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CULTIVATED PLANTS OF SOUTH
AND CENTRAL AMERICA

By Carl O. Sauer

INTRODUCTION

One of the most important, most difficult, and least-known classes of culture traits is the body of plants taken under native cultivation. The following sections attempt a review of some of these plants as living artifacts which give evidence of culture origins and diffusions independently of, and sometimes contradictory to, the conventional records of archeology, linguistics, and ethnography. The evidence at hand is shockingly fragmentary, considering the importance of the material to an understanding of culture history, and the conclusions here offered are to be considered rather as queries than assertions. The evidence considered has been of the following kinds:

(1) Observations that were made before a significant displacement of crop plants took place through European influence. Not only are the Spanish chronicles, and to a lesser extent those of the Portuguese and French, remarkable in the sharpness and detail of such observations, but for all Spanish colonies the Relaciones geográficas of the end of the 16th century made formal and systematic inquiry as to native and introduced field crops and fruit trees (Jiménez de la Espada collected four volumes of these for South America and provided masterly notes, 1881–97). In addition, there are the priceless natural histories for Spanish America of Oviedo y Valdés, the first version of which was completed in 1525, the last in 1548; of Soares de Souza for Brazil in 1587, and of the Jesuits, Acosta in 1590 and Cobo in 1596–1653. These give an approximately continuous series of competent observations from 1514, the year when Oviedo first came to Darién, to 1653, when Father Cobo ended his long activity of noting New World agriculture. Perhaps no other part of the world has an equal wealth of such data for that time. (In bibliographic references to these works, the date of the modern edition will be used.)

(2) Archeological materials, mostly limited to the desert Coast of Perú and Chile. Not only were organic remains preserved here by reason of aridity, but the cultures of Nasca, Moche, and Chimú utilized plant motifs for decoration or reproduced them plastically with fidelity and frequency. These have been briefly examined by
the writer in the west Coast museums, and even more cursorily in the field. The excellent study by Yacovleff and Herrera, "El Mundo Vegetal de los Antiguos Peruanos" (1934–35), is one of the foundation stones of the present paper.

(3) Regional studies of native cultivated plants and agriculture: Richard Latcham for Chile and adjacent lands (1936 b), F. C. Hoehne for Brazil (1937), Lorenzo Parodi for Argentina (1935), Fortunato Herrera for Perú (1921, 1934, 1942), and A. E. Nordenskiöld for South America in general.

(4) Systematic botanical studies that have regarded the historical agency of man as a distributing and modifying agent: W. E. Safford, (1917 a, 1917 b, 1925), O. F. Cook (1901, 1910, 1925), Wilson Popenoe, (1921, 1924), Oakes Ames (1939), Paul Standley (1920–26, 1928, 1937–38), and Fortunato Herrera (1921, 1934, 1942) being especially noteworthy for their awareness of the role of man in plant distributions and modifications.

(5) Genetic studies, which are increasingly throwing light on cultural processes and contacts. Maize, cotton, and tobacco are already sufficiently known as to hereditary composition and geographic distribution so that important conclusions may be drawn as to their origin and spread. The forms that have been established through selection by the primitive cultivators are actually culture traits, with the peculiar advantage that they continue to exist long after the aboriginal population has disappeared. They may also reveal cultural origins and movements far antecedent to the usual data of archeology. The attempt has been made, therefore, to evaluate not only the gross distribution of species, but to use the results of genetic studies where these are sufficiently advanced to give an insight into the diversification of a cultivated species.

The evidence presented in this paper is weakest for eastern South America, especially for Brazil. Less advanced native agricultures, early fading of native populations, the limited number of botanical observations focused on the differences between cultivated and wild plants, and unfamiliarity on the part of the author with this part of Latin America are the reasons for the gaps in treatment.

Cultivated plants may be classed under four groups, though the knowledge is inadequate at present thus to allocate many, if not most, of the plants under cultivation: (1) The unmodified wild species which is planted for convenience of harvesting or for increase of producing units, or which may be allowed to increase by protecting a wild stand. The number of such plants is almost indefinitely large, especially among woody species. Here man serves only to enlarge the local population of the given species or to extend its range by carrying it to settlements and clearings where it did not grow originally. (2)
Domestication takes place when, in addition to the care and planting of the wild species, local improved races are created. These may replace the unmodified wild form in certain areas, but not in others. Here man definitely appears as an agent of selection. (3) Full domestication is achieved when the wild form, though still existent, is discarded for purposes of cultivation, and only improved mutants or hybrids are grown. (4) Finally, there are the cultigens of which the wild ancestors are lost, and which in most cases depend on the care of man for their continued existence. In numerous cases these have lost the capacity to produce seeds or are otherwise unable to maintain themselves.

We are only at the beginning of the study of the cultivation of plants. Those grown by man have been much less well recorded than the wild flora. Field botanists tend to pass them by, unless they are suspected of being wild; students of native peoples too rarely have known enough about plants, their tillage, and use to identify or collect the material needed. The question as to whether a plant occurs wild or as an escape from cultivation is in very many cases unanswered and may be answered only by a painstaking comparison of the cultivated with the wild-growing form and its locale. Valid cultural historical data can be secured only by gradually building up records of the variations within each kind of plant and their geographic distributions. In the main, the definitive labeling of the relationship of one form to another will have to be done by genetic study, as is now being done for maize and cotton. A hundred field observations and collections are needed where we now have one, and these need to be communicated to plant specialists and then reinterpreted in terms of culture history. For error in the following pages no apology is offered if they stimulate observation of the basic cultural process of modifying native plant materials to suit economic needs and preferences.

**MAIZE**

Maize, the great food staple of the American Indian, was grown to the farthest limits of New World agriculture, with the exception of the excessively cold Highlands of the Andes. Its range in latitude was from the lower St. Lawrence and upper Missouri Rivers southward to the Island of Chiloé. The latter area demanded perhaps even a greater adaptive selection than did the high northern latitudes, for the summers of Chiloé are not only short, but extremely cool with few, brief, and uncertain stretches of sunny weather.¹

¹ Latcham, who knew the southern part of Chile well a half century ago, thinks that the maize grown there was the old form known as curahua in Araucanian, a round-seeded pop or flint corn of reduced size of plant and ear and of precocious growth, maturing in about 4 months (1936 b, pp. 136–137). He seems to have overlooked the implication of a quotation he uses elsewhere from Cartés Hoge relating to Chiloé in 1558. This first visitor to the island spoke of a large supply of big (crecido) maize and of large ears.
The famous "sacred corn of the Incas," grown in sheltered sun-warmed slopes above Lake Titicaca, marks the highest limits of the grain (about 3,900 m. or 12,700 feet). It is grown there not only on the islands, but in terraces above Puno. The Titicaca maize has been at times referred to as though, for ritual and traditional reasons, it was grown here at altitudes far above those attained elsewhere. Maize is a crop of importance, however, in the upper Vilcanota Valley well above Sicuani (3,574 m. or 11,615 feet). Farther down valley, Cuzco is in the heart of a region of flourishing and diverse cultivation of both maize and potatoes. Indeed, almost the whole length of the Vilcanota-Urubamba depression is brimming with many kinds of maize, from the edge of the puna to the tropical lowlands.

The Andean valleys of south Perú, of Bolivia, and of North Chile (Highlands of Tarapacá and the upper Loa Valley) mature maize at considerably higher altitudes than is possible in more equatorial regions. In these margins of the tropical zone, longer summer days and greater summer warmth are found than in the equatorial Highlands. Near the Equator, where there is no summer season, maize culture hardly reaches 3,000 m. (9,750 feet), as about Quito. Bogotá, at 2,660 m. (8,645 feet), is near the upper limit for central Colombia. In Ecuador and Colombia the inflow of cloud-forming air from the tropical lowlands also depresses the day temperatures. In contrast to the south, in the northern Andes are grown types of corn that take nearly the entire year to mature. Here there are also extremely dwarfed types, growing only knee high. Seeds of such types, brought from the Quito area and planted at Pasadena, however grew to plants of normal height.

Although maize is but a single botanical species, and one that normally is cross-fertilized, yet geographical separation, differences in time of flowering, and preferences of the native cultivators have formed in time and preserved to the present an extraordinary variety of forms, hardly equaled among cultivated plants. The tracing of kinship and diversity in this wealth of forms promises much new light on the history of man and of agriculture. Maize has been the subject of a vast amount of study by geneticists, and is the best-known plant as to its genetic constitution. At the moment, these studies are in full course of being directed to the analysis of its origin and diversification. Especially Paul Mangelsdorf, Edgar Anderson, and associates are making notable contributions thereby to genetics and anthropology (Mangelsdorf and Reeves, 1939; Mangelsdorf and Cameron, 1942; Anderson and Cutler, 1942). Any future consideration of maize as relating to Indian culture must be based on a knowledge of these remarkable investigations, too comprehensive to be summarized here, but basic to the remarks that follow. They are
supplemented by personal observations in the Andes, the South American west coast, and México. These remarks, it is hoped, may invite a study of the relevant genetic literature.

There is sadly little in most written accounts of maize that helps to recognize the particular kind under consideration. The older historical records rarely noted more than the color of the grain, or occasionally the time it took to mature and some items on its utility in food and drink. Field botanists were little interested, since it was a cultivated plant. Ethnologists have had small curiosity about the plant and its habits, and not a great deal about its uses in the kitchen. The simple things we need to know about Indian corns in all parts of the New World for the most part remain to be gathered: the habit of growth of stalk, leaf morphology, the nature of tassel and ear with its husks and silk, plant color, tillering, shape of the cob, arrangement of the seeds, and their shapes. Less significant are the items most commonly noted, i.e., the color of the seed and the nature of its endosperm (excepting in popcorns).

The work of Mangelsdorf showing that *Teosinte* (*Euchlora*) is not an ancestor of maize but a hybrid between maize and a species of *Tripsacum*, has clarified the problem of origin and classification. It has removed the strongest argument for considering Central America as the place of origin for maize. Perhaps even more significantly, it has laid the basis for distinguishing between "pure" maize and the forms that have *Tripsacum* admixture in varying amount. This is interpreted as due to a backcrossing into maize from *Teosinte*, and hence the "secondary" maize varieties may have been developed in Guatemala (and central México?). Cytologically, a fundamental distinction is made between the pure maize with knobless chromosomes and the *Tripsacum* admixed forms that have knobby chromosomes. Morphologic differences further distinguished the *Tripsacum*-free maizes from the tripsacoid ones.

The nontripsacoid maizes are considered as the older group, and they seem to occur especially (though not generally) at the outer peripheries of corn cultivation, in highland situations, especially with cultural isolation, and widely in South America, but much less so in North America. Tripsacoid qualities, in so far as known, are strongly present in tropical maizes, supporting that cultivation spread from temperate climates into hot ones.

The "pure" maize probably involves the following characteristics: Knobby joints and a somewhat zigzag stalk, hairy leaf sheaths and stiffish leaves, purplish color in all or several parts of the plant, coarse root system, ears of pyramidal shape (markedly tapering and having a heavy butt), soft, brittle cobs and long glumes, irregularly rowed seeds, and erect tassels. A tripsacoid maize by con-
trast is likely to exhibit slender, candlike growth, elastic and little subject to breaking or lodging, often of bright green color; cylindrical ears; dense woody cobs and short glumes; seeds in straight rows; widely branching tassels; and free tillering.

