Handbook of South American Indians,* Bulletin of the Bureau of American Ethnology 143, 2: 501–574.

United Nations. Mission of Technical Assistance to Bolivia
1951. *Report of the United Nations Mission of Technical Assistance to Bolivia.* New York. 128 pp.

Venezuela. Dirección de Recursos Naturales Renovables
1959. *Recursos agrícolas, pecuarios y forestales del Estado Apure.* Caracas. 493 pp. plus maps.

———. Dirección de Planificación Agropecuaria
1960. *Atlas agrícola de Venezuela.* Caracas. 47 pp.

Viedma, Francisco de
1900. [1788] *"Descripción geografica y estadística de la provincia de Santa Cruz de la Sierra," in* Pedro de Angelis, ed., *Colección de obras y documentos relativos a la historia antigua y moderna de las provincias del Rio de la Plata,* 2:419–542. Buenos Aires: Imprenta Editora de V. Colmegna.

Waibel, Leo
1943. "Place Names as an Aid in the Reconstruction of the Original Vegetation of Cuba," *Goegraphical Review,* 33:376–396.

Wegman, R. E.
1959. "Aerial Reconnaissance in North Bolivia." Shell Oil Exploration Report No. 35. Cochabamba. 5 pp. and map.

Wegner, Richard N.
1931. "Die Mojos-Indianer: Eine Jesuitenmission im 18. Jahrhundert und ihre spätere Entwichlung," *Mainzer Zeitschrift,* 26:92–97.

West, Robert C.
1959. "Ridge or *Era* Agriculture in the Colombian Andes," *in Actas del XXXIII Congreso Internacional de Americanistas* [San José, 1958], 1: 279–282. San Jose [Costa Rica].

White, Orland E.
1922. "Botanical Exploration in Bolivia," *Brooklyn Botanic Garden Record,* 11(3):93–105.

Wilhelmy, Herbert
1958. "Das Grosse Pantanal in Mato Grosso." *in Deutscher Geographentag: Tagungsbericht und Wissenschaftliche Abhandlungen* [Würzburg, 1957]. Wiesbaden: Frans Steiner Verlag. Pp. 45–71.

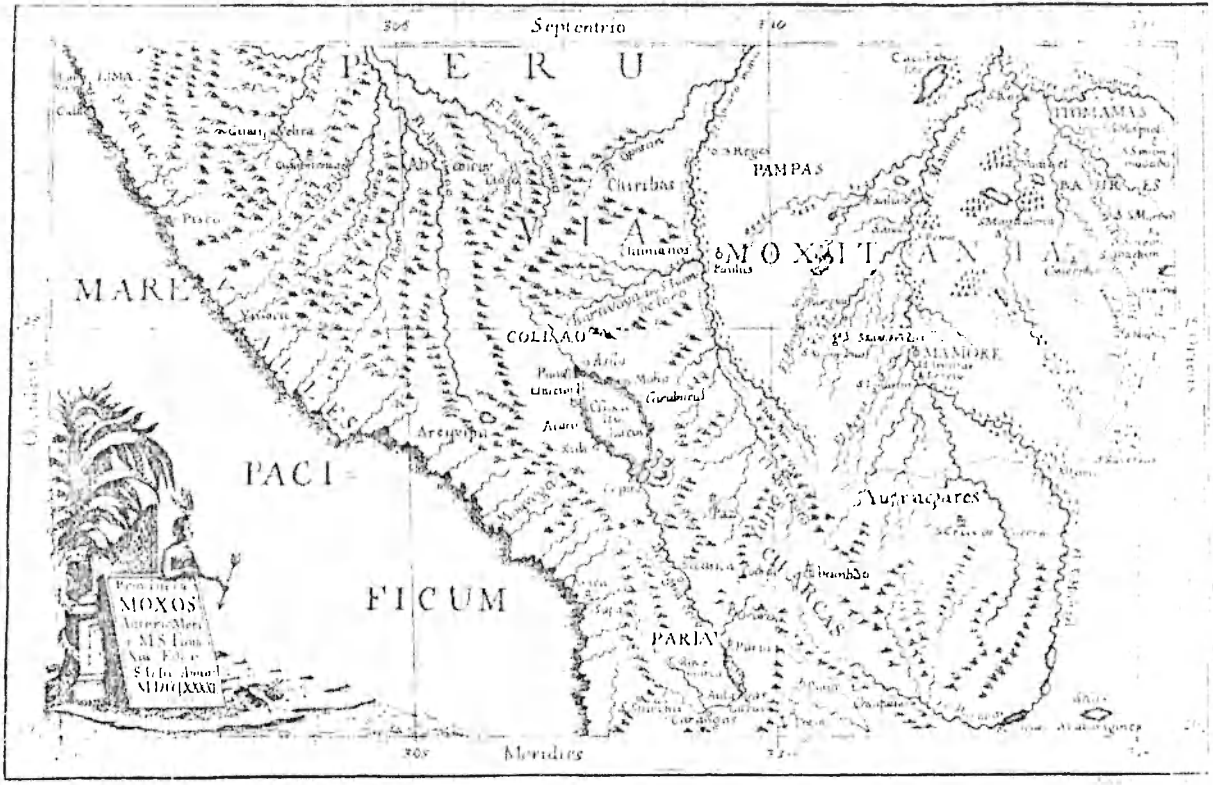
Willey, Gordon R.
1948. "Ceramics," *in* Julian H. Steward, ed., *Handbook of South American Indians,* Bulletin of the Bureau of American Ethnology 143, 5:139–204.
1958. "Estimated Correlations and Dating of South and Central American Cultural Sequences," *American Antiquity* 23:353–378.

