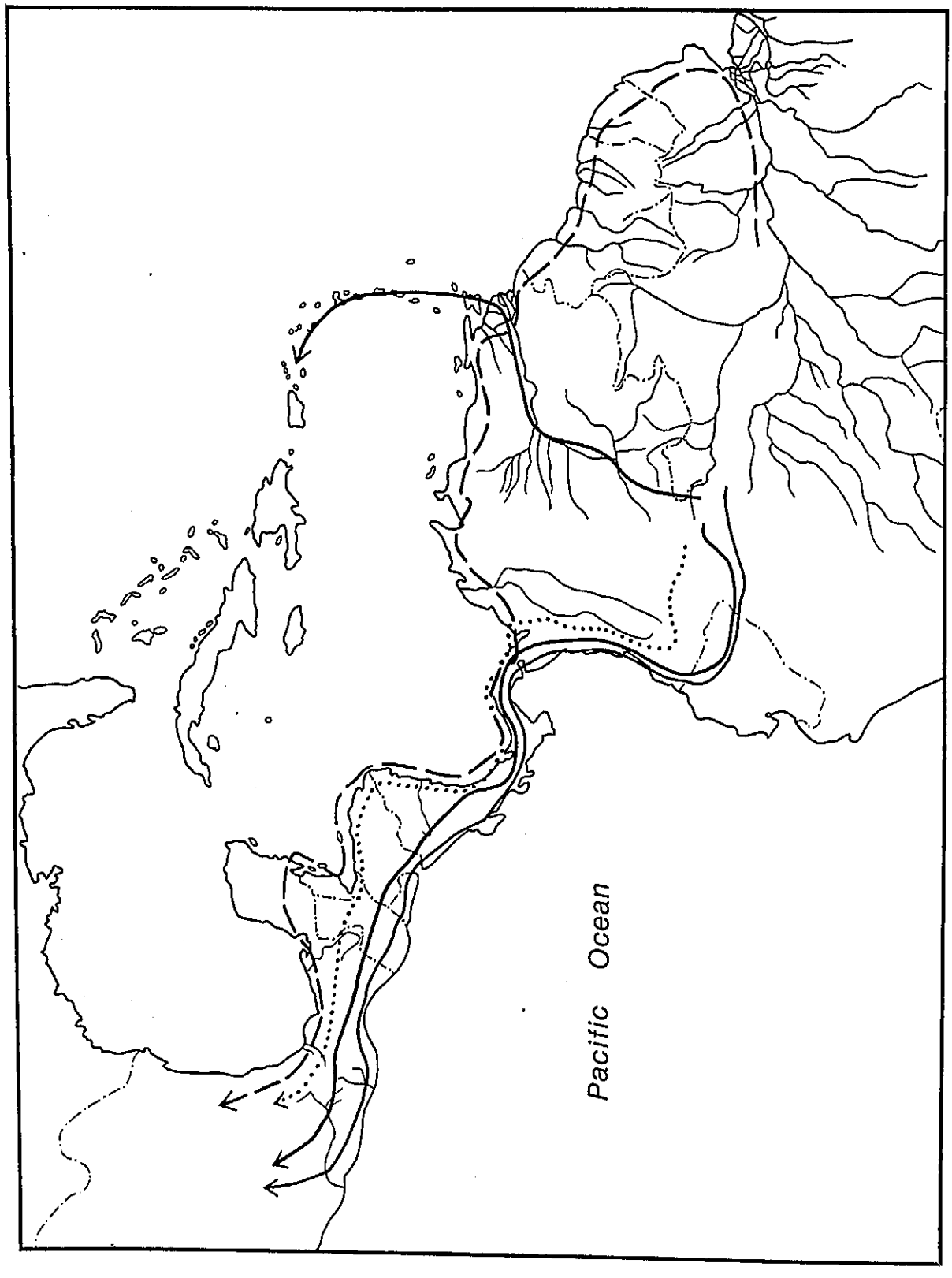

Possible routes of migration of Amazonian plants to Mesoamerica and the West Indies in pre-Columbian times.

Pre-Columbian Plant Migration

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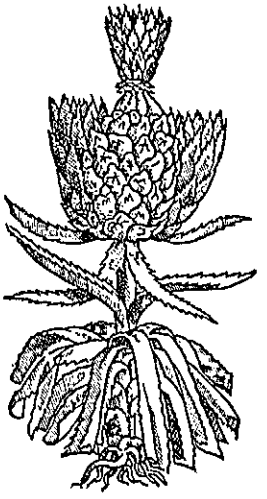
Amazonian Cultigens and Their Northward and Westward Migration in Pre-Columbian Times

Richard Evans Schultes



The Amazon Valley has never been considered to be one of the major centres of origin of cultivated plants, yet some of our well-known and imported domesticated tropical species have apparently come from this wet forested area. Several of these plants spread from the Amazon in pre-Columbian times, and some of them spread rather widely from this area. The routes of their migrations are often not known and must be surmised from available information which has been gleaned from several fields of investigation. The origin, botanical relationships, and possible early odysseys of cassava (*Manihot*), cacao (*Theobroma*), cocao (*Erythroxylon*), yopo (*Anadenanthera*), pineapple (*Ananas*), achiote (*Bixa*), and the peach palm (*Guilielma*) and their significance in early extra-Amazonian cultures are considered.

El Valle del Amazonas nunca se ha considerado como uno de los principales centros de origen de plantas cultivadas. Sin embargo, al parecer algunas de las más conocidas e importadas especies domesticadas tropicales provienen de esta húmeda región selvática. Varias de estas plantas se esparcieron del Amazonas en la época pre-Colombina, y algunas de ellas con cierta amplitud. Las rutas de su migración se ignoran con frecuencia, por lo que se deben conjeturar partiendo de la información disponible obtenida de varios campos de investigación. En este capítulo, se discutirán el origen, las relaciones botánicas y las posibles primeras odiseas de la casava (*Manihot*), del cacao (*Theobroma,* de la coca (*Erythroxylon*), del yopo (*Anadenanthera*), de la piña (*Ananas*), del achiote (*Bixa*) y del pejiballe (*Guilielma*), así como su importancia entre las culturas primitivas fuera del Amazonas.