According to Mangelsdorf and Cameron (1942, pp. 237–238), the pure South American maize spread to Guatemala and hybridized with *Tripsacum* growing about the maize fields. By repeated back-crossing, *Teosinte* was formed, and from it new forms of maize arose by further crossing. They state:

New varieties came into existence in which the seeds were smaller, more inclined to be indented, more uniform in size and shape and arranged in straight rows on the rachis. The cobs became firmer and less susceptible to shattering, the stalks became tough and resistant to lodging, the leaf-sheaths became glabrous instead of pubescent and the plants became resistant to smut. These new *tripsacoid* varieties were much superior to the pure maize at lower altitudes, and rapidly replaced it, if indeed it was ever extensively grown there.

These new forms then spread both north and south, especially at low altitudes, and extended the range far beyond that of the "original" Andean kinds.

Dent corns are a highly complex group needing much additional collecting and study. Some are secondary hybrids of maize and *Teosinte*. Denting (a depression in the mature kernel) is based on the inheritance of a number of genes. The Russian geneticists established the greatest diversity of this type as located in México. There is a strong correspondence between the major area of denting and that of the preparation of hominy by soaking in lime or wood ash (nixtamal in México). Mangelsdorf and Reeves (1939) point out the rarity of dent corn in the Andean area, though it must be noted that denting is quite common in prehistoric corn of the Coastal desert of Perú (as in the large finds at Paracas). The implication is that the immigration from a secondary center (from Guatemala?) took place at a rather remote time.

The tropical flint corns are another group showing *Tripsacum* introgression. They dominate the shores of the Caribbean, and may have been almost the only maize of the West Indies. Vavilov and Kulashev consider that this was the parent of the maize introduced into Spain and now grown all about the Mediterranean. In the tropical valleys of Colombia it is very tall, with thin but very elastic stalks, bright green color, loose tassels, and produces long, cylindrical ears, with rather large, flinty, honey-yellow kernels. A similar corn was probably before the eyes of Oviedo y Valdés when he wrote (1851–55, bk. 7, ch. 1) of a stalk like a lance, more or less the thickness of the thumb, growing much taller than a man and with leaves greener than that of sugarcane. The flintiness of these types makes them especially weevil resistant, and hence most suitable for storage in hot
climates. To what extent the flinty corns of the Andean lands (morocho) are of the secondary types remains to be investigated. It is probable that they include both pre- and post-Tripsacum forms.

We know that numerous kinds of flour corn (capia, in Quechua), popcorn, and sweet corn are of very wide aboriginal distribution and undoubtedly were often selected at different places and times for cultivation. They have as yet little diagnostic value. Some of the popcorns, however, are old, as shown by their archeological frequency in Perú and Chile. Edgar Anderson, in studies under way, is finding that certain forms of popcorn are genetically primitive.

Mangelsdorf has revived the hypothesis that the most primitive corn is pod or tunicate. He further suggests that this may have existed wild and, indeed, that it may perhaps still be discovered growing wild, perhaps in the Paraná-Paraguay Basins. He cites five references to its cultivation by the Guaraní Indians, the name “pisingallo” there being given to it, and its general suitability to the climate of that area with long, warm, and rainy summers, and a following dry season.

A pod-corn-like ancestor may well have existed. There are many cobs and ears in the desert archeological sites of both Perú and Chile showing excessively large, long glumes, also soft, brittle, extremely thin, and perhaps hollow cobs, and sharply up-curved pointed seeds. This hawk’s-bill type of seed is still common in the Highland corns, as about Quito and Cuzco.

The location of the cradle of maize in the Guaraní land appears unwarranted. Its position is quite peripheral to agriculture as a whole and to the distribution of advanced culture traits and complexes. There are many areas as suitable ecologically. The distribution of pod corn in cultivated maize is very wide, and extended to North American Indians, as Mangelsdorf points out. The term “pisingallo” is probably Quechua and is known at least as far as Antioquia in Colombia.

It seems more reasonable, therefore, to consider that maize originated sufficiently far away from the Equator to have a well-marked contrast between a warm, rainy summer, and a dry, cool fall (but no cold winter). Northward, it is difficult to locate an area suitable as to climate and soil much short of Guatemala. Southward, however, such a condition exists, especially south of lat. 10° S. in the large eastern valleys of the Andes of Perú, such as the Urubamba. In this valley, incidentally, maize growing is not restricted to irrigation, as Mangelsdorf appears to think. There are sections of secure and sufficient rainfall, and the flood plains generally have sufficient flooding and subirrigation.

Present evidence points to a dissemination in all directions of the
early forms from an unknown center, and especially their successful specialization in the upper parts of the temperate and the lower part of the cold zones. In the northward migration a new group of forms developed in Guatemala, México, and the North American Southwest, especially by backcrosses with *Teosinte (Euchlena)*. These new forms, especially the tropical flint corns, but also dent forms, were then distributed southward as well as northward. The former supplied an admirable grain suited to moist tropical lowlands. They penetrated the West Indies, but apparently did not pass to the adjacent mainland of the United States. They also became the chief grain of Brazil, it would appear. The other tripsacoid corn distributions are not sufficiently well known for South America to make any conclusion at present.  

The original home of maize is a greater puzzle at present, with genetic studies continually enlarging the phylogenetic picture, than ever before. It was probably not tropical, nor did it come from land deficient in rain, but we cannot say that it began in the northern or the southern hemisphere nor can it even be attributed with certainty to the New World as long as certain matters concerning Southeastern Asia remain unsolved. It is likely, however, that the origin of maize will be discovered in a fairly near future.

As to the uses of maize, we have also only fragments of information. The Spanish annalists give the impression that more of it was drunk and less eaten in the West Indian-South American area than in the Mexican-Central American area. "Chicha" is an island Arawak word. The first Spanish visitors, such as Cieza de León, were impressed by the drinking powers of the Indians in Colombia. The records on chicha in the Inca-dominated lands are numerous and well known. In general, flint corns appear to have been most used. The distribution of sprouting and roasting, of chewing the grain, and of the fermentation of (roasted and unroasted ?) meal needs further study, as does the occurrence of wine from green cornstalks. Parching entire ripe grain and popping are also much more emphatically South American than Middle American. It would seem also that the boiling and roasting of ears in the milk stage consumed a larger share of the crop in South American practice than of that to the north. Certainly today corn is more a vegetable and less a grain than it is in México. Whether the preparation of hominy by soaking in lye or lime water, and its subsequent grinding while moist, were known aboriginally in South America is still doubtful. It seems that maize

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1 Unpublished work by Hugh Cutler has shown the wide occurrence of a species of *Tripsacum* along the eastern base of the Andes. It is possible, therefore, that the earliest tripsacoid traits were acquired in South America and that additions took place when corn was mingled with the *Tripsacum* of Guatemala.
was nowhere, south of Honduras, the staple foodstuff that it was further north.

LESSER SEED CROPS

Grasses, other than maize, were cultivated in the New World only, insofar as known, in Chile and in the Sonoran region: (1) A domestic cereal grass has been collected lately among the Varohio tribe of northwest México and identified as *Panicum sonorum* (Gentry, 1942, p. 64). (2) Teca is a lost winter cereal of Chile, well documented in early accounts and there called a form of small barley or oats, but not known to have survived to the latter part of the 18th century (Latcham, 1936 b, pp. 161–163). It was roasted, ground, and mixed with water as a drink (ulpo) (Lenz, 1904–10, 2: 714, 758), similar to the pinole of the Mexicans. (3) Somewhat better known is the Chilean mango, which was found by Gay in 1837 still grown in Chiloe, and identified by him as *Bromus mango* (Gay, 1854). His type specimens have been preserved, and there are rumors that the plant is not extinct. It was a biennial; and it also was drunk as ulpo, used somewhat for making chicha, and was baked in pones. Latcham (1936 b, pp. 159–161) calls attention to the fact that it was not mentioned by the early chroniclers, who, with one exception, however, did not know the Indians of South Chile (such as *Chilote*).

Chile also is the home of madi (*Madía sativa*), a species of Compositae grown for its oily seeds. A wild form is known in California as tarweed. This plant was cultivated from Central Chile south to Chiloe. Its seeds were ground, cooked, and mixed with other meal. It is a fairly good source of edible oil, though there is no evidence that the Indians pressed the oil and used it separately. The Mexican chia (*Salvia hispanica*, though not a native of Spain) is still an Indian crop grown well southward into Central America. Its gelatinous seeds are valued as food for infants and the infirm.

Chile holds a singular position in the cultivation of seed crops. In addition to maize its aborigines grew quinoa (see below), mango, teca, and madi, the last three peculiar to that country. The inference is that these are ancient crops native to that land and that they preceded the cultivation of the more productive maize and quinoa. Chile has a rainfall regime opposite to that of the rest of South America, with the dry season in summer. Its endemic crops were planted in the cool and rainy season (spring, or even winter) and matured in summer. Later, we may imagine, they were gradually replaced by quinoa and maize, both introduced from Perú. The adjustment was not difficult in the case of quinoa, which is grown on the Andean Highlands at minimal vegetative temperatures and met similar conditions in Coastal Chile. In the case of maize, however, the passage from the irrigated, warm summer lands of the north to
nonirrigated cultivation in the cool south undoubtedly required long selection.

The goosefoot and amaranth families have yielded a number of cultivated plants, grown mostly for their seed but also used as greens. They served in Indian cooking, and still do in part, as substitutes for spinach. The most important is the Andean quinoa or quinoa (Chenopodium quinoa), replacing maize in the higher mountains; it was formerly cultivated from the Chibcha Highlands of Colombia to the southernmost limit of agriculture in Argentina and on the Pacific Coast as far as Chiloé. It may be noted that in higher latitudes quinoa became adapted to the contrasted climates of central Argentina (= mid-Texas) and Chiloé (= Oregon coast). It has now retreated from the extremities of its earlier range, but is still a characteristic food plant of the Inca-dominated Highlands. Quinoa is definitely a cultigen, with no close wild relative. Possibly it is the same plant as the nearly lost Chenopodium nuttallii of the Valley of México.

Quinoa is a remarkably useful plant to the Highland Indians. It needs little warmth for its growth, tolerates some frost, and yields far more than any other grain in the Highlands. A gross feeder on nitrogen, it is often planted in old enclosures used by llamas and sheep. A number of varieties are distinguished, largely by color of plant and seed. A large-growing, whitish-seeded form may be a long-established selection from the general polymorphous stock. Fields of quinoa give the only note of bright color to the puna landscape, their color range nearly duplicating the autumn display of hardwoods in the United States.

The seeds are bitter and require repeated washing. In addition to being used as boiled grain and ground as meal, they are fermented in making chicha. Ashes of the stalks are kneaded into pellets to be chewed with coca beans. Archeological occurrences have been noted by Safford (1917 b), Yacovleff and Herrera (1934–35, 3: 306–307), and for Chile by Latcham (1936 b, p. 155).

Cañihua, or cañahua, has been recognized as a species (Chenopodium pallidicaule) (in 1929 by Aellen). The old chroniclers usually named it as a form of quinoa or as grown with the latter; Cobo (1893) for instance, called it an "ashy-colored quinoa producing an especially potent chicha," neither of which qualities seems to be especially pertinent to the plant. Cañihua is a much less vigorous plant than quinoa, commonly growing only to a height of 1 to 2 feet; its seed panicles are looser and smaller. It is especially used as a roasted meal, is usually stirred in cold water, and, like the Mexican pinole,

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There is an account of the Indians of Córdoba cultivating quinoa (Jiménez de la Espada, 1881–97, 2: 151).
is a mainstay of Indians in their travels. The plant is less exacting of fertile soil, I should judge, than quinoa and even more resistant to cold. It is common on the high puna of Bolivia and in the coldest parts of southern Perú. There is a good summary of it by César Vargas, 1938.