Wills, J. Brian (editor)
1962. *Agriculture and Land Use in Ghana.* London: Oxford University Press. 504 pp.

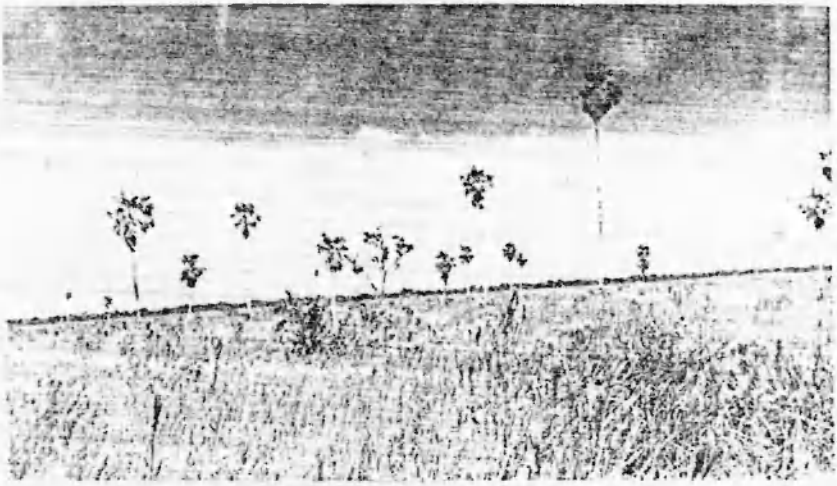
WOODBURY, RICHARD B.
1961. "A Reappraisal of Hohokam Irrigation," *American Anthropologist*, 63:550–560.

ZAPATA, AGUSTÍN
1906. "Carta del Padre Agustín Zapata al Padre Joseph de Buendía, en la que da noticias del Paititi, 8 mayo 1695," *in* Maurtua, 1906*a*, 10:25–28.