Throughout the world, there are a few specific regions cited where the major cultivated plants presumably originated or were first domesticated. The most comprehensive investigation of the origin of cultivated plants, carried out on a worldwide basis by the Russian botanist N. I. Vavilov, postulated eight such regions: (1) the Chinese Centre; (2) the Indian Centre; (3) the Indo-Malaysian Centre; (4) the Central Asian Centre; (5) the Near Eastern Centre; (6) the Mediterranean Centre; (7) the Abyssinian Centre; (8) the Mesoamerican and South American Centre (Vavilov 1951). We would now divide the Mexican-Mesoamerican Centre from the South American Centre; a id the South American would be subdiv:ded to separate the Andes from the warmer lowlands areas.

Sc me botanists have apparently pointed out that these centres nearly cover the earth's surface. But such a criticism is hardly valid. All of Australia, all of North America north of Mexico, and all of Africa except for Abyssinia, as well as most of Europe are responsible for only a few cultivated species, and those few are of exceedingly minor or local importance.

The vast humid forested area of the Amazon Valley has likewise in general been considered to have played a relatively minor role in providing modern civilization with important economic species from its exceedingly rich flora, calculated to encompass 85,000 species of higher plants. Yet this belief is not supported by the importance of Amazonian plants that have already entered the roster of significant modern cultivated species; and when the untapped potential of promising species for new crop plants is taken into account, the Amazonia would seem to take its place as one of the world's major centres (Schultes 1979).

The tapioca plant, or *Manihot esculenta* Crantz, for example, may have been domesticated in the Amazon or adjacent regions. The cultivated pineapple, *Ananas comosus* (L.) Merr., is thought by some botanists to have originated in this vast region. Specialists now believe that the cultivated cacao tree, *Theobroma Cacao* L., source of chocolate, arose through the hybridization of wild species in the westernmost Amazon of Colombia and Ecuador. It seems probable that the cultigen, *Erythroxylon Coca* Lam., originated on the eastern or Amazonian slopes of the Ecuadorian Andes. Achiote, or annatto—*Bixa Orellana* L.—now widely cultivated throughout the tropics as a colourant for foods, is native to the Acre in the southwesternmost part of the Amazonia. One of the richest caffeine-yielding plants known—guaraná or *Paullinia Cupana* HBK—has long been grown in the central part of the Brazilian Amazon, where it is undoubtedly indigenous. The place of origin of the palm known in English as peach palm and in Portuguese as pupunha—*Guilielma speciosa* Mart.—now widely cultivated throughout tropical America, may have been the western Amazon, where its diversity appears to be greatest (Schultes 1979).

Two of the world's most recently domesticated plants are likewise native to the Amazon Valley. One of these, the rubber tree, or *Hevea brasiliensis* (Willd. ex Adr. Juss.) Muell.-Arg., domesticated only one hundred years ago, has had an extraordinary effect on human affairs, completely altering living conditions throughout the world and making possible many of the industrial advances of the century since the British took it to the Old World tropics and created the great plantation industry. The other plant, timbó, or *Lonchocarpus Nicou* (Aubl.) DC., a main source of the biodegradable insecticide rotenone, attracted attention for plantation production only during the Second World War, about forty years ago (Schultes 1979).

The potential of the Amazon for still new cultivated plants of major significance for modern civilization is not a theoretical question; it is a practical reality. Current research has focused attention on several promising plants, which are now under investigation preparatory to domestication and incorporation into the present world of commerce and industry.

But what about the Amazonian plants domesticated in pre-Columbian times? How far did they spread north and west from the Amazon Valley before European intervention? And over what routes did they migrate?

The vast Amazon region—2,700,000 square miles in extent—is for the most part hot, humid, and lowland. Its flora is bewilderingly extensive, calculated between 80,000 and possibly even 100,000 species. Its plants are adapted generally for environments providing ample rainfall and consistently high temperatures.

Any pre-Columbian wanderings of cultivated Amazonian plants would undoubtedly have had to be due to slow and gradual penetration into newer and favourable regions. And it is safe to assume that man must have had a major or even a definitive role in such geographical spread.

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Records for pre-Columbian migrations of cultivated plants are sparse or, in most places, nonexistent; but we do fortunately have some early information on the presence or use of Amazonian species in other areas of pre-Conquest America. While certain Amazonian species undoubtedly were taken by man to other tropical regions of South America—the Orinoco basin, the Guianas, and the humid forests south of the Amazon Valley and even, as with *Anadenanthera peregrina* (L.) Spegazzini, to the West Indies—the presence of Amazonian plants in Mexico and Middle America is probably the more spectacular. While records for most areas are sparse or nonexistent, we do have tangible indications of the presence and use of a number of South American plants in pre-Conquest Mexico. For this reason and because of the great distance of Mexico from South America and the existence of formidable ecological barriers between the two areas, a consideration of the pre-Columbian wanderings of Amazonian plants to Mexico may be of special interest.

Although a few plants of minor importance and of incipient cultivation undoubtedly left the Amazon, six seem to be of major importance today. These six are *Ananas comosus; Bixa Orellana; Erythroxylon Coca; Guilielma speciosa; Manihot esculenta;* and *Theobroma Cacao*.

Ananas comosus (L.) Merrill

The pineapple—piña in Spanish-speaking countries and abacaxí or ananas in Brazil—is a cultigen unknown in the truly wild state, although on occasion it may escape and become seminaturalized (figs. 1–3). The plant is frequently referred to in the literature as *Ananas sativus* (Lindl.) Schultes, an older binomial.

There is still uncertainty concerning the exact region of South America where it was first domesticated. The most widely held theory suggests that the Tupí-Guaraní Indians of northern Paraguay were the original cultivators and that it diffused northward into the Amazonia with these wandering natives (Collins 1960; Purseglove 1972; Pickersgill 1976). It is in this region that several related wild species occur: *A. bracteatus* (Lindl.) Schultes, *A. ananassoides* (Bak.) L. B. Smith, *A. erectifolius* L. B. Smith, *A. Fitzmuelleri* Camargo, *A. parquazensis* Camargo et Smith, and the only representative of the monotypic genus *Pseudananas, P. sagenarius* (Arudda) Camargo. *Ananas bracteatus* has, in fact, been cultivated in Paraguay. All the wild relatives are seedy types, quite in contrast to *A. comosus*. All these bromels are distinguished from other members of the family by having syncarpous fruits. Both genera—Ananas and Pseudananas—have the chromosome number basic to the family: $x = 25$; but Ananas is typically diploid and Pseudananas is tetraploid. There seem to be no biological barriers to hybridization, and the F_1 hybrids are fertile (Collins 1960).