Colonial records from north México into Northwest Argentina make brief note of the cultivation of amaranth, most commonly designated as “bledo.” The classical study is still Safford’s “Forgotten Cereal of Ancient America” (1917 b), which contains most of what is known to this day. In central México the Spaniards discouraged its growth because of the ritual use of the meal in pagan ceremonies, but it is by no means an uncommon Indian crop today, and the cakes of huautli or tzoal are still seen in markets of many towns and villages now celebrating Catholic feast days. It is one of the major crops of the hill Mayo in southern Sonora, and probably survives in Indian cropping throughout the hot summer lands of México and Central America. In the Andes, Fortunato Herrera (1942) has identified it particularly with the Huana people, and as grown in the barrancas of Huancavelica, Junín, Ayacucho, and Apurimac, below the levels of quinoa cultivation. It has a number of Indian names in Perú, perhaps the commonest being “quihuicha.”

The botanical position of the cultivated amaranth is still uncertain (Ames, 1939). There are a number of varieties, more or less intergrading, but whether these are distinct species is undetermined (such as caudatus, paniculatus, hybridus, etc.). They are of ancient, possibly very ancient, culture in México and the Andes, but also in India and other Asiatic monsoon lands; in each case they are deeply embedded in native ways and bear old local names, and serve as cereal and pot-herb among conservative and remote people. Ames points out that the relationship of the crop amaranth remains to be determined for both sides of the Pacific as part of the question of early trans-Pacific cultural connections.

The possible role of amaranth in the beginnings of agriculture was considered by Safford. Gilmore (1931) has shown since that an amaranth was cultivated in the Mississippi Valley along with other weedy plants, before maize and beans were known there. The cultivated amaranths and chenopodiums are improved relatives of the common pigweeds of barnyards and fields. They establish themselves with ease on flood lands, rich in organic matter, wherever nature or man provides an open sunlit space. The first attempts at growing crops by primitive man are likely to have been on precisely such sites. It seems likely however, that these first trials at cultivation would have been made with some other plant, such as an edible root, more inviting to culture than a small-seeded, weedy annual. In such case the
pigweeds would be thought of as entering the primordial floodplain clearing as volunteers, perhaps tolerated for their abundant seeds. Yet the Mississippi Valley primitive horizons disclose no such crop, but only the seeds of "weeds," judged from their augmented size to have been selected and planted. Safford's surmise of the high age of amaranth cultivation may be correct therefore. The cultivated amaranth was developed not so much in the direction of great increase in seed size as of the forming of large panicked heads, carrying a great number of seeds. An individual crop amaranth plant is probably not inferior in the weight of seed produced to a plant of maize, and a field of amaranth in Indian cultivation is likely to out-yield one of maize. Both amaranth and quinoa are efficient economic mechanisms. Their failure to pass into the White man's agriculture is apparently due to a disdain that attaches to them as food for Indians, as in Perú and Bolivia, where public and private effort is directed to the expansion of wheat and barley.

BEANS

Legumes were cultivated for edible seeds in every agricultural area of the New World. The American domesticated plants include four species of the common bean (Phaseolus), perhaps one jackbean (Canavalia), the peanut (Arachis), and a lupine (Lupinus).

The lupine (Lupinus—species undetermined; Fortunato Herrera first called it tauris, but later changed it to mutabilis) is restricted to the high Andes from Ecuador to Bolivia, above the altitudes at which the kidney bean can be grown. It is known in Quechua as "tarhui," in Spanish as "chocho" or "altramuz." This handsome plant is usually interplanted with the dwarf Andean maize and grows to about the same height. The very large white seeds are extremely bitter and reputedly also poisonous (alkaloid?). They require repeated soaking for a number of days to become palatable. It is apparently a cultigen developed from a local wild lupine as a cold land substitute for the kidney bean. With its large seeds and its tolerance of low temperature and poor soils it would be a valuable crop plant had selection succeeded in getting rid of the bitterness of the seed. Archeologically it is known from Tiahuanaco designs (Yacovleff and Herrera, 1934–35, 3:305–306). In modern times it has been replaced in large measure by the Old World broadbean (Vicia faba) and field pea (Pisum arvense) which grow well in the higher levels of Andean agriculture.

The peanut (Arachis hypogaea) is one of the few domesticated plants attributed to Brazil, the nearest wild relative being found from Bahia to Rio de Janeiro (Bukasov, 1930, pp. 177–179, after Chevalier). Indians in Mato Grosso and Santa Catarina have cultivated somewhat
divergent forms, which however are referred by Chevalier in his monographic treatment to the species *hypogaea*. The peanut grown by the *Nambicuara* of the Plateau of Parecis in Mato Grosso retains the perennial habit, and may therefore be the most primitive form in cultivation. If the *Nambicuara*, situated between Arawak tribes on the west and *Tupí* southeastward, are the keepers of one primitive cultigen, their study may yield further light on the origins of Brazilian agriculture. The peanut was generally important in *Tupí* economy. Soares de Souza gives a good early account of the plant and its use in the Bahia area, stating that its culture was reserved to the women. The peanut also was grown, it seems, throughout Arawak territory into the Antilles, whence the name “mani” under which it is commonly known in Spanish America.

It was also well established in the warm valleys flanking the Central Andes on both sides, and therefore a familiar product by trade in the Highlands. Large quantities of it are found in the tombs of Coastal Perú. They indicate therefore a cultural connection between eastern Brazil and Coastal Perú of considerable antiquity. Ames (1939, pp. 47–48) has pointed out the resemblance of the Peruvian archeological forms to the kind of peanut grown in the Orient and suggests the need of comparative morphologic-genetic studies. (See also Bois, 1927–28, 1: 94–96, who recognizes after Dubard a Brazilian and a Peruvian subspecies, the latter the cultivated form in the Orient.) The assumption that it was introduced into the Malayan, Indo-Chinese, and south China areas by Whites rests on no specific evidence. Bukasov (1930, p. 178), following Rivet, suspects the possibility of a pre-Columbian trans-Pacific dissemination that reached Africa. In view of its wide and important establishment about the China Sea and Indian Ocean, the weakness of its penetration into continental North America is remarkable. In México it has been only an incidental food item, not appearing for instance on Montezuma’s list of tributes. Its Mexican name “Tlalcacahuatl” (ground cacao), suggests late introduction. Nor was it grown north of central México, though soil and climate are suitable. There is a strong suggestion that it belonged in the complex of manioc cultivation (both bitter and sweet) in its New World distribution.

The jackbean (*Canavalia ensiformis*) belongs to a tropical genus, with both American and Old World species. The taxonomy of the cultivated Canavalias remains unsettled. By some they are all placed in one species, by others in two, *ensiformis* usually considered of New World, *gladiata* (swordbean) as of Old World origin. The morphologic distinctions are minor and have not been tested genetically. One of the points of difference usually brought out is that the seed color of the New World jackbean is white, and that of the Old
World brown, pinkish, spotted, etc. However, the graves of Coastal Perú yield numerous lots of colored and spotted jackbeans. (In the Uhle collection at the University of California are two large lots of Canavalia, one consistently particolored, dark brown mottled on light brown, and the other a single color, now like old saddle leather.) See also the illustrations and text in Yacovleff and Herrera (1934–35, 3: 290–291), where in addition particolored beans of present cultivation are noted. The bean has also been determined archeologically for the southwestern United States (Whiting, 1939). No notice seems to have been taken of the plant by Spanish chroniclers, nor do I know of the survival of native names. It survives, on a very small scale, in cultivation from México to Perú and Brazil, including the West Indies (Bukasov, 1930, p. 177, in part after Piper). Apparently it is a cultigen, with occasional escapes. Its archeological distribution and relation to wild species indicate the jackbean as a New World domesticate. Future studies may determine whether the Old World forms are derivative from the New World stock. The New World forms have a low repute as a food, but I am not aware that definitely poisonous qualities are ascribed to them. In some of the Old World forms toxic qualities (HCN?) have been claimed.

Aside from its size the jackbean has little to recommend it as a foodstuff. It is not clear why its domestication should have been undertaken or its culture maintained at the side of the lima and kidney beans, which grow in the same areas. However, very little is known of its role in native economies. May it have been a more ancient tropical domesticate than the other beans, and simply continued to be grown out of conservatism of habit after the better beans were available?

The true beans include four American domesticates: (1) Phaseolus vulgaris, the common, kidney, navy, string, or snap bean; (2) P. lunatus, the lima bean; (3) P. multiflorus (or coccineus), the scarlet runner bean; and (4) P. acutifolius var. latifolius, the tepary bean. For the common bean the name “frijol” (and its variants) is used through most Spanish and Portuguese areas. This name is of Mediterranean origin (cf. the Latin form Phaseolus) and was there applied to a similar plant, probably either a Vigna or Dolichos. With the immediate transfer of an Old World name, Indian names for the like-appearing New World legumes were not taken up by Europeans, except in the Inca region where “poroto” became an alternative name for the frijol, and “pALLar” for the lima bean. For the latter, haba is a common term in many sections, giving rise to confusion with the real haba (Vicia faba).

The tepary bean has the most limited distribution and is probably the latest to be developed at the hands of man. Its major use has
been by the Càhîta and Piman tribes and their neighbors, that is, in
the area adjacent to the upper Gulf of California. A minor series of
occurrences has been noted lately in the lowlands of Chiapas and
Guatemala, and in spots north along the Coast; nothing is known of
its presence elsewhere. It would seem therefore to be a domesticate
by substitution for the other beans in the very hot, and more or less
arid, lands of Sonora and Arizona, because of its heat tolerance,
partial tolerance of soil alkalinity, and minimal demands of water.
It is fairly old archeologically in the southwestern United States.

The lima bean predominates over the frijol in the majority of the
American Tropics. It is a usual crop in the tierra caliente, wherever
there is a sufficiently well-marked dry season. In its basic forms it
is a tall-growing, climbing perennial, requiring a warm, wet growing
season followed by a warm, dry period. Rarely is it found much
above 1,200 m. (4,000 feet) above sea level. Truly wild limas have
been reported from Guatemala, and the form assemblage of the kinds
cultivated there favors this area as the primary center of domestica-
tion (Mackie, 1943; Bukasov, 1930; Ditmers, Ivanov, and Popova,
1937).