PLATES

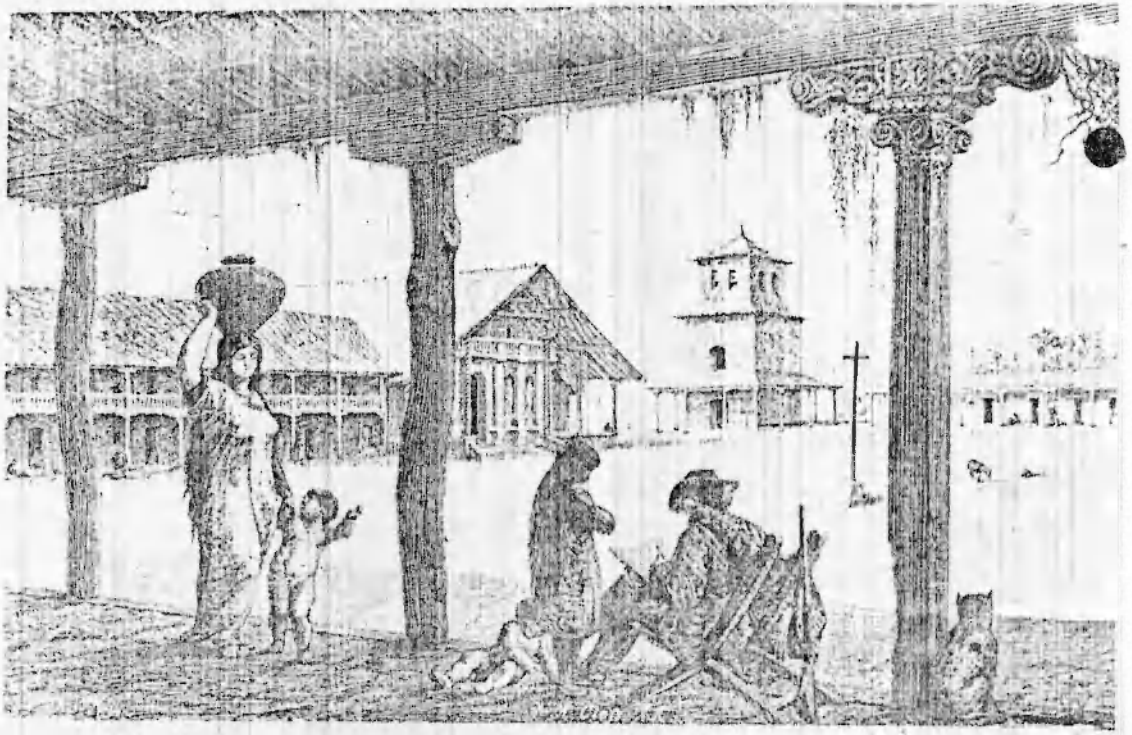


Map of Peru showing Mojos (*Moxitania*) at time of Jesuit expulsion in 1767 (from Eder 1791)