There are, however, wild relatives in the Amazon, especially the closely allied *Ananas microstachya* (Baker) Lindm., which has been suggested as a possible ancestor (Ducke 1946). Furthermore, the area of extreme variability of *A. comosus* comprises the western Amazon, in Peru and Colombia. These two considerations might be interpreted as valid arguments for domestication within the Amazon Valley itself.

The pineapple, of course, was unknown in the Old World before the discovery, but the records of the earliest European explorers indicate that it had been widely distributed in tropical America (Patiño 1963). Columbus met this plant on November 4, 1493, on his second voyage. As one of his men wrote of the fruit: "There were some fruits like artichoke plants but four times as tall which gave a fruit in the shape of a pine cone, twice as big, which fruit is excellent, and it can be cut with a knife like a turnip, and it seems to be wholesome." It was reported on the coast of Panama in 1502; Martyr in his *De Orbe Novo* described it from the West Indies in 1516; Pigafetta reported it from Brazil as early as 1519; in his famous *Historia General y Natural de las Indias* of 1535, Oviedo figured and described the pineapple from the West Indies in the most glowing terms (Laufer 1929; Collins 1960).

The many records of the cultivation of the pineapple before 1600 place the plant in such separated places as the Pacific coast of Ecuador and Colombia; the Brazilian coast southeast of the mouth of the Amazon; the coastal areas of the Guianas, Venezuela, and Colombia; the southwestern part of the Brazilian Amazon; the Atlantic coast of Panama, Costa Rica, Honduras, and British Honduras; and the coastal regions of Vera Cruz in Mexico (Pickersgill 1976). In the second decade of the sixteenth century, the natives of Río San Antón in Mexico gave the Spaniards presents of zapotes and pineapples (Las Casas 1951).

Figure 1. Ananas comosus. *From Rumphius,* Herbarium Amboinense *5 (1747).*

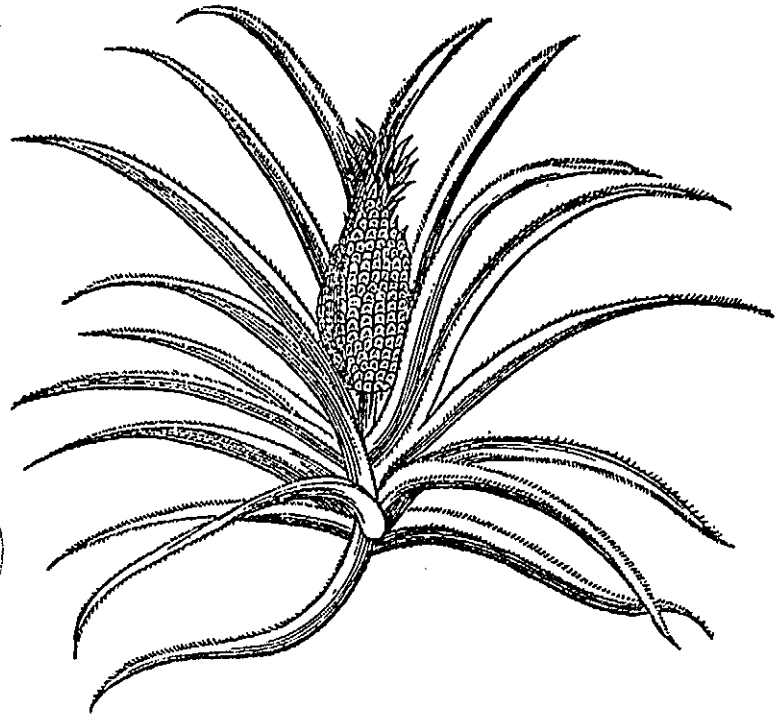


Figure 2. Ananas comosus. *From Marcgrave,* Historia Natural do Brasil *(1942).*

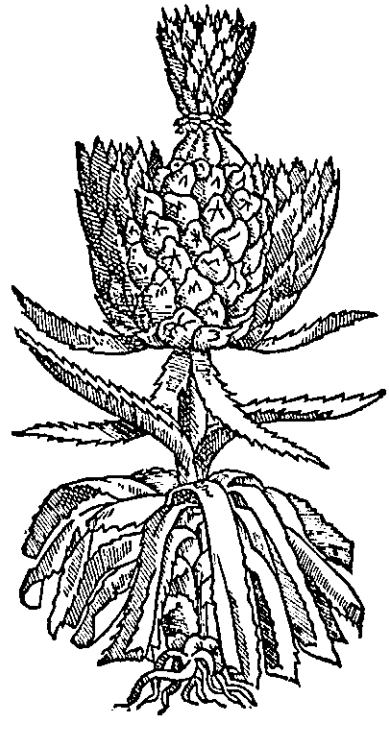


Figure 3. Ananas comosus. *From Hernández,* Rerum Medicarum Novae Hispaniae Thesaurus . . . *(1651).*

These many early reports are significant, since a plant of such remarkable characteristics challenged the attention of all observant travellers. As Laufer has noted, there is hardly any other plant with a history illuminated by so many interesting documents (Laufer 1929).

This coastal distribution at such an early date indicates that at least one route of diffusion northward and westward might have been along the Atlantic coast of South and Central America. Another route may have been by way of the Orinoco to Trinidad with the Arawak and Karib migrations. An explanation of the presence of the pineapple at this early period on the Pacific coast of Colombia and Ecuador might be that the cultigen migrated slowly southward from the Gulf of Urabá.

The pineapple, quite unlike many cultivated plants native to the humid tropics, is altitudinally and environmentally rather tolerant. It can live from sea level to up to 4,700 feet in Central America, and it is able to grow and produce under a wide range of rainfall—from 24 inches to more than 99 inches a year (Collins 1960). Consequently, other routes of migrations unavailable to most plants from the Amazon forests would have been appropriate for the spread of the pineapple.