The genetic architecture of the species is poorly known as yet.
Mackie (1943), on the basis of long experience in lima bean breeding,
has undertaken the most comprehensive appraisal of its origin and
dispersal in these terms. He recognizes three main "branches"—the
Carib, the Hopî, and the Inca—all dispersed from the primary center
in Guatemala. The first, and probably oldest, of these passes through
Yucatán, the Antilles, into Venezuela, and possibly into Brazil, though
the Amazonian lands are unfavorable to it. In the Carib branch
"potato" shapes and bright-red color are common, and many plants
produce seeds high in a glucoside that causes cyanide poisoning if
cooked in the ordinary manner. The possible connection with this
branch of the Konian bean in French Guiana may be suggested (Bois,
1927–28, 1: 153, after Chevalier). A second division is called the Hopî
branch by Mackie, extending up the Mexican west coast, through the
southwestern United States, and into the southeastern part. This
small-seeded group is sharply separated from the Carib branch by
lack of photoperiodicity, flatness, and lack of glucoside. It is appar-
ently a selection for cultivation in areas of warm summers and long
days. That this selection was slow is shown by the late and subordi-
nate appearance of the lima bean in archeological records of the south-
western United States, and this despite the apparent antiquity of
domestication of the lima bean. The third or Inca branch consists of
the Peruvian pallar, of maximum size of pod and seed, least primi-
tive in its characteristics. The Peruvian or "Inca branch" is the
most highly bred, and in it forms were established that were able to
penetrate far southward, as in Chile, into latitudes of greatly lengthened summer days. On Brazil the records do not permit a conclusion as to whether Inca and Carib branches are both represented. Soares de Souza described a white fava of superior quality and larger than the broadbean of Portugal, which would seem to have resembled the big Peruvian limas.

The major difficulty in the dispersal routes proposed by Mackie is the derivation of the Carib branch from Guatemala by way of Yucatán, since the existence of this ethnic bridge is not substantiated by most ethnographic data. However, the lima-bean data do point in this direction. As known at present, from the Russian studies, the lima beans and also the frijoles of Colombia belong with Perú, those of Venezuela (and Guiana ?) with the Antilles and Yucatán. It should be noted that the word “henequen,” according to Henriquez Ureña (and also the plant ?), was taken from the Maya of Yucatán into the Taino culture of the Antilles.

In Coastal Perú there was an extraordinary preoccupation with the pallar as decorative motif. In Mochica art the “lima-bean warriors” are famous. Conventionalized forms are extremely common on Nazca pottery, and in Paracas textiles are many beautifully worked and expert, very exact representations of beans of different color markings (all figured in Yacovleff and Herrera, 1934–35; 3: 287–289). (See also Handbook, vol. 2, p. 175; fig. 21, c.) Here this bean had an economic significance unequaled elsewhere, and apparently also a certain symbolism was attached to it.

A curious problem attaches to the cyanide content of the probably primitive races of the cultivated lima. Mackie (1943) called attention to the occurrence of lima beans on uninhabited Socorro Island off northwest México and the poisoning of Captain Colnett’s crew there in 1798 by eating these beans. Such beans have been collected on Socorro and grown. They probably may be considered as an escape and are referred by Mackie to the Carib line. From the Dutch East Indies through Indochina and Burma (to Réunion) a race of lima beans of primitive characteristics has long been in native cultivation. Throughout southeastern Asia the appearance of high cyanide content in such beans is common and well known. Perennial habit, dark colors, and small to moderate size are prevalent. A genetic basis of the glucoside is probable and possibly rests on a number of genes that became suppressed outside of the Caribbean and southeast Asia by deliberate selection. If, then, southeastern Asia should prove to be a reservoir of the more primitive lima beans, long since extinct in Perú and México, a further problem of the time and manner of trans-Pacific connection is raised by which the American bean was communicated to the native population across the Pacific. The great
cyanide-poor white limas of South Africa, on the other hand, suggest Peruvian origin (via Brazil and the Portuguese).

The common bean \( (P. \text{ vulgaris}) \) and the (scarlet) runner bean \( (P. \text{ multiflorus} \text{ or coccineus}) \) are the principal forms in temperate land (C climates) native agriculture, with wide penetration, however, into tropical margins and, in the United States, into microthermal (D) climates.

The runner bean has been little specialized and everywhere in its range appears to be a secondary legume; the reason is not clear, since it has admirable qualities for cultivation and eating, raw as well as cooked. Even the tuberous roots are a food. On limited evidence the Russian geneticists assign its origin to Central America or southernmost México. It is also common in the Cauca River drainage of Colombia. Little information is at hand as to its occurrence elsewhere in South America. There is no known reason for ascribing great antiquity to it, and it is possible that a fuller knowledge of its distribution, especially as to types, will be useful in tracing later prehistoric diffusions from Central America.

The common bean, with the exception of high altitudes and of tropical regions, is almost coextensive with the distribution of maize. From the southern edge of the Mexican plateau northward, dwarf, bush forms predominate, and there is also commonly, but not always, a segregation of bean field and corn field. In equatorial latitudes, and through South America generally, climbing forms appear strongly predominant in aboriginal agriculture, and mixed planting with maize seems to be the rule. A wild ancestral form may possibly occur in the western Highlands of México and Central America (from Jalisco to Guatemala?). The Russian studies favor this area for the origin of its domestication, based further on the great variety of primitive characteristics in the cultivated plants and seeds. They consider Perú definitely as a secondary, later center for more highly bred, specialized forms, with Colombia falling into the Peruvian pattern. The beans of the Andean lands are mostly of large size, somewhat cylindrical shape, and the black-seeded forms, so common in México and Central América, are less representative. Despite the great collection of the Russian expeditions and the elaborate genetic analyses based thereon, information is most incomplete on many parts of Latin America and conclusions as to phylogeny and dispersal are still uncertain.

It may be remarked, finally, that Old World legumes in Indian cultivation also need study. These are divergent forms of the cow pea \( (\text{Vigna} \text{ sp.}) \), not a few areas of cultivation of \( \text{Cajanus indicus} \), and even some of Oriental \( \text{Phaseolus} \), all of which need to be localized
exactly and the seeds planted for comparison with known Old World forms.

THE CUCURBITS

The Old and New World cucurbitis are clearly divided, the New World having produced four genera: Cucurbita, to which belong all squashes and pumpkins and some gourds in the English vernacular; Sicana, so named from its Quechua name but called "curua" in Brazil; Sechium, which yields the "chayote" of México; and Oclanthera, cucumberlike when immature. In addition, the Old World bottle gourd (Lagenaria) is of immemorial cultivation in America and the vegetable sponge (Luffa) is widely distributed in the Tropics.

In the genus Cucurbita a minimum of four species is recognized. Cucurbita maxima, called "zapallo" in western South America after the Quechua name, is exclusively South American in its aboriginal distribution. It is not known to have reached the Caribbean in Colombia, but appears in the northern temperate lands of Inca domination. It was spread throughout the warmer parts of the Inca realm, and its apparent failure to penetrate northward beyond the Inca conquests suggests that it was carried northward by them. The situation in Venezuela and the Antilles is quite unclear. Oviedo seems to have noticed on the islands only the calabash vine, or true gourd. From the Indians of Cumaná, according to Henríquez Ureña, the name "auyama" was taken by the Spaniards as meaning a squash, and it was used in New Granada until the Quechua term supplanted it. But what it was has not been determined and present-day Antillean agriculture has imported so many things from all sides that it may be impossible to name the aboriginal squash. Hoehne (1937, pp. 158, 188) recognizes in the "moranga" of northern Brazil C. maxima. In Mochica and Chimú pottery there are many faithful reproductions, including a form much like our Hubbard squash. The seeds are found in mass in graves of desert Perú. Southward, in Chile, it is grown to the limits of agriculture, and in middle Chile has developed the most gigantic form of all pumpkins. In late years, Chilean varieties have been brought to northeastern and north-central United States, where they now have become common winter squashes. Here belong also the turban squashes. The species is recognized in its fruit by its cylindrical, often bulbous and spongy, stem and the filling of the central cavity by fibrous placenta and seeds, and its origin is to be placed east of the Andes.

Cucurbita moschata, widely grown in Central America and Colombia, is apparently of Mexican or Central American origin. Bukasov has divided it into two races, white-seeded Mexican and brown-seeded Colombian. The former is the "ayote" of the Nahua. The Crook-
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neck form, with its angular stem, is well represented in Mochica pottery. Hoehne considers the “gerumú,” much planted in northeast Brazil, as \textit{C. moschata}.

The common field pumpkin, summer squash, vegetable marrow, and ornamental gourd of the United States, \textit{Cucurbita pepo} (the species of most extreme variation in form and size), probably did not get into South America at all, and not strongly into Central America. The cold-land member of the genus is \textit{C. ficifolia}, the black-seeded, watermelonlike vine with figlike leaves. It is now very commonly grown by the Indians in the Andes, much more so, in fact, than in its native Mexican plateau, where it is called “chilacayote.” It should be noted that a white-seeded race also exists. In most of the Andes, \textit{C. ficifolia} is called \textit{Mexicana}; in Colombia, \textit{Victoria}. It is therefore considered a Colonial introduction. Nor is there mention of it in Acosta, Cobo, or other early accounts. If true, this pre-Columbian absence of a cucurbit in the cool lands of the Andes is perhaps the most curious quality in the geographic distribution of the genus.

The importance of the squashes in native economy was and is great. Immature, they are in their season the most important green vegetable. Ripe, they are boiled and especially roasted as an important source of starchy and sugary food. Their excellent keeping qualities make storage possible for months, and they are often cut in strips and dried in the sun or over coals. The seeds are largely used roasted, and in some cases are even more prized than the flesh. Commonly they are sown with other plants, but in areas deficient in moisture they are frequently seeded during the dry season on a stream bar, or even in the stream bed. The marked geographic detachment of the center of each species from the other indicates a plural origin of their cultivation, or else that \textit{C. moschata} is the oldest form, \textit{C. maxima} being a South American, \textit{C. pepo} a North American derivative. The habit of the plant further suggests that it may have come in as a volunteer into primeval fields, there been tolerated, and then deliberately associated by man with the main field crop.

\textit{Sicana odorifera} is probably to be listed as a native cultivated plant. Cobo said that in Perú it was known as “calabaza del Paraguay” because it was native in that Province. \textit{Sicana} is, however, a \textit{Quechua} name, and, as is “curua,” is considered Brazilian. It was eaten, according to Cobo, both raw and cooked, but was prized for its fragrance, as is the case today. It is found widely about houses in the Tropics and, in view of the native names, may be supposed to have been disseminated independently of the Europeans.

Somewhat more important in cultivation is the \textit{Cyclanthera pedata}, undoubtedly of South American origin, and probably from the Caribbean. Cobo gives a good account of it as resembling a cucumber in
looks and flavor. It is also cooked. He gave as its Haitian name, "cáygua," and as the Quechua term, "achoccha." It is commonly grown in Colombia today.

Sechium edule, the "chayote" of the Nahua (also "guispui" in Guatemala: Bukasov, 1930, p. 79) is identified by Cobo only for New Spain. In South America it is known to me only by its Nahua name, and this distribution therefore seems modern. The fruit is ordinarily cooked as a green vegetable; its numerous tubers are boiled and roasted (the "chinchayote" of the Nahua).