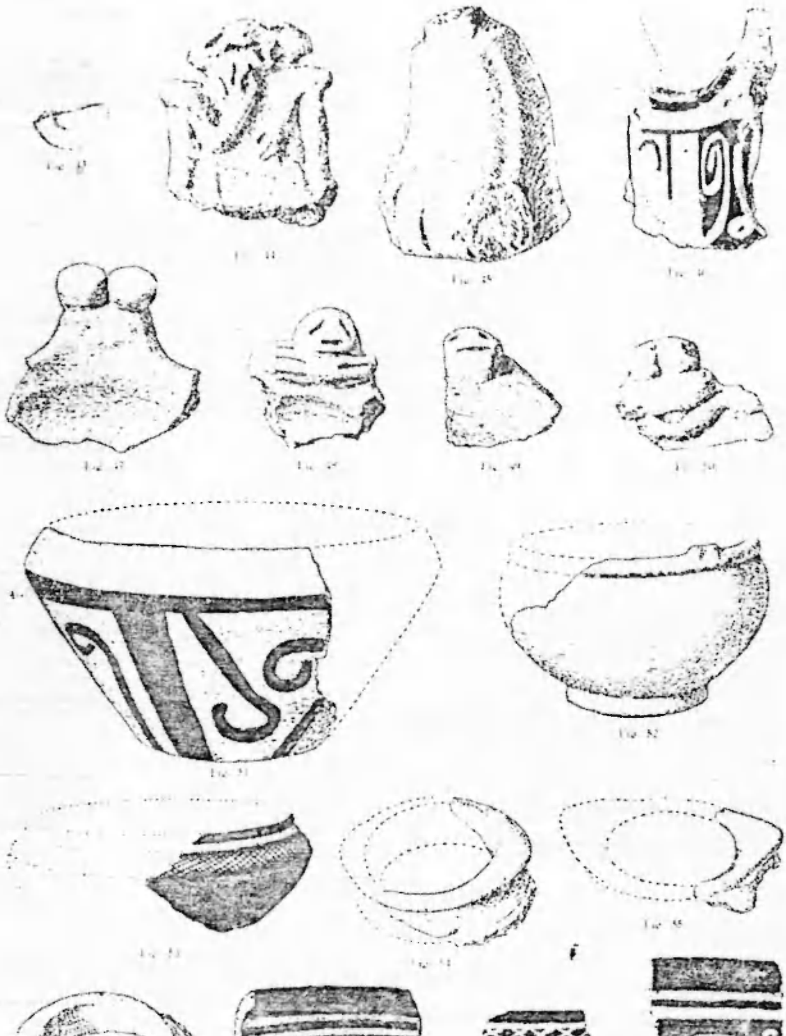


A. Carandá (*Copernicia cerifera*) palm savanna between Loreto and Trinidad in May, 1962. There were several inches of standing water present throughout the area.

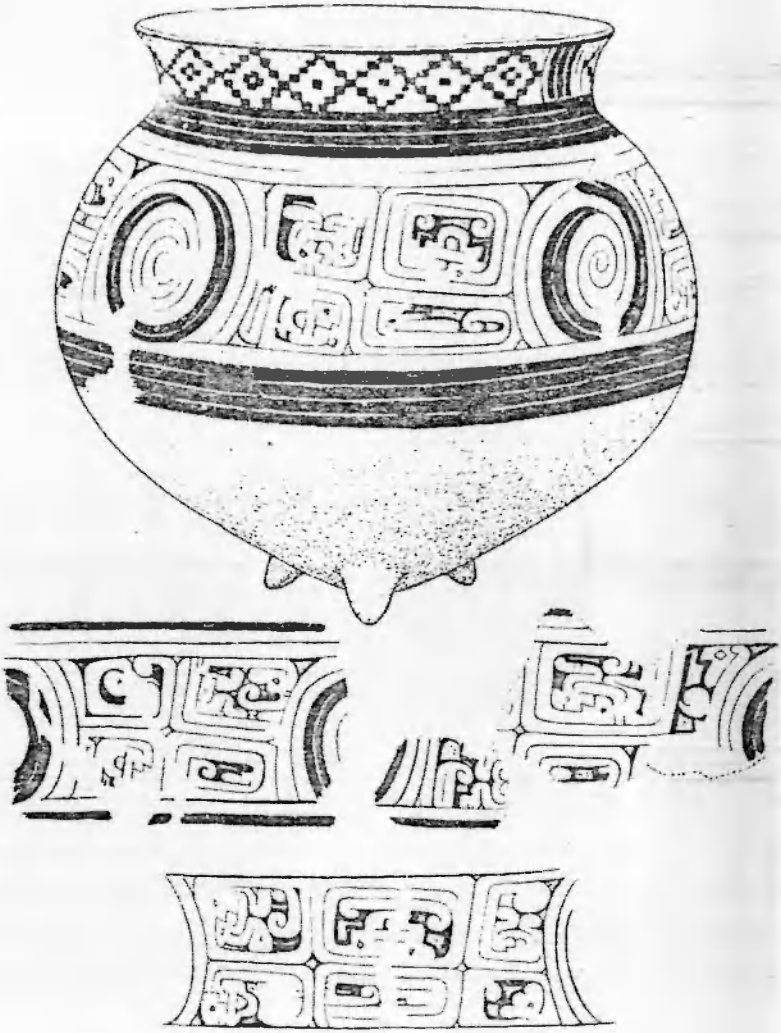
B. Elevated street at the south edge of Trinidad during the "dry" wet season of 1962 (February).



Sketch of Exaltación about 1870 (from Keller, 1875:200). The town in this view probably has changed little since Jesuit times. The houses shown are in one continuous building with overhanging roofs, pillars, and raised sidewalks for protection from rain, flooding, mud and dust. This "Santa Cruz style" replaced the early pattern of separate houses and is still characteristic of Oriente towns.