Bixa Orellana Linnaeus

Known as urucú or annatto in Brazil, and achiote in Spanish-speaking countries, *Bixa Orellana* is a small tree, profusely fruiting to give seeds that are the source

ACHÍOTL

Figure 4. Bixa orellana. *From Hernández,* Rerum Medicarum Novae Hispaniae Thesaurus . . . *(1651).*

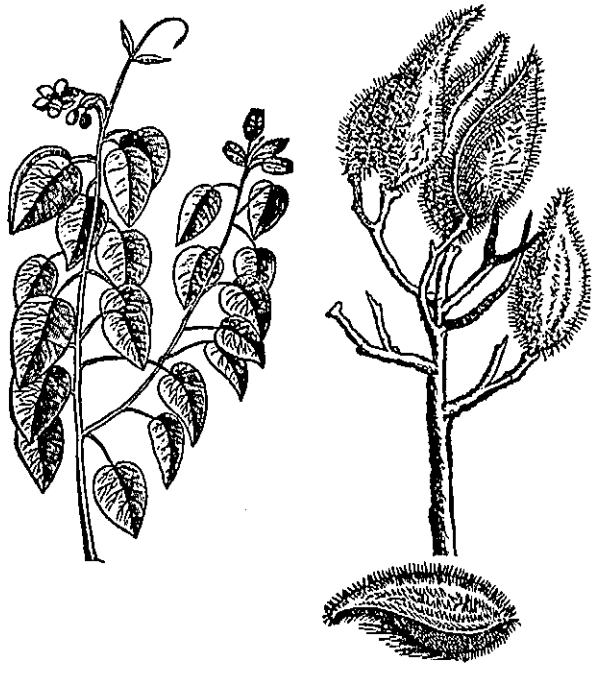


Figure 5. Bixa orellana. *From Piso,* De Indiae utriusque Re Naturali et Medica Libri quatuordecim . . . *(1658).*

of a reddish or orange dye and a spice commonly added to foods in tropical America (figs. 4, 5). It is an excellent source of vitamin A, in which tropical diets frequently are deficient. The species was named by Linnaeus for Orellana, the early European explorer of the Amazon River.

Bixa Orellana, now cultivated widely throughout the tropics of both hemispheres, is unknown in the wild. It is thought that this plant may have arisen from *B. excelsa* Gleason et Krukoff, a large tree of the forests of the Acre in the southwesternmost part of the Amazon (Ducke 1946).

The plant had undoubtedly spread throughout the Amazon and other tropical areas of America centuries before the discovery of this continent, for its use was fully established as far away as Mexico by the time the Europeans arrived. Hernández, the personal physician of the King of Spain, who studied Mexican Indian medicinal plants in the early sixteenth century, figured the plant and described it in great detail as *achiotl,* a "medicine good for dyeing." He enumerated the numerous therapeutic uses that the Mexicans made of it, mentioned the value of its wood for fuel, spoke of the preparation of a strong fibre from its bark, extolled its virtues as a dye, and reported its addition to chocolate.

Bixa Orellana is a plant of the humid tropics, and its route from the Amazon as far west as Mexico undoubtedly followed the coastal regions of South America, either the Atlantic or the Pacific or, more probably, both.

26 *Figure 6. Drawing of* Erythroxylon Coca *Lam., executed by Joseph de Jussieu in 1749 at Sica Sica in Bolivia and preserved in the Museum d'Histoire Naturelle in Paris. Cavanilles copied this drawing for his* Dissertiones *published in 1789 (plate 229). Jussieu's drawing was copied also and published by Mortimer in his* History of Coca *(1901). Courtesy of T.C. Plowman.*

Erythroxylon Coca Lamarck and *Erythroxylon novogranatense* (Morris) Hieronymus

There are two species of cultivated coca (Plowman 1979a). Both are cultigens unknown in the wild. *Erythroxylon Coca* (fig. 6), the more important, is cultivated in Andean South America between 1,500 and 4,500 feet; it extends from Ecuador south to Bolivia and northern Argentina. The second species, *E. novogranatense,* in highland Colombia and Venezuela in lower, warmer and drier regions, is more tolerant of wider environmental conditions; it is known commercially as "Colombian coca."

Each of these species has a variety: *E. Coca* var. *Ipadu* Plowman (Plowman 1981) and *E. novogranatense* var. *truxillense* (Rusby) Plowman (Plowman 1979b). The former is cultivated in the western part of Amazonia; the latter is cultivated in the drier western slopes of the Andes up to 5,400 feet near Trujillo, but archaeological evidence indicates that it was formerly widely grown along the xerophytic coastal areas of Peru 1,750 to 1,900 years ago (Towle 1961; Patterson 1971; Cohen 1978; Naranjo 1981).

Where did *Erythroxylon Coca* originate? By the time the Europeans arrived, coca was being cultivated from Bolivia to Colombia and Venezuela (Antonil 1978). Plowman believes that *E. Coca* is native to the montaña of the eastern Andes, possibly in Peru or Bolivia (Plowman 1981). Another possibility is that it was domesticated somewhere on the Amazon slopes of the Andes, probably in Ecuador and southern Colombia, where an abundance of ceramic representations known as coqueros—faces showing the cheeks puffed up with the typical coca quid—and iscupurus—containers for keeping the ashes or lime—date back 2,500 years to 500 B.C.; furthermore, vases with coquero representatives from the region around Ambato, a central inter-Andean region of Ecuador, date also from this early period. This is a region with direct access to and from the Amazon through the Pastaza Valley. Since all these artifacts apparently are the oldest known objects connected with coca chewing, they might be taken as an indication of this general region as the home of the coca plant (Naranjo 1981).

As this species diffused into the Amazon, a distinct cultivated variety arose, which has recently been recognized and named *Erythroxylon Coca* var. *Ipadu* (Plowman 1979b, 1981). *Ipadú* is the Tupí-Guaraní name for the coca plant and is now generally employed for the narcotic in the Brazilian Amazonia. There are several morphological differences between *E. Coca* and its Amazonian variety; and the latter has consistently lower concentrations of cocaine than has the former.