The bottle-shaped gourd (Lagenaria) is often cited as the one cultivated plant common to both the Old and the New World, and its dissemination attributed to waves and currents. It is usually thought that the plant derives from the Old World. It is a cultigen as we know it in America and depends on the care of man for its preservation. It is in no sense a strand or marsh plant. The theory of its accidental dissemination involves, in addition to the undamaged transit of an ocean, a waiting agriculturist who carried it in from the seashore to a suitable spot of cultivation. It is at any rate an anciently grown plant in the New World, as the many gourds in archeological sites attest. A variety of types from Peruvian graves is shown by Yacovleff and Herrera (1934–35, 3: 314) who point out also that many forms of the ancient pottery, especially in Nazca, derive from Lagenaria shapes. Gourds with designs burned into them are widespread through the old pre-Conquest sites of Coastal Perú and North Chile. In Quechua the bottle-shaped gourd was called "purú," the globular one "matti" (now commonly "mate") (ibid. p. 316). From the Nahua the term "tecomate" has been applied in North America to the cup gourds, "jicara" to the form bisected for basins. (Hernández, 1942, bk. 2, ch. 8). Pyrogravure, carving, and lacquering of gourds has been and is a well-developed craft from Perú to Michoacán. The growing of the gourds is largely concentrated in certain lowland valleys where selection has given rise to specialized forms for which there is a wide demand in native trade. They are carried further by native trade than is pottery. Shapes range from small cups and dippers, through constricted bottles carried by field laborers, to the great flattened globes, cut in half for kitchen pots and storage basins, and used entire, for floats used in ferrying streams. The assemblage of forms and their distribution have never been studied. Nor have comparisons with Old World forms been made. Oviedo, Cobo, and others pointed out that the "calabazas" of the New World did not serve as food, as did the immature Lagenaria in the Mediterranean (and incidentally also in the Orient.) It is generally a hot-country plant, but in Colombia a large form exists that is grown in the cool Highlands of Antioquia.
TROPICAL ROOT CROPS

The early Europeans were much interested by the root crops of the New World Tropics. These were something new to them, for at home they knew only such things as turnips, carrots, and radishes, garden vegetables rather than field crops. In consequence, the early accounts are especially full on these strange new plants and their care and use. The shores of the western Atlantic, first entered by Spaniards and Portuguese, depended on root crops rather than on seeds as food staples. About the Caribbean and on the east coast of Brazil the food tubers and fleshy roots basic to the native economy were chiefly manioc and sweetpotato, but also certain plants of the monocotyledonous families of the yam and arrowroot. The peanut has been considered earlier, under leguminous seed plants.

Manioc (Manihot utilissima), “mandioca” in Brazil and Paraguay (from the Tupi-Guaraní), “yuca” in most parts of Spanish America (from the island Arawak), is thought to have originated on the Coast of tropical Brazil, because of the concentration of Manihot species there. It is possible, however, that it was derived from some drier area in the Andean base of the Amazon drainage. (There are such, though not manifest in weather records.) I should prefer an origin on the dryish shore of the Caribbean. Manioc is a cultigen, and has not been referred to a specific wild ancestor. In the course of long cultivation it has practically lost the capacity of reproduction by seed, having been handed down from one generation to another by cuttings.

An indefinitely large number of varieties have been developed, grouped in use as poisonous and nonpoisonous, or as bitter and sweet. The sweet maniocas are known as “aypi” in Tupí, and were called “boniato” in the Caribbean. (For discussion of the term boniato, see Henriquez Ureña, 1938, pp. 87–94). The range of variation in the species has never been studied satisfactorily and the botanical relation of hydrocyanic acid to other plant qualities is not clear. In eastern South America the bitter and sweet manioc are both grown, often in the same field, and the producers are able to distinguish them with certainty. It has often been assumed that the poisonous form is the older and that the sweet forms were selected from parent bitter stock.

Functionally the two groups are differentiated. The “aypi” is simply boiled or roasted, like the sweet potato. The bitter manioc is subjected to grating, washing, pressure, and baking. The resulting “bread” is “cazabe”; from the colloidal starch tapioca is prepared, perhaps originally an Amazonian Indian process. In general the bitter maniocas are higher in starch content and superior to the sweet group as food.
The sweet group has enormously the wider distribution. (1) It is grown throughout the range of the bitter manioc; that is, the tropical lands of Brazil, Venezuela, and the West Indies. (2) It extended to about lat. 30° S. in Brazil, with the southern Guarani and their agricultural neighbors. (3) Grown in Northwest Argentina, it is also common in the yungas of eastern Bolivia, Peru, and Ecuador. (4) On the Pacific Coast it extends from the Aria area northward beyond South America, and is grown especially where a minimum amount of water must suffice for irrigated farming. It is abundant in the pre-historic graves of the desert. (5) In Colombia it is cultivated in the tierra caliente and also in the tierra templada to an elevation of around 1,800 m. (5,850 feet). (Bukasov, 1930, p. 92, who also made the observation: "In this very dry year [1926] amid maize plantings killed by drought and yellowed fields of sugarcane, the yuca fields stand out by their flourishing appearance.") (6) Still grown throughout the lowlands of Central America and southern Mexico, it formerly extended northward about to the northern limits of the advanced coastal cultures, i.e., into Sinaloa. Its Mexican name, "quauhcamote" ("tree" or "great sweet potato"), indicates a late arrival there.

At least some forms of sweet manioc withstand more severe dry periods and require less warmth than do the bitter kinds. Yet the restricted distribution of the bitter manioc is not to be explained by climate alone. Climate does not explain its failure to expand into Colombia and Central America. This indicates either that it was a late form that had not had time to reach these areas, which is unlikely, or that there was a lack of receptiveness to it on the part of the cultures about the western end of the Caribbean. In this connection it may be pointed out that where bitter manioc is dominant, it was the main breadstuff, with maize of subordinate importance, and grown only in one variety, or a few. (Maize and manioc alike do best with a dry season following a rainy one, manioc requiring less rain. The dominance of bitter manioc over maize from the Antilles southward through Brazil (mostly lands of abundant precipitation) is therefore almost certainly not due to climatic advantage).

On the other hand, the sweet manioc is nowhere the staple and hardly anywhere was it prepared as bread. It was subordinate everywhere in the west to maize, which was grown in greater varietal and functional diversity than in the bitter manioc regions. Oviedo's classical account of agriculture about the Caribbean makes this clear (1851–55, bk. 7, chs. 1 and 2). He knew both islands and mainland well, and noted the absence of the bitter manioc in "Tierra Firme" and the importance and variety of maize culture there as compared with its lesser role in the islands. The Tupi and Carib seem to have been the main carriers of the bitter manioc culture, and in part also
the *Arawak*. The absence of the bitter manioc in Colombia including the Caribbean coast suggests a cultural break between it and Venezuela, paralleling the situation with regard to frijol and lima beans. Information is needed for the Amazon Basin; the Spanish accounts from the upper tributaries in general identify only the sweet form.

Cobo (1893, bk. 4, ch. 7) gives details for western South America; Soares de Souza (1851, pt. 2, chs. 37–43) gives a full account of cultivation and preparation in Brazil. A good review of economic botany is supplied by Bois (1927–28, 1: 436–446).

The sweetpotato (*Ipomoea batatas*) had a New World distribution similar to that of manioc, but somewhat wider. (1) It reached farther into the temperate zone of the Pacific Highlands; (2) it was grown in Chile as far south as the Quillota Valley (near Valparaiso), according to Latcham; (3) it was more widely distributed in México and an older crop than yuca, but its northern limit of cultivation barely crossed the Tropic.

The genus of the morning-glory or *Ipomoea* ranges widely through the warm lands of the world, with hundreds of species, a number of which are tuber bearing. Among botanists there have been adherents of belief in an Old World origin of the sweetpotato as well as those who thought it originated in the Americas. The genetic studies of Tiomine (1935, pp. 3–11) make it probable “that the generic relationship between *I. batatas* and *I. fastigiata* is closer than that of the other species.” The latter is a wild species of tropical America, a common “batatilla” of Caribbean lands. We may consider therefore the likelihood of domestication of the sweetpotato in the latter area, and more probably on the South American mainland than in the islands or on the Central American side. The sweetpotato belongs in a culture complex that operated by vegetal means of reproduction, that is, by cuttings of plants or tubers, and not by seed reproduction. Western Central America falls with México into the seed complex, and the sweetpotato is to be regarded as adventive there into an older agricultural pattern. It seems also that South America is markedly richer in varieties of sweetpotato than Central America and México, though no adequate collection and study of these have been made.

Under ordinary means of reproduction the sweetpotato is multiplied entirely by plant division. It is now known that occasionally seeds are set, and these are being used in scientific hybridization, but they played no role, it would seem, in the domestication or in the development of the existing varieties, which operated by taking note of bud mutations and planting divisions of the desirable new form. It is possible, therefore, that all sweetpotatoes have been derived from a few ancestral plants which were multiplied by dividing and planting their shoots by generation after generation of planters.
Native names of the sweetpotato have been the subject of two masterly studies by Henriquez Ureña (1938, pp. 15–86): “Papa y batata,” and “El Enigma del Aje.” “Batata” and “aje” are names derived from the West Indies. The old and now largely disused name “aje” belongs more probably to the sweetpotato than to the yam (Dioscorea), though numerous students have applied it to the latter, perhaps by reason of later confusion, just as we confuse yams and sweetpotatoes in the United States. The term “aje” seems to have been given to an inferior sweetpotato of large roots and rapid growth. Oviedo considered aje and batata as closely akin, and among the characteristics of aje which he described that point to its identification with the sweetpotato was the planting of it by the division of the young shoots, a procedure general with the sweetpotato, and hardly applicable to the tubers of yams. The Nahua name “camote” has spread through Spanish Colonial influence over much of Spanish America, and has replaced largely the Quechua name, “apichu.” For a starchy form the Quechua designation “cumara” survives from the days of the Conquest (used by the Inca Garcilaso). Fortunato Herrera thinks, with some reason, that this was the group described as “ajes” by Oviedo.

The name “cumara,” used in Perú and in Oceania, raises the oft-discussed question of the date of the introduction of the sweetpotato into the South Seas. It is not necessary here to resume the views of Rivet, Friederici, Dixon, Nordenskiöld, and others who have engaged in this controversy. The case for the carriage of the tubers by Europeans across the Pacific is weakened by two considerations: (a) The extraordinary variety of forms cultivated in the South Seas (20 varieties being claimed for the Maori), and (b) the fact that the sweetpotato developed races in New Zealand much farther removed from tropical growth conditions than anywhere in the New World. It extended in the South Island well beyond the Canterbury Plain (about lat. 45° S.), the highest latitude reached by aboriginal agriculture anywhere in the Southern Hemisphere. This was about 12° farther south than it penetrated in Chile and 20° beyond its aboriginal Northern Hemisphere dispersal. Such an adaptation to high latitude and very cool summers is nearly incredible for a selection to have been made as the result of casual, late introduction by European sailing vessels. It may also be noted that these Maori forms seem to have been starchy and coarse-fibred, like the cumara of the Andean yungas, and suggest a derivation from an older, and now nearly extinguished American form. The Maori sweetpotato was rated by Hooker as a separate species, though only varietal rank is now accepted (Bois, 1927–28, 1: 317–318).

The ordinary yams (Dioscorea alata, cayenensis, and batatas) are
natives of the Old World. Their introduction with the African slave trade was described by Oviedo for the West Indies and Soares de Souza (1851) for Brazil. The New World Tropics hold a number of wild species of *Dioscorea*, some with edible tubers. In eastern Brazil, in particular, a number are grown (such as *D. dodecaneura*, *piperifolia*, and *hastata*, according to Bois, 1927–28, 1: 484–485), no information being given as to whether domesticated forms have been developed out of the wild parents. One American *Dioscorea*, the "yampee" (*D. trifida*, to which is referred also *D. brasiliensis*) may be a truly domesticated plant. Its smallish, but reputedly excellent, tubers are rather widely grown in the Atlantic Topics from the Antilles to Brazil. These may be the "carazes" (modern Brazilian name "cara" ?) to which Soares de Souza referred (1851, pt. 2, ch. 44) and which he distinguished from the Old World "inhames" (ibid., ch. 35); the vines were supported by stakes and the mature tubers preserved by smoking.