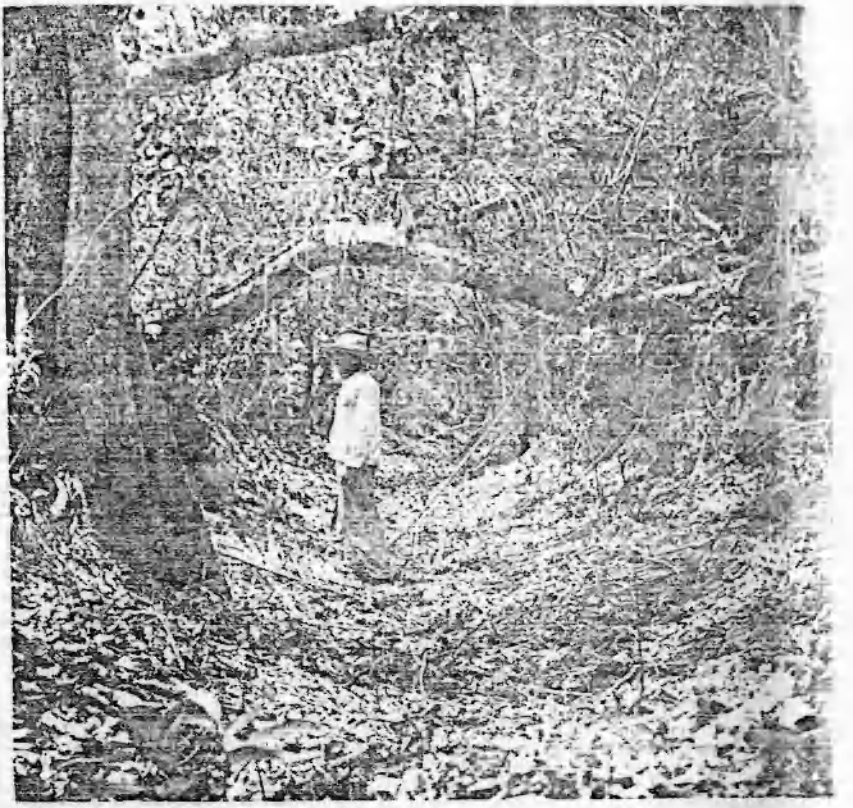


Pottery from Lower Mound Velarde (Nordenskiöld, 1913:219).



Partial urn from Mound Hammarck (Nordenskiöld 1913: 89).

Potsherds from Mound Masicito (Nordenskiold, 1913:244).



Floor of circular ditch or moat 8 kilometers east of Magdalena, measuring about 6 feet i depth and 15 feet in width. This and another circular ditch are encircled by a larger circul ditch which is about 1,800 feet in diameter.

Artificial mound with Sriomó mission church on top at Eviata. The mound is about 20 feet high and 220 feet long and is on a low ridge. Potsherds, burial urns, and stone arrow heads have been found in the mound.