There is a difference of opinion concerning the age of coca-chewing in the Amazon. Schultes and Ducke believe that it is ancient (Ducke 1946; Schultes 1981); other specialists argue for relatively recent introduction (Uscateguí 1961; Plowman 1981). At any rate, since the use of coca is and apparently has been restricted to the westernmost half of the Amazon Valley, it is probable that no migration of *Erythroxylon Coca* var. *Ipadu* took place from that area.

There is no evidence that the coca plant reached Mexico, nor that it was ever established in the West Indies. It may, however, have penetrated into Central America as far as Costa Rica, where archaeological artifacts suggest its possible use. It was reported from Nicaragua during the sixteenth century, apparently diffused in with Chibcha-speaking Indians (León, personal communication). References are, however, unreliable. If indeed coca did get that far west, it undoubtedly came by way of Colombia, where the major species cultivated was *Erythroxylon novogranatense.* Since this species is much more tolerant of altitudinal and climatic factors than *E. Coca,* it might easily have diffused slowly northwestward in the highlands and in the lowlands through Panama and into Costa Rica. One of the persistent enigmas in American ethnobotany is why a plant of such aboriginal predilection as coca—and a plant so widely adaptable to diverse climates and environments—should not have enjoyed an extraordinarily wide distribution in the Americas in pre-Columbian times.

28 *Guilielma speciosa* Martius

This palm, with its highly nutritious and delicious fruit, has been cultivated apparently for millennia in the humid American tropics (fig. 7). Known in English as peach palm, in Peru as pijuayo, in Colombia as chontaduro, in Brazil as pupunha, and in Central America as pejibaye, it is sometimes technically termed *Guilielma Gasipaes* (HBK) L. H. Bailey, *G. utilis* Oersted, or *Bactris Gasipaes* HBK.

The exact area of origin of *Guilielma speciosa* is not known, and it is widely but probably incorrectly stated that it can no longer be found wild. Over a century ago, the explorer of the Amazon, Bates, wrote (Seibert 1950:71), "Pupunha grows wild nowhere on the Amazons. It is one of those few vegetable productions . . . which the Indians have cultivated from time immemorial and brought with them in their original migration to Brazil."

There seems, however, to be every probability that the home of *Guilielma speciosa* is the Amazon. Barbosa-Rodrigues suggested in 1903 that *Guilielma speciosa* may have arisen from the presumably wild *G. mattogrossensis* Bar.-Rodr., that it spread throughout the Amazon Valley by way of the Ríos Tapajóz and Madeira and that centuries of cultivation changed its appearance (Barbosa-Rodrigues 1903). In 1898 Huber found the palm in what he considered a wild state in the Peruvian Amazon—in the Huallaga and Ucayali valleys—and suggested that it was native to the southwestern part of the Amazon, having originated in the Acre as a hybrid between *G. microcarpa* Hub., which the natives of the Río Purús call pupunha brava (wild pupunha) and *G. insignis* Mart. of Bolivia (Huber 1904). Ducke seems to favour Huber's explanation (Ducke 1946). Seibert found *G. speciosa* in typical rain forest areas in eastern Peru, where, he states, "it seems safe to assume that here, at least, Guilielma is native" and that "the same may well be true of other eastern Andean valleys throughout northern Bolivia, Peru and Colombia" (Seibert 1950:70). Plowman has recently reported seeing *Guilielma speciosa* in what he considers an undoubted wild state on the Amazonian slopes of the Peruvian Andes (Plowman, personal communication). There is no question, however, that the greatest range of variability occurs in the westernmost Amazon in Colombia and Peru. I have seen an incredible variability of this palm in the northwest Amazon of Colombia.

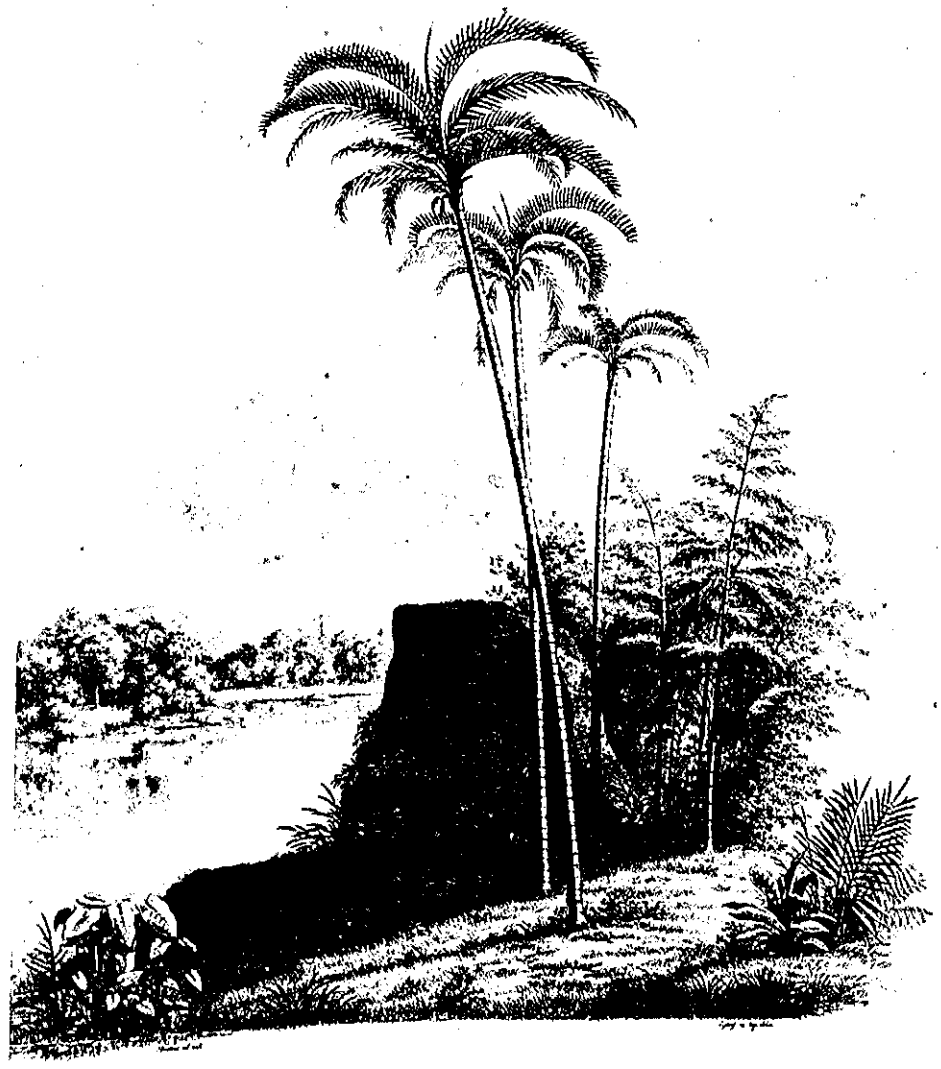
A very new theory suggests that *Guilielma speciosa* arose from two distinct hybridizations: one in Central America, the other in South America. This theory is based in part on the significant differences between the Central American populations and those of South America (Mora Urpí, personal communication).