In the arum family the place of the taro of the Old World is taken by species of the New World genus *Xanthosoma*, called "yautia" or "malanga" in the Caribbean, "mangareto" (Bois, 1927–28, 1: 526) in Brazil. The principal cultivated species is *X. sagittifolium*, with Engler ("Pflanzenreich," 1920, IV, 23E) also listing *X. jacquinii* as of wide insular and mainland distribution about the Caribbean. Bois lists further as cultivated *X. brasiliensii*, *X. belophyllum*, *X. caracu*, *X. mafaffa*, and *X. violacecum* for parts of the Atlantic Tropics. In addition to the tubers, the leaves are used as cooked greens. As in the case of taro, the cultivation is usually in moist lowlands. The yautia was known to Oviedo and Cobo for the Caribbean, and is apparently discussed by Soares de Souza (1851, pt. 2, ch. 44) under the term "taiazes": "the leaves being eaten with fish in place of spinach, and with green beans in place of lettuce, and have a very superior savor; the Indians eat them [the tubers ?] boiled in water with salt, and with large quantities of peppers." In the Peruvian yungas, according to O. F. Cook (1925, p. 100), the roots are dried and stored.

The arrowroot (*Maranta arundinacea*) is widely distributed from Brazil to the Caribbean and is grown in wetish land. The preparation from it of starchy flour, "fecula," is said to be a modern invention, and the name of the plant is said to derive from the older use of the root as an antidote to arrow poison (Schumann, in Engler’s "Pflanzenreich," 1902, IV, 48). The name "lerén" (lirén, llirén, etc.) may apply to this plant. The description of lirén by Oviedo (1851–55, bk. 7, ch. 13) and Cobo (1893, bk. 4, ch. 9) clearly does not, but may refer to Calathea alluvia, the Carib "alluia" also known as topimampur in the West Indies (Schumann, loc. cit.), where this plant is still cultivated.
ROOT CROPS OF TEMPERATE LANDS

The lone New World umbellifer transformed into a cultivated plant is the “arracacha” or “racacha” (Arracacia xanthorrhiza or esculenta), a major food in the tierra templada of the northern Andes, especially in Colombia. Its extension into the tropical Caribbean may be modern, since it was not described by Oviedo. In the temperate yungas of Perú its use in native economy is less than in northern South America. It is reproduced usually by division of the root crown; it would be interesting to know whether its planting by seed is practiced in native agriculture. The wild ancestor is not known. The failure to penetrate through neighboring Central America and México may argue for the lateness of its cultivation or simply that it was not accepted into the seed-agriculture complex of that region. Neither explanation is very satisfying.

Peruvian archeology has numerous ceramic representations of the starchy roots of the “achira” (Canna edulis, probably), still a fairly common market item in Coastal Perú and the temperate valleys as far as Jujuy and Salta in Argentina (Parodi, 1935, p. 141), and often naturalized along irrigation ditches. There may be other canna grown for edible roots in Latin America (C. coccinea and C. discolor in the West Indies?).

“Yacon” is the Quechua name and “aricona” the Aymara term for a tuberous composite (Polymnia edulis) grown in temperate valleys from Colombia to Northwest Argentina. Its tubers resemble the Dahlia, to which it is related—“on the outside the color of earth and inside white and of the consistency of a turnip. They are eaten raw as fruit and have a very good flavor and much better if exposed somewhat to the sun” (Cobo, 1893, bk. 4, ch. 16). Because of its sweetish, watery quality it is considered a pleasant refreshment; its food value is low and probably lies chiefly in its sugar content.

The “jicama” (Pachyrhizus sp.) of the Mexicans has become “xiquima” in the Andes, the older Quechua name being “ajipa.” The large turniplike roots are edible, the beans poisonous. Yacovleff and Herrera demonstrated the presence of its roots in Peruvian graves and the use of the plant as “decorative motif” in Nasca art (1934–35, 2: 51–66; 3: 282–284). The plant as described by Cobo (1893, bk. 4, ch. 17) is almost unknown in modern Perú, but is still cultivated in the Bolivian yungas. Parodi (1935, pp. 137–141) lately has called attention to the cultivation of both a violet- and a white-flowered variety about Jujuy, and to the taxonomic uncertainties of the whole jicama complex. I am acquainted with it only as a refreshing raw vegetable eaten out of hand like the yacón, in which form it is a very common summer food in México and Central America. It is apparently cooked in the West Indies, where its English name is yam bean,
and especially also in southeastern Asia (Bois, 1927–28, 1: 170–172). In South America it is boiled and would seem to have a notable starch content; possibly Mexican and South American jicamas are different species. Old and New World forms have been divided into two species (references in Bois), but the distinction is not sharp, and perhaps all of the distinguishing marks of the supposed Old World species exist also in the American plants. This is another case of a trans-Pacific occurrence of a cultigen, morphologically somewhat differentiated on the opposite sides of the ocean, but almost surely of common origin. In both areas the plant is of concern only to native cultivators.

The starchy root cucurbit, chinchayote, was noted in the section on cucurbits (p. 506).

Aside from the arracacha, the root crops of the temperate Tropics are not, nor are they likely to become, staples replacing other sources of starch and sugar, such as are provided by the maize-beans-squash complex, fully suited to these climes.

ROOT CROPS OF COOL LANDS

The origin of the potato ("papa" in Quechua and many parts of Latin America), and its diversity in native agriculture have received new light through the work of the Russian Institute of Applied Botany, especially through the monograph of S. M. Bukasov (1933). As the result of very extensive collection of wild and cultivated materials they have radically redefined the concept Solanum tuberosum.

This specific name they would limit to the potatoes of Chile (and possibly the commercial forms of European and North American derivation). In Chile the home of the potato is in the coastal lowlands of cool summers and long summer days, and especially in the wet areas of the south. Possible local wild ancestors were suggested. (They are inclined to exclude the oft-claimed "malla," S. maglia, of Chile as ancestor of the cultivated species.) The greatest diversity of cultivated types is in the island of Chiloé and the adjacent mainland on the north, both of which they regard as the cradle of what we of North America know as the potato, which found a similar, congenial home in the high latitudes of the Northern Hemisphere (possibly with incrossing of blood from other Andean (?) potatoes).

The Russian students point out "the restricted area and plasticity" of the Chilean group of potatoes as against the great Andean form assemblage. It is doubtful, therefore, whether the first origin of potato domestication may be assigned to this southern area, marginal moreover to aboriginal American agriculture. Perhaps, rather, in view of the great number of species of tuber-bearing Solanum distributed from the North American Southwest to Uruguay, Chile may be
regarded as a secondary center of domestication, making use of a Peruvian domesticate after an earlier pattern of potato domestication had been elaborated in the Andes to the north. (The Bukasov monograph assumes a wide geographic gap between the aboriginal cultivation of the Chilean and the Andean potatoes, omitting all North Chile from the area of potato growing. This is in error and means only that the Russian workers did not get material between Central Chile and the Bolivian Plateau. The mountain villages of North Chile have an important and varied potato culture. As a casual observer, I should place these with the potatoes of Bolivia and Perú. The area is of particular interest for future study as probably holding the long-day forms of the Andean potatoes, and possibly as the meeting place with the southern, Chilean, kinds.)

For the Andes the Russian work has established 13 new cultivated species, which they have named. These occupy a large continuous Andean area from the Boyacá district in Colombia to that of Calchaquí in Argentina. Of these Solanum andigenum has the widest distribution, and includes within its range most of the areas in which the other species are found, the exceptions being the species of high frost resistance and those of the warm valleys.

For central and south Perú and Bolivia the Russian studies of Solanum andigenum have yielded 1 subspecies, 17 varieties, and 34 forms, representing also large ecologic and functional diversity. Most of the kinds grow at altitudes from 3,000 to 4,000 m. (9,900-13,000 ft.). A few, grown around the higher elevation, are somewhat frost-resistant, and these are usually of the "bitter" sorts used in preparing chuño. Such is the variety "ccusi," with blue or lead-colored tubers; "yani-cusi" in Vargas (1936, pp. 46-47). An important and readily recognized kind is "ccompis," the only white-flowering potato in Perú and widely grown in Bolivia and southern Perú because of its heavy yield.

The pioneering Russian studies have now been greatly enlarged and revised by the collections, cytogenetic examinations, and taxonomic systematization of the Imperial Bureau of Plant Breeding and Genetics, by Dr. J. G. Hawkes and associates. The principal publications to date are all by J. G. Hawkes (1941, 1944, 1947).

This finely conceived enterprise, still in progress, already has given a clearer view of the systematic position and evolution of the cultivated potatoes than we have for most plants. Passing over the examination of wild and weed species, which will be of more and more significance in determining cultivated origins and modifications, I will attempt to give in the following paragraphs a brief abstract of the British findings on the cultivated complex, which is a polyploid series
Hawkes accepts 10 cultivated diploid species, individually for the most part of restricted range, but with an over-all extension from Boyaca in Colombia to the Cochabamba region in Bolivia. In general these may be regarded as the more ancestral forms, the ones taken first into cultivation and modified. They are in the main less vigorous and yield fewer and smaller tubers than the higher polyploids, and hence have given way largely to the latter, except in out-of-the-way areas. At the most primitive end of the whole series of cultivated potatoes lie five species, notable for quick maturity, short dormancy, and occurrence at low altitudes and under higher temperatures than are characteristic of other potatoes. These fall into two geographic groupings: at the north (1) the large species of *Solanum rybinii* of the Colombian departments of Boyaca, Popayán, and Pasto; (2) *S. kesselbrenneri* of inter-Andean valleys of Ecuador and southern Colombia; and (3) *S. ascasabii* from the Ecuadorean east-Andean montaña. Far to the south (4) *S. phureja* is at home in the temperate yungas east of La Paz; and (5) *S. cardenasi* about Cochabamba. Most diversified of the diploids in variety and habitat is the *S. stenotomum*, which extends from Central Perú to Central Bolivia. To it belongs the famous jet-black chapiña, used for dyeing rather than food. Notable also is the diploid *S. goniocalyx*, the white-flowering, golden-fleshed *Papa amarilla* of Perú, prized for its nutritiousness and nutty flavor, its climatic position apparently being cool temperate. *S. ajanhuiri* and some clones of *S. stenotomum* are notably frost resistant, but in the main the diploids are dominant at the lower elevations of potato growing.

Far and away the most important potatoes are the tetraploids, which Hawkes has placed in one great species complex, *S. tuberosum*, with two great geographic subspecies, *andigenum* and *chileanum*, disagreeing in this respect with the Russian views. Hawkes makes a strong case for the derivation of the Chilean potatoes from Andean lands, pointing out that there are no diploids known, wild or cultivated in Chile, and that the only other possible Chilean wild ancestors, a few tetraploids, are hardly suitable and seem to be merely feral, namely low-yielding types that have been dropped from cultivation, but not yet exterminated. He sums up his case as follows:

The tetraploid potatoes arose in the Peruvian and Bolivian Andes, spreading rapidly, chiefly by human agency. The higher yielding types moved more quickly than the lower yielding ones and hence became especially abundant at the edges of the distribution range. They are, therefore, to be found in Chile, the southern end, and in Colombia, the northern end of the Andes. In the south (Chile) the widely different climatic and latitudinal conditions, coupled with a more or less complete geographic barrier, aided in the differentiation of a new
species, *S. tuberosum* s. str. [Hawkes, 1944, p. 108. In the 1947 publication this is reduced to the subspecies *chileanum.*]

The triploids are an indefinitely large lot of casual hybrids, a few superior clones having become established by man through vegetative reproduction. Chiefest of the triploids is the luki, *S. juzpeczuki*, most remarkable for its frost resistance, and often the dominant tuber at high altitudes in northern Bolivia and adjacent Perú. Bukasov’s original surmise that this plant, which is sterile, originated by a cross of the wild *S. acaule* and a cultivated diploid, has been confirmed lately by Hawkes (1947, p. 628), who succeeded in reconstructing it by crossing the wild *S. acaule* with the cultivated *S. stenotomum*. The one cultivated pentaploid, *S. curtilobum*, at high altitudes from Cuzco to Potosí, is a bitter tuber and is prepared by freezing, the plant being markedly frost resistant.