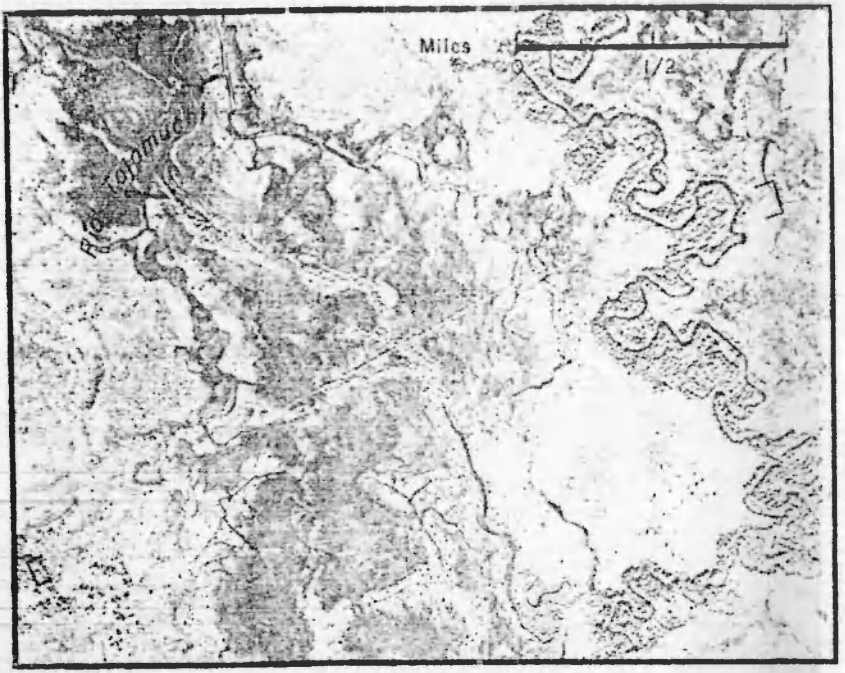
a. Probable artificial island near the Río Matos west of La Esperanza. The smooth-textured area in front of it is wetter than the surrounding pampa and may be an excavation.

b. Canoe path through flooded savanna between Trinidad and the Río Ibare in February, 1962.

Artificial canal (arrow) connecting the Río Mamoré with the Río Ipurupuru, a tributary of the Río Machupo, a few miles north of San Pedro. The canal is about one half mile long and was still being used by Canichana Indians in 1914. (Bolivia California Petroleum Co., Photo No. P350/58-T36, 5130-4: July, 1958.)

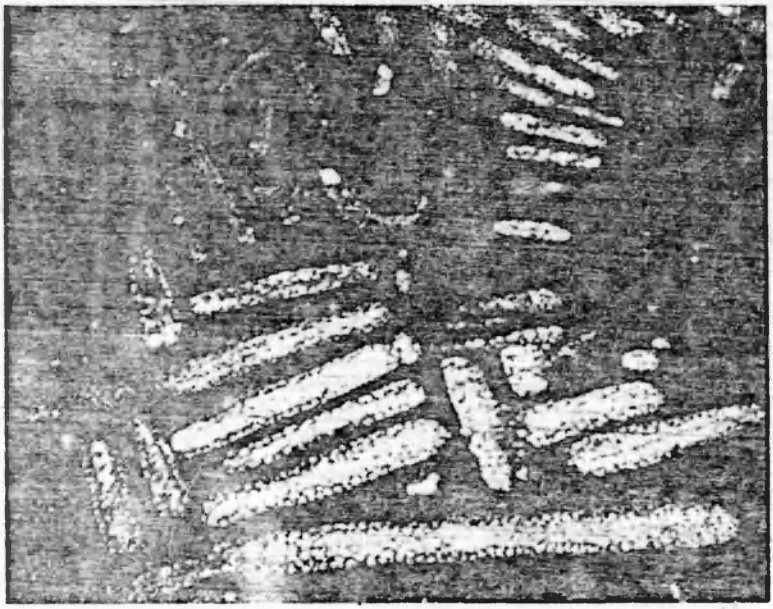
Numerous causeways and ridged fields near the Río Apere about 13 miles southwest of San Ignacio. The fields are encircled, and the causeways (over 50) show up as straight, narrow lines of trees across open pampa. Elevation varies between 780 and 786 feet. (Bolivia California Petroleum Co., Photo No. P 350, 58-33, 4954-130, May, 1958.)

Causeway crossing area of ridged fields next to the Río Apere between El Peru and La Esperanza. The humps on the fields seem to be bushes.



Causeway across a flooded bajío 12 miles north of San Lorenzo (15° 23′ S, 65° 31′ W). The portion of the causeway on the east side of the Río Tijamuchi is 2.4 miles long. (Bolivia California Petroleum Co., Photo No. P350/58-34, 4934-47: May, 1958.)