Wherever this most useful palm originated, it early spread to the north throughout the Amazon, Orinoco, and the Guianas and eventually established itself in Trinidad and possibly other West Indian islands, the humid Pacific coastal areas of Colombia, and Ecuador, and penetrated into Central America, where it is now most common in Costa Rica (Seibert 1950). Archaeological remains of the fruit have been found in San Agustín in southern Colombia in sites dating from the tenth, eleventh, and twelfth centuries (Duque-Gomez, personal communication).

Historical documentation indicates that *Guilielma speciosa* was well established in Costa Rica in pre-Columbian times (Fernández 1907; Stone 1956). It did not and has not apparently arrived, at least as a crop plant, as far west as tropical southwestern Mexico.

This palm tolerates well altitudes to 3,600 feet. Consequently, it could have migrated from the Amazon and passed the Andes to become established in Central America—presumably in pre-Columbian times. Two plausible routes have been suggested. Slowly penetrating the whole Amazon Valley, it eventually could have been taken by the Arawak and Karib Indians up the Rio Negro and down the Orinoco to Trinidad; the Karib travelled widely over the Caribbean and easily could have introduced the tree to various parts of Central America. Another—and, in my opinion, the more plausible—route might have been the lower passes through the Andes to the coastal areas of northwestern Ecuador; once established, the tree could easily have migrated northwards to Panama and along the humid lowlands to the rest of Central America, for it is known that the Indians had both sea and trade routes through this Pacific region (Seibert 1950).

Figure 7. Guilielma speciosa. *From Martius,* Historia Naturalis Palmarum 2 *(1824).*



GUILIELMA speciosa.

30 *Manihot esculenta* Crantz

One of the dozen most important food plants of the world, cassava, or *Manihot esculenta* (fig. 8), ranks also as one of the most complex cultigens known. Because of its great variation, many species names have been applied to what in reality seem to be strains, races, or ecotypes: the most frequently encountered in the literature are *M. Aipi* Pohl (the nontoxic type with low concentrations of the cyanogenic glycoside); *M. utilissima* Pohl (the toxic type with high concentrations of the glycoside); *M. dulcis* Pohl; and *M. palmata* Muell.-Arg. The genus Manihot has 98 species, all of which apparently can cross; all of the species studied have 36 chromosomes. *Manihot esculenta,* an allotetraploid, is unknown in the wild (Jennings 1976).

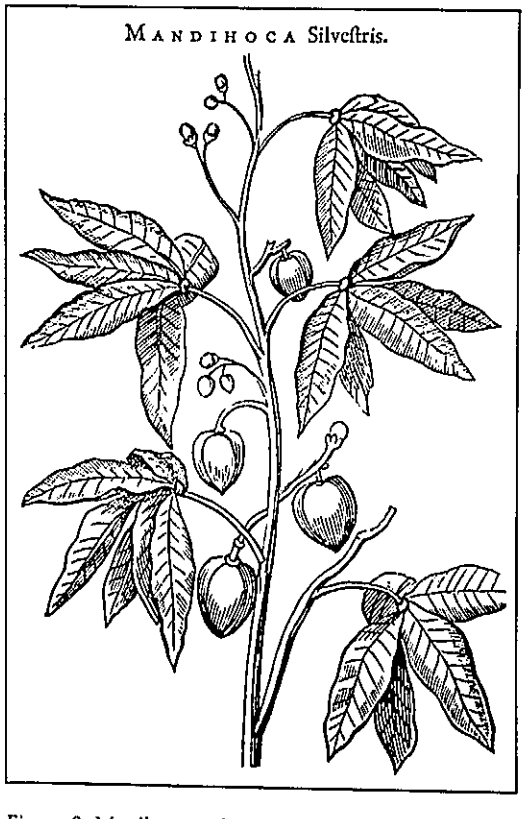


Figure 8. Manihot esculenta. *From Piso,* De Indias utriusque Re Naturali et Medica Libri quatuordecim . . . *(1658).*

Older writers on cultivated plants tended to favor a South American origin for *Manihot esculenta:* de Candolle (1883), northeastern Brazil; Vavilov (1951), northeastern Brazil; Schery (1947), Brazil. Sauer, on the basis of ecological and anthropological considerations, postulated that the savannahs of Venezuela should be considered (Sauer 1952). Ducke confessed in 1946 that "nothing is known with certainty concerning the origin" of cassava (Ducke 1946:15). De Albuquerque considered the area of origin to be Bahía, but he pointed out that there has been great uncertainty and that Mexico, Central America, central Brazil, and even Africa had been proposed (de Albuquerque 1969). Schwerin holds that the origin took place in Mexico or Central America (Schwerin 1970).

The most thorough and recent study of this cultigen is that of Rogers and Fleming, who believe that there are two geographical centres of diversification of Manihot and that *M. esculenta* may have arisen in two centres, a view which Rogers later renounced: Mexico (including Guatemala) and northeastern Brazil (Rogers 1963; Rogers and Fleming 1973). They suggest that the closest wild relatives of *M. esculenta* are *M. aesculifolia* Pohl, *M. rubricaulis* I. M. Johnston, and *M. Pringlei* Wats. Mangelsdorf et al. (1964) have postulated that the sweet and bitter strains of cassava originated separately and developed independently.