The preparation of potatoes for indefinite storage as chuñu and moraya utilizes (1) certain forms of *S. andigenum* (as eccsi, huaña), and (2) the three high mountain species, *S. juzpeczuki* (luki or rukki), *S. curtilobum*, and *S. ajanhuiri*. For the most part these chuñu potatoes are bitter kinds (papas amargas), not suitable for consumption by boiling or baking. However, some nonbitter potatoes may also be thus used, such as the form of *andigenum* called “alceai huarmi” (No. 16 of Bukasov; also Herrera (1921).) The botanical meaning of the term “luqui” (rukki), applied to certain bitter potatoes used in chuñu remains undetermined. In general, also, the bitter potatoes are late-maturing, have some degree of frost resistance, and constitute the group grown at the highest altitudes (3,800–4,300 m., about 12,500–14,000 ft.). The whole culture complex of plant and product is tied to the cold limits of agriculture, especially to the part of the puna centering upon the old Collao. The process of freezing, thawing, and drying by which chuñu is produced, and that of refining it into moraya or tunta has been well described by Cobo (translation in Safford, 1925). (See also Handbook, vol. 2, pp. 527, 578.)

The complex constitution of the cultivated potatoes and their geographical distributions does not admit of an unequivocal interpretation as yet, but the data indicate a revision of usual views on Andean agriculture. There is every probability that the diploid species are the oldest in cultivation, only the *Papa amarilla* having quality and yield to make it a successful competitor with the higher polyploids. The 10 known diploid species range from warm temperate valleys to the cold extreme of agriculture in the tropical latitudes of the Andes; insofar as known, they do not enter extratropical latitudes. Within the Tropics, in other words, they form a series of cultigens, connecting at the lower end with tropical root crops, at the upper
limits reaching into the coldest spots where tillage can be practiced. Five of the ten known cultivated species are restricted to the lowest altitudinal limits of low-latitude potato growing, and these "are altogether more primitive and more closely related to the wild species" than other cultivated potatoes (Hawkes, 1944, p. 99). Four of the five "most primitive" species belong to the far north, Colombia and Ecuador. The superior S. goniocalyx would appear to belong zonally immediately above them. The S. stenotomum complex falls into the heart of the Andean Highland potato country, from Central Perú to Central Bolivia; the frost-resistant S. ajanhviri to the colder parts of north Bolivia. The luki, notable as a source of chuñu, has been demonstrated to be a stenotomum × acaule cross, the latter a weed in fields at high altitudes. The diploids and their known hybrid cultigen, therefore, by themselves may have provided a series of stepping stones, perhaps from North to South, and from low to high altitudes, for the establishment of potato culture. Root crop cultivators, coming originally from tropical lowlands, may well have found in wild tuberous Solanums a gradual means for ascending as cultivators to the cold puna. (Further comment on this thesis is given below.)

The S. tuberosum (tetraploid) complex developed later, probably out of both cultivated and wild diploid ancestry. Their greater yield and superior vigor caused them to be substituted increasingly for the older diploid lines and to dominate the Altiplano of Bolivia and Perú. Still later they were carried to the cold lands of Colombia and down to the cool coasts of Chile, where they differentiated into one varietally diverse subspecies. The comparative advantages of S. tuberosum andigenum in highest altitudes is not evident, and at warmer levels they have not been able to take the place of more primitive sorts. Their common origin is attributed to the Altiplano centering about Titicaca.

The major cultivated Oxalis is the "oca" (Oxalis crenata), probably the second most important root crop of the Highlands. Like the Andean potatoes, it is markedly photoperiodic and seems to find its highest latitudinal limit somewhere in northern Argentina and Chile (Puna de Atacama?). (Farther south Oxalis has been cultivated in the Coastal lowlands from Coquimbo to Chiloé, perhaps O. tuberosa, the data being disorganized; see Latcham, 1936 b, pp. 90–92.) Northward, Bukasov (1930, p. 237) reports it as extending into the Venezue-elan Andes. In Perú Yacovleff and Herrera (1934–35, p. 308) name five sweet varieties. It is eaten raw and cooked, but is most commonly seen offered in the markets as "cavi," dried in the sun and considered as having a chestnutlike flavor. The process, in which much of the acid is lost, is described by Weddell (cited in Bois, 1927–28, 1: 80–81).
A heavily yielding bitter variety is prepared by a method identical with the making of chuñu and the product called "caia" (ccaya).

The ulluco, or "papa lisa" (Ullucus tuberosa) apparently exists as a single cultivated species (Bukasov, 1930, p. 232), from the Bogotá area southward into northern Argentina (Parodi, 1935, p. 141). Its smooth red, yellow, or variegated tubers are seen fresh in the markets more commonly than oca. It is a satisfactory source of starch and sugar, but rather insipid, and its consumption is mostly confined to Indians. The tuberous nasturtium (Tropaeolum tuberosum), called "añu," "isaña," or "mashua" in the central Andes, and "cubio" in Colombia, may be sufficiently differentiated between the Colombian and Peruvian forms to constitute two distinct species (Bukasov, 1930, pp. 227 ff.) The tubers are too sharp in flavor to be eaten raw. In Bolivia a chuñu is prepared from them, named "taiacha" (Weddell, in Bois 1927-28, 1: 78-79). The plant received emphasis from the chroniclers because of its reputed antiaphrodisiac properties, Cobo for instance stating the the Inca emperors fed their armies on the march with such tubers "that they should forget their wives." (1893, pt. 4, ch. 18). Least among the highland root crops is "maca" (Lepidium meyenii), a relative of the peppergrass. Cobo gave its occurrence as restricted to the province of Chincha-cocha [Junin?] where it grows in the highest and coldest parts of the sierra, where no other cultivated plant succeeds. The root is of the size and form of a Muscadine pear (cermeño), pearly-white inside like a turnip, and after drying is much reduced and has the appearance of dried pears. It is sweet and of good flavor; it is eaten after drying, both boiled and roasted. It has a strange quality, that wherever planted one year, it exhausts the soil in such a manner that in more than ten years it is impossible to return to planting that land, and in order that it may not be frozen with the continuous snows and frosts which prevail where it is grown, the Indians are accustomed to cover it with straw until the time for harvest. [Cobo, 1893, pt. 4, ch. 15.]

Diversity, staple use, and geographic extension make it seem reasonable that Andean Highlands, like the tropical lowlands, owe their basic agriculture to reproduction by plant division. It is possible to assign to the potatoes the leading role in the agricultural colonization of the Andes, except for the one fact of the existence, side by side with the potatoes, of the lesser tuberous crops just noted. The only one that seems to have its own ecologic niche is the maca. All the rest are grown under the same conditions of cold climate and under the same edaphic situations. None has any peculiar place in economy, kitchen, or diet. The potatoes in general produce more, have better food value, and are perhaps more tasty. It is difficult, therefore, to explain the presence of less useful tubers as of later origin than the more useful ones. Oca, ulluco, and añu are real cultigens, bred to differ
largely from their wild kin. Why should people have troubled to select inferior tuber-yielding plants, if they had better ones to hand in potatoes?

It seems to me, therefore, that we have in these minor tuber crops the remnants of the oldest Highland agriculture; that long before potatoes were bred to grow on the bleak reaches of altiplano and paramo, these microthermal native tubers had made sedentary life possible by supplying starch food and had been made into domesticated plants. Also, the storage problem had been solved by inventing chūnū making and this was transferred later to potatoes, when these became developed for puna climate cultivation. Between the earliest cold-land and warm-land root crops (oca, ulluco, añu vs. manioc, racacha, and achira) there may remain a sensible climatic gap that was bridged by the cultivation of mesothermal diploid potatoes. In this case the major course of primitive potato breeding has been up-slope into colder and colder lands, with gradual replacement of the earlier cold-land tubers.

GARDEN PLANTS OF THE NIGHTSHADE FAMILY

The Old World distinction of tillage, as field or as garden, was largely lacking in the New World. New World cultivation was really gardening. Columbus, for instance, properly referred to the landscape about Puerto Bello as being like a painted garden (huerta). On the other side of the Atlantic, field crops were not used until their fruits had matured. There was a definite, usually brief harvest season and the time of gathering the ripened crops was marked by harvest festivals. Green vegetables in the Old World were a separate lot of plants cared for in special plots by a different mode of culture. In the New World, on the other hand, the major food crops also yielded for the most part the fresh vegetables. Regularly, an important part of these was consumed during different stages of the period of growth. With maize, use began with the collection of the oil-rich pollen. Everywhere an impressive variety of dishes was prepared from maize grain in the milk and soft-dough stages. Beans were used first as green pods; later the immature beans were cooked. Squashes yielded a first harvest in their blossoms; the fruits were boiled as green vegetables at all stages prior to maturity. Thus it was with plant after plant. Leaves, blossoms, and immature fruits supplied salad and pot vegetables from the same plants that by their mature fruits furnished the staple foods of the Indian communities.

The nightshade family (Solanaceae) has been much more important in the New World than in the Old World in yielding cultivated plants. In the latter such minor edible fruits as the eggplant and the Jerusalem-cherry were domesticated, and the drug plants developed were
belladonna, mandragora, and henbane. In addition to potatoes, the New World cultivated for food and condiment species of *Solanum*, *Capsicum*, and the genera collectively known in gardening as tomatoes; poisonous plants taken under human care were Nicotianas and Daturas.

The genus *Solanum* has provided an additional cultigen, more fruit than vegetable, in *S. muricatum*. Formerly known in Quechua as "cachun" it is now most commonly called "pepino", sometimes, in English, "melon pear." Though flowering freely like a purple-blossomed potato, good races of the plant have lost the capacity of seed production. The better sorts contain no or only vestigial seeds and are therefore reproduced by cuttings. It is a plant of temperate climates, grown as an herbaceous perennial in the coastal area of Perú and south to Norte Chico, Chile. In Ecuador and Colombia it is found in valley cultivation between 1,200 and 2,500 m. (4,000–8,000 ft.) above sea level. There is a good deal of variety from place to place in shape, size, color, and quality, the best tasting being somewhat like a cucumber and somewhat like a pleasantly subacid melon. The Peruvian varieties are the more highly bred, the Colombian ones more seedy and primitive (Bukasov, 1930, pp. 295–300). Its cultivation probably began by cuttings in temperate valleys of the northwestern Andes. Its spread northward from South America is probably Colonial. It is represented in various Peruvian pottery, clearly recognized by the characteristic discontinuity of stripes.