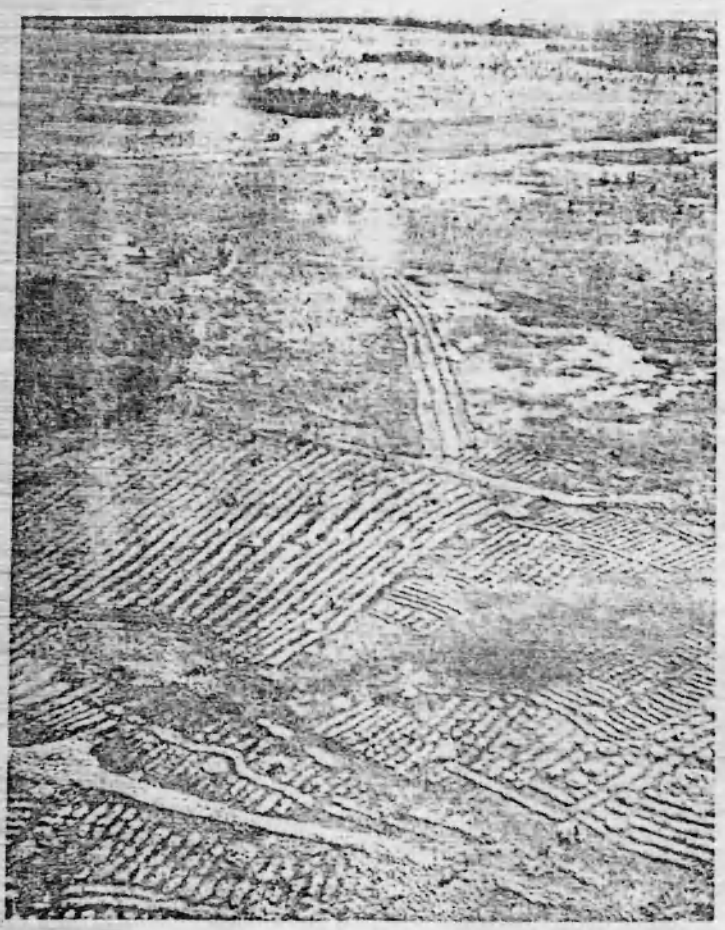
A. Causeway between Magdalena and the Río Itonama, measuring approximately 250 yards in length, 3 to 4 feet in height, and 20 to 25 feet in width.



B. Large raised fields between the Río Iruyani and Lago Rogoaguado. The long field at the bottom is about 50 feet wide and 1,100 feet long. The small ovals on the edges of the fields are termite mounds.

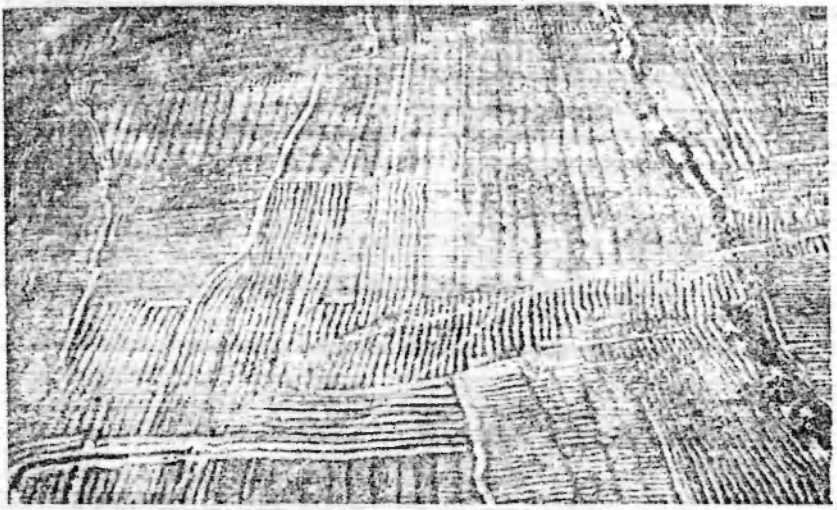
a. Large raised fields at Estancia Santiago between Exaltación and Lago Rogoaguado.

b. Large raised field (center) at Estancia Santiago. The field is about 35 feet wide and stands 15 inches above the adjacent swales (darker grass). Most of the trees are *chaco* (*Curatella americana*). November, 1961.