While there are hundreds of strains of *Manihot esculenta,* they are all usually grouped into two categories: the so-called "sweet varieties" (strains with low concentrations of the cyanogenic glycoside); and the so-called "bitter varieties" (strains rich in the glycoside). The former are usually more widespread than the latter, are more closely associated with the older civilizations, and were customarily employed as secondary foods, not as the basis of nutritionary needs. No types of *M. esculenta,* of course, are completely devoid of the glycoside, and it has been suggested that the bitter varieties might have been favoured for cultivation where predators presented problems. As Jennings notes: ". . . any recessive mutant gene which conferred an incapacity for producing glycosides would have had little chance of becoming homozygous in an allotetraploid like cassava" (Jennings 1976:82).

A most thorough evaluation of the several theories on the origin of cassava has been published by Renvoize. Taking into account botanical, ethnological, and archaeological evidence, she has concluded that sweet cassava was first domesticated probably in Mesoamerica as one item in an assemblage of vegetatively propagated crops and that there is no evidence of the early cultivation of bitter cassava in this region. Bitter cassava, on the other hand, seems "to have first come under cultivation in northern South America and to have achieved great prominence as the major crop in horticultural systems depending mainly on vegetatively propagated crops . . . In Brazil, where there is considerable varietal diversity and an abundance of related Manihot species, there must have been particularly favorable conditions for hybridisation and the development of new varieties of manioc; but on present evidence, it seems unlikely that the bitter manioc was first domesticated there" (Renvoize 1972:359).

Ancestral types of modern cassava may have been amongst the first food plants used by man in tropical America. Evidence is not firm enough, however, to decide whether modern cassavas have come from one or from several species. It has been postulated that the great food value of cassava was recognized in both putative centres of origin. The idea has even been put forth that the bitter variety of *Manihot esculenta* was first employed not for its high starch content but for the ichthyotoxic properties of the water with which the cyanogenic glycoside is extracted.

There is no doubt that cassava has been cultivated for several millenia in both Mexico and South America. Archaeological evidence indicates that cassava has long been a major food in the wet tropics of the New World, pointing to its cultivation 2,500 years ago in Mexico; secondary or circumstantial evidence suggests that it may have been cultivated as long ago as 4,000 years (Purseglove 1968; Cock 1982). There is likewise evidence that cassava was an article of trade in northwestern South America in the second and third millenia B.C. (Reichel-Dolmatoff 1965; Lathrop 1973). A large number of griddles of the kind upon which flour from bitter cassava was and still is made have been found in archaeological sites in northwestern South America, near the Guajira Peninsula; these have been dated at between 1000 and 5000 B.C. (Rouse and Cruxent 1963). Similar griddles and other indirect evidence place cassava much later at the mouth of the Amazon—at A.D. 1300 and the first European contacts (Galvão, quoted in Rogers 1965; Meggers and Evans 1957). Excellent remains have been found in Peru from the Cupisnique period on the north coast, at Ancón and from Chuquitanta, Pachacamac, Ica, Chillón, and Paracas (Towle 1961). Material believed to represent *Manihot esculenta* has been excavated from La Perra Cave in Tamaulipas (MacNeish 1958); and starch grains in coprolites from caves in the Tehuacan Valley in Puebla (900–200 B.C.), Mexico (Callen 1967), appear to be those of this species.

All early European voyagers to the New World mentioned cassava. By 1696, a long bibliography on the plant had grown up, and Sloane in his *Catalogus Plantarum in Insula Jamaica* and his later *Natural History of Jamaica* said that it was "of the most general use of any provision all over the West Indies, especially the hotter parts, and used to victual ships" (Burkill 1935).

If *Manihot esculenta* originated as a cultigen in two centres, there would in all likelihood have been no need for long routes of early migration from South America to Mexico or vice versa. As Renvoize points out, ". . . intercommunication between and migration of Amerindian tribes has evidently caused both types of manioc to diffuse widely and to become established as crops of major importance (Renvoize 1972:359). The plant could easily have spread to the Caribbean islands from the Amazon by way of the Orinoco or along the Atlantic coast of northern South America; it could have as easily spread to the West Indies from Central America. If it had an Amazon or Orinoco origin, it could have reached the Pacific coast of South America through passes in the Andes, for cassava can grow at altitudes sufficiently high to have penetrated through some of the lower passes; but it could also have crossed the northern coast of South America to the Gulf of Urabá and then easily have diffused southward to Peru along the Pacific coast. If cassava did migrate from South America—where obviously it is older—to Mexico, it would have encountered little difficulty in gradually spreading westward from northwestern South America, where it has long been established, through Central America to Guatemala and Mexico.

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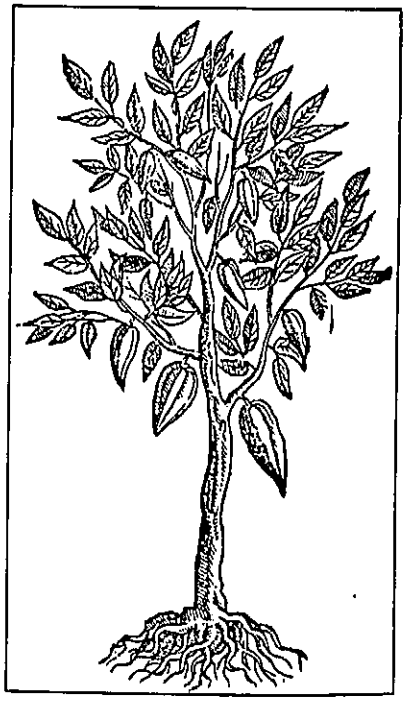
Theobroma Cacao Linnaeus

Theobroma Cacao (fig. 9) is an ancient cultigen in Mexico and Central America, having been grown there possibly for more than two millennia, although there seems to be complete agreement amongst botanists that the tree is South American in origin—from the eastern or Amazonian slopes of the Andes in Colombia and Ecuador. It is such an ancient and favourite cultigen that natives have ascribed a divine origin to the tree, and Linnaeus recognized this in coining the generic epithet *Theobroma,* from the Greek "food of the gods."