The naranjilla (*Solanum quitoense*) of the fruit drinks of Ecuador, ranges from Baños to Otavalo, 1,500 to 2,600 m. (5,000–8,500 ft.). According to Popenoe (1924, pp. 133, 149) there is no information on degree and age of its domestication.

The husk tomatoes or groundcherries (*Physalis*) are placed by Bukasov (1930, 286–291) into a Mexican group which are glutinous and not sweet (*P. aequata* or *izocarpa* and *P. angulata*) and the sweet-fruited aromatic Peruvian species (*P. peruviana*) called cape gooseberry in the United States. In México the groundcherries bear the name "miltomate," or tomato of the milpas, a term that may signify planting with other crops in the milpas or volunteering among such crops. They are commonly grown and widely marketed through México and Central America; they keep for a number of months, and are used cooked or in sauces with chile. The plant is an annual, with greenish to purplish fruits that commonly burst their husks. The Peruvian species is a perennial with an orange-colored fruit that does not fill the husk. It is commonly cultivated northward through Colombia.

The history of the tomato (*Lycopersicum esculentum*) is most obscure. The usual reference of its origin to Perú has little in its favor
except the fact that several wild species of the genus belong there, none of them, however, being indicated as ancestor. The use of the tomato in the diet of Indians and common people is much more incidental in Perú than in México and Guatemala. No native name is known for it in Perú, and its archeological occurrence there is doubtful. The primitive, semiwild (and wild?) cherry tomatoes (variety cerasiforme) are widely distributed about clearings and in old fields through the lower lands of México and Central America but also occur thus in Perú. These little tomatoes are often grown in back yards with some selection as to size and quality. The name “tomato” is Nahuan. In México the true tomato generally is called “jitomate” to distinguish it from Physalis and other solanaceous fruits. A study of “tomate” words, including both plants and place names, is needed. There are native names also in Mayan, but none apparently in languages of lower Central America or north of Central México. It has been remarked repeatedly that Hernández in his description of the plants of México did not include the tomato. Bukasov suspects that its real domestication is post-White and that earlier it was a volunteer in milpa crops (1930, pp. 273–287).

The tree tomato (Cyphomandra betacea) is widely grown in western South America in temperate valleys (Popenoe, 1924, p. 134, says chiefly between 1,500 and 3,000 m., 5,000 and 10,000 ft. It is a common garden plant in every city of the Ecuadorean basins, including Quito. The tree tomato is not known in the wild state (Bukasov, 1930, p. 295).

The chief condiments of the New World are fruits of the genus Capsicum. These so-called peppers are known as “aji,” from the island Arawak, through nearly all Spanish South America, and as “chile,” from the Nahuan, in México and Central America. The homeland of the original Capsicum peppers remains undetermined while we await a better knowledge of Brazil and Guiana, whence a great variety of species have been reported in considerable systematic confusion, and with much uncertainty as to what is wild and what is cultivated. In mild climates the New World peppers naturalize themselves readily, partly because birds attack the ripe fruits eagerly. Views on classification range from grouping all the condiment Capsicum under one or two species to the making of scores of species, and from considering many of them as wild to saying that none has been found in a truly wild state. An uncertain guess at present is that there are two wild species, C. pubescens and C. frutescens. Both are semiwoody perennials of Aw climates. The former, the “roccoto” of the Quechua, violet-flowered, globular-fruitied, was a common pepper of

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1 James Jenkins (1949) in a study published since this paper went to press clears up the historical confusion, and attributes the amelioration of the plant largely to native cultivators along the Gulf of México.
Perú in Conquest days (e. g., one of the three peppers named by Guamán Poma, and called “el común” by Garcilaso). The *C. frutescens* fruit is far more widely distributed, and perhaps the small-berried variety *baccatum* is the basic form. The latter is reported as having great varietal diversity in Brazil, but it is also very common through the hot lands of Central America and México, where it is usually known as “chiltepín,” the small, fiery green pepper. The cayenne pepper is usually regarded as a garden form of *C. frutescens*.

Most of the cultivated peppers are herbaceous annuals constituting the species *Capsicum annuum*. They are grown (1) in low altitudes at altitudes intervening between the hot lowlands and the cool highlands; (2) in the tropical margins in areas of *Cw* climate; and (3) beyond the Tropics, as in Chile, in sunny valleys with long summers. The species is definitely a cultigen and seems to have been derived from *C. rutescens*. The greatest diversity of forms is found in México (and also in Brazil?). The Russian collections register a marked impoverishment of variety about the Caribbean. In Perú there are types of advanced breeding, but no great diversity of form, a conclusion that is supported also by the archeological record. Judging from historical accounts, the role of the pepper in South American Indian fare appears to have been larger in the Conquest period than at present. In México, however, the cultivation of chile has not diminished in significance. Green, ripe, and dried, each kind has its special uses. Villages still are noted for a particular chile which is carried to distant markets. The greater survival of culture traits based on chile in México is probably associated with greater aboriginal importance. The data of Hernández, for instance, on growth and use of different species of *Capsicum* are unmatched by any records from South America. Speculation as to the place of origin of the annual peppers requires more knowledge of the philogeny of the group. If the perennial small-berry (*C. frutescens*) peppers are native to a large part of the American Tropics, instead of being naturalized, a plural development of the annual peppers may have taken place through culture. We are sure only that breeding of the annual peppers was carried farthest in México (botanical data especially in Bukasov, 1930, and Bois, 1927, vols. 1, 3).

There are two cultigen tobaccos, *Nicotiana tabacum* and *N. rustica*. The former has been determined by Goodspeed and Clausen as a hybrid formed from *N. tomentosum* and *N. sylvestris*. The wild *sylvestris* is found in the Province of Salta in northern Argentina; the wild *tomentosum* has a wider range, through the yungas of Perú and Bolivia. It is not known that the two species overlap in their natural range. It may be, therefore, that one of these was taken under cultivation and thus carried to a place where hybridization with the other
resulted. In any case the cultigen *Nicotiana tabacum* should have originated in the eastern valleys of the Andes, probably in Bolivia. Thence, one may surmise, it was carried down Amazonian tributaries into the flood plains of the Amazon, through Guiana, and into the Antilles. The manner of its introduction into Europe records also a spread part way through the east coast of Brazil. Ethnically it would seem to be associated mostly with *Arawak, Carib,* and *Tupi* peoples. Its distribution coincides reasonably well with that of the bitter manioc.

On the other hand, *Nicotiana rustica* was spread almost to the farthest limits of American agriculture, apparently from Quebec to Chiloé. This was, of course, the tobacco of the Indians of eastern North America, the “piciete” of México and Central America, and probably the “petúm” of Brazil. Its use appears to be strongly coincident with the distribution of the elbow pipe. Its very great range, involving high latitudes, makes it proper to consider it as an older cultivated plant than *N. tabacum,* which did not extend beyond tropical climates. It has strong narcotic properties and was, therefore, probably the more suitable plant when ceremonial smoking was introduced. It is not known whether *N. tabacum* was established on the mainland of Central America or in México. The accounts of Hernández (1942, bk. 2, chs. 107–112) make clear that the name “yetl” was applied to unrelated medicinal (narcotic?) plants. In his lengthy description of “piciel” he notes briefly another tobacco as “quauhyetl,” the great “yetl” which was *tabacum.* Since the account was written after the Spaniards had begun to cultivate *N. tabacum* in México, it may refer to the plant introduced by them from the islands. “Piciete” or “piciel” is the usual early name for *N. rustica* in México and Central America, and it is still cultivated widely in remote settlements north through Sonora. Prof. Roy Clausen has recently pointed out in a genetics seminar at the University of California that *N. rustica* also is a hybrid, derived from species native to the west side of the Andes in the borders of Ecuador and Perú, that is, in the margins of the ancient Mochica and *Cañari* lands. It too, therefore, is an old South American domesticate which appears to have spread in much the same fashion as did maize.

The most puzzling thing about both cultivated species of *Nicotiana* is their place of origin within the one agricultural area of the New World in which there is neither historic nor archeological evidence of the smoking of tobacco. Clearly, therefore, Nordenskiöld was right in judging that smoking was a secondary use of tobacco. The solution of the problem of the early use of tobacco may involve the relationship of the chewing of tobacco to the chewing of coca. May its use as a masticatory (or snuff?) have preceded smoking, and smoking later have extinguished the earlier use except in a few areas? May
the chewing of coca have replaced that of tobacco in the Andean lands and presented an effective resistance to the diffusion of smoking when that habit got established to the east or north? It is very perplexing that the two cradles of tobacco domestication should have abandoned the use of the plant, except as a minor drug.

CULTIVATED FRUITS AND NUTS

Some of the plants previously discussed, such as the pepino and naranjilla, may be classed as fruits. Some herein considered as fruits, such as the avocado and pejibaye, are substantial foods. No definition is offered for the cultivated items here assembled, which we should call fruits in English. In order not to get entangled in a functional classification of various cultures and domestic uses, the arrangement here followed is in botanical order (Englerian system).

Palms.—Probably only two palms in the New World were truly domesticated in aboriginal culture, the coconut and pejibaye. The others appear to be unmodified wild species, which may receive some protection in native economy or may occasionally be planted about houses and fields.

The domestication of the coconut (Cocos nucifera) has been assigned by O. F. Cook to an American origin (1901, 1910). These studies are still the most significant contribution to the subject even though the conclusions are not sustained in toto. The evidence that coconuts were grown on the Atlantic side of the New World in pre-European days is inconclusive, but there can hardly be doubt as to the tropical Pacific shores. Oviedo is an adequate and explicit witness of their establishment in great groves in Panamá, Costa Rica, and on Cocos Island, and he was one of the first Spaniards to become acquainted with Central America. It is possible that such groves of coconuts existed as far north as the coast of Jalisco. Cook has presented strong arguments that the distribution of coconuts along tropical sea coasts is the result of deliberate planting by man and that they do not establish themselves by being washed onto beaches. The earliest known groves in the New World were in part along the coast and in part at some distance inland, but then, as now, apparently always as groves, and not scattered through the native jungle or brush. Cook is further of the opinion that these plantations were not made by chance contacts on the part of South Sea Islanders, but that the plant originated in the New World, and was there fashioned into a cultigen, and was taken westward from America across the Pacific. This evidence rests on the following: (1) The New World concentration of almost all the species of palms related to the coconut. (2) Cook's hypothesis that the primitive cultigen originated in interior tropical valleys where salt springs impregnated the soil. This condition is
frequently met with in the valleys of Colombia, such as the Cauca, where near relatives of the coconut are native. (3) The seed is a remarkable mechanism specialized for germination in climates having a long dry season, rather than for facility in marine distribution. (4) The varietal simplicity of the coconut in the New World, as contrasted with the great multiplicity of forms across the Pacific, is explained as showing that "the greatest and most definite variations of the cultivated plant are much more likely to occur and be preserved outside its natural range, where intermixture with the wild type is prevented." The complete hypothesis of Cook has met with resistance, especially because it requires an ancient skill in navigation and because the coconut has had little significance in American economy, as compared with that of Indonesia. The thesis remains, however, to vex the question of origin of this great cultivated plant.

The pejibaye, or peach palm (Guilielma utilis or Bactris utilis) is one of the spiny-trunked palms with hard, dark wood commonly called "chonta" in South America. In many cases it has lost the capacity to produce fertile seeds and is reproduced by planting sprout cuttings. It is, therefore, the most striking arboreous element in the agricultural complex that depends on the planting of cuttings and tubers. The palm is said to be unknown in a truly wild state. Its