Ridged fields about ten miles west of El Perú on the Río Apere. The larger circular [illegible] may have been house sites. Also, note the rows of small mounds.

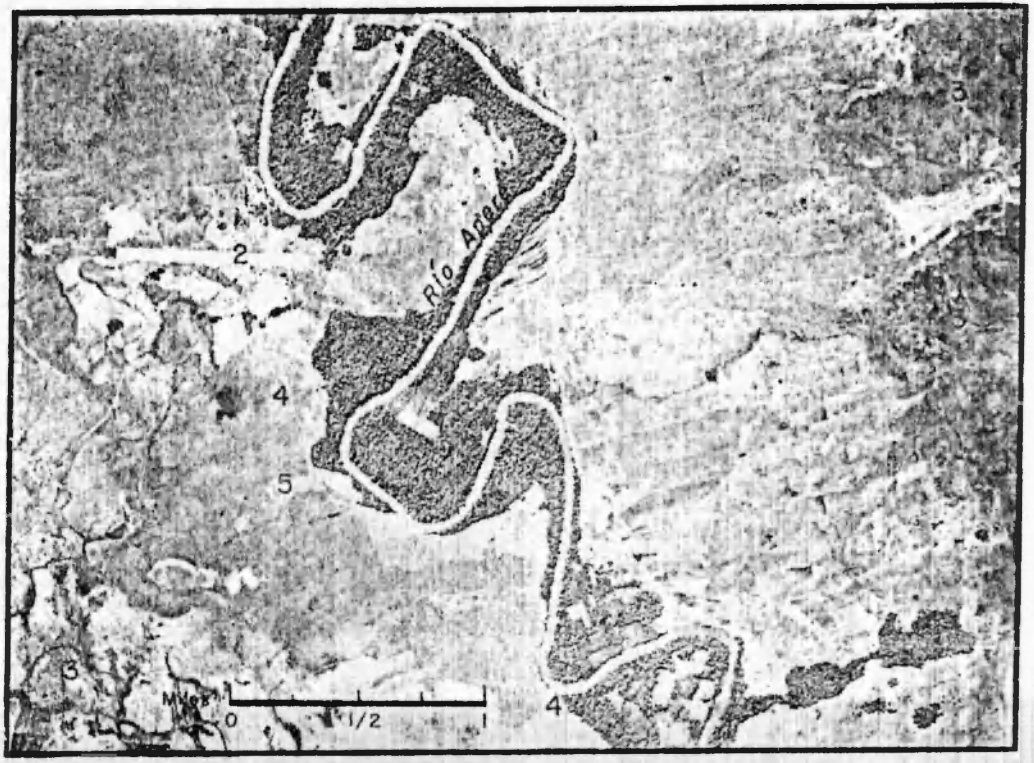
Ridged fields and causeway about ten miles west of El Perú on the Río Apere. The causeway is about 25 feet wide.



Ditched fields at La Esperanza. The fields measure 5 to 25 feet in width and 25 to 500 feet in length. The ditches are 2 to 4 feet wide and 6 to 12 inches deep. The long dark feature running from top to bottom leads to a bajio and may be the remains of a drainage ditch.

Ditched fields obscured by grass near the Río Apere about 30 miles north of San Ignacio

Ditched fields at La Esperanza. The ditches are about 2 feet wide and 6 to 12 inches deep. The fields between the ditches are about 12 feet wide.



Ditched fields at La Esperanza along the Río Apere. There are several thousand individual fields solidly covering the areas between the gallery forest and the bajíos (darker areas) at the right and at the lower left. The fields average about 100 feet in length. (1) Estancia La Esperanza; (2) Landing field; (3) Bajíos; (4) Drainage ditches (?); (5) [illegible] Bolivia Caldeonia Exploration Co., Photo No. P45[illegible]

Large raised fields in flooded pampa near the Rio Iruyani in northwestern Mojos. December, 1962.

Mojo Indian in cotton, mission *tipoy*, and feather headdress (from Eder, 1791: fig. 63). In the pre-Jesuit period the Mojo wore short shirts of either cotton or bark cloth.