The genus Theobroma has 22 species, all tropical American. The only commercially important species is *T. Cacao.* Cuatrecasas recognizes six taxonomic sections; *T. Cacao* represents one (Cuatrecasas 1964). Hybrids between *T. Cacao* and species in the other sections of the genus do not give viable progeny. *Theobroma Cacao* has been divided into two subspecies and four forms, all interbreeding to give fertile F_1 hybrids. The Venezuelan trade names classify the principal types of *T. Cacao* into three groups: (1) Criollo (Central American and Venezuelan types), (2) Amazonian Forastero, and (3) Trinitario (Venezuela and Trinidad). The Central American Criollo has been cultivated in Middle America for probably 2,000 years and has developed seeds with no astringency and requiring little fermentation; the Venezuelan Criollo developed in northern South America from the Central American Criollo after the reintroduction of this latter type into Venezuela and Trinidad in 1525. The Trinitario is a hybrid of Criollo and Forastero ancestry (Cope 1962, 1976).

Pound (1938) and Cheesman (1944), after extensive studies, agreed that *Theobroma Cacao* originated on the Amazonian slopes of the Colombian and Ecuadorian Andes. This area exhibits the greatest variation in the plant; the variation decreases as one travels eastwards in the Amazon. Furthermore, the greatest concentration of species of Theobroma is found in the western Amazon. Cuatrecasas (1964:507) believes that "in early times a natural population of *Theobroma Cacao* was spread throughout the central part of Amazonia-Guiana westwards and northwards to the south of Mexico" and "that these populations developed into two different forms geographically separated by the Panama isthmus." It has, however, been suggested that "the Criollos began as mutations and the fixing of homozygous recessive characters in populations on the periphery of distribution and were then maintained through geographic isolation and selection" (Purseglove 1968:572).

Figure 9. Theobroma cacao. *From Hernández,* Rerum Medicarum Novae Hispaniae Thesaurus . . . *(1651).*



The Spaniards found chocolate commonly used in Mexico at the time of the Conquest, especially amongst the Mayas. The Aztecs and other tribes of central Mexico employed the seeds as currency. An early European chronicler wrote: ". . . there is growing a great store of cacao, which is a berry like unto the almond. It is the best merchandise that is in all the Indies. The Indians make drink of it, and in like manner meat to eat. It goeth currently for money in any market or fair and may buy flesh, fish, bread or cheese or other things (Baker 1886). European writings following the Conquest abound in references to cacao (Knapp 1920; Urquart 1955; Chatt 1953). One of the most reliable sources is Hernández' *Rerum Medicarum Novae Hispaniae Thesaurus, seu Plantarum, Animalium, Mineralium Mexicanorum Historia.* Distinguishing four kinds of cacao in Mexico, Hernández detailed the use of cacao seeds as food or drink, for currency, and as a medicine

for treating dysentery; he also warned that immoderate use "obstructs the intestines, destroys the complexion and causes a general degeneration of the health" (Hernández 1651:79–80).

Notwithstanding its important and ancient use in Mexico and Central America, it seems that the Indians of its original Amazonian home knew nothing of its outstanding economic value. So far as we know, these people were unaware of the value of chocolate. Probably the Amazonian Indians esteemed *Theobroma Cacao*—as indeed they do today with this and other species of Theobroma and the related genus Herrania—only for the sweet pulp surrounding the seeds.

In the instance of *Theobroma Cacao,* we must make a distinction between what Barrau has called its "botanical birthplace" and its region of domestication (Barrau 1979). As Cuatrecasas has stated: "... historical knowledge at present can only relate cacao to Central American man, especially the Mayans, and not to the South American Indians. Central American Indians undoubtedly developed the art of planting and selecting of cacao through several thousands of years, finally obtaining the high quality produce which the Spaniards found at the time of the Conquest" (Cuatrecasas 1964:507).

But if the Amazonian Indians were unaware of the great value of the seeds for chocolate, how did the plant begin its spread from the western Amazon to such far distant areas as Mexico and Central America? What sparked such an odyssey? And by what route did it migrate?

I cannot begin to offer an explanation of the reasons for the interest that would have been strong enough to urge Indians to disseminate a tree the use of which lay solely in a sweet pulp on which one might suck. There are many Amazonian plants that provide sweet pulp around the seeds. Or did some tribe discover and utilize the caffeine-rich seed of *Theobroma Cacao*—a use of which, for lack of written records in this forested area, we are still unaware?

Whatever the causative reason, the trek out of the reduced area of its homeland undoubtedly embraced first the Amazon itself. Once spread through much of the Amazon Valley, *Theobroma Cacao* could have worked its way north and westwards by two routes—and undoubtedly both routes did play a role. When the cacao tree finally became established at the mouth of the Amazon, it could gradually have made its way along the humid forested Atlantic coast of northern South America, across the Guianas and Venezuela. The Caribbean coast of Colombia, however, is arid, and cacao would not survive in that area; it would necessarily have to be taken by man to the northwesternmost corner of Colombia—the Gulf of Urabá, a highly humid region—whence it could then continue on its way through Panama, Costa Rica, Nicaragua, Honduras, Guatemala, and into tropical Mexico.

Another route might have been by way of the Orinoco. The penetration of the Rio Negro of Brazil would lead directly to the Casiquiare, a canal linking the Amazon drainage area with the uppermost Orinoco. The necessary environmental continuum for this strictly tropical tree requiring abundant rainfall would have been available along this route to the coastal region of Venezuela.

Theobroma Cacao can be cultivated successfully up to 4,000 feet in Venezuela and 3,000 feet in Colombia; but most of the crop is planted below 1,000 feet. Therefore, it might have been possible for cacao to have travelled with Indians from its home on the eastern slopes of the Colombo-Ecuadorian Andes through some of the low passes to be planted on the wet, hot tropical western slopes of the Andes. Once established in the humid forests of the Pacific coastal region of Ecuador and Colombia, it would have no ecological barrier to travel westward into Central America and southern Mexico.

Several academic reasons urge us to unravel the early wanderings of plants, but academically oriented specialists might easily overlook what to me seems to be a most compelling reason: the value of such knowledge to the task of domesticating new crop plants or in the improvement of plants already domesticated.

We are now on the threshold of attempts to domesticate new economic plants from the rich flora of the Amazon. It is imperative that, with modern techniques developed in the plant sciences, we know as much as possible about the biology of plants in the wild state. In order fully to understand the biology of a new candidate for domestication, we must begin with a study of its history—information especially from archaeological ethnobotany and records, whether written or on various monumentals, still available to specialists.

It is in great part to help in our efforts towards improvement of the plants which I have discussed that my interest in their pre-Columbian wanderings has centered.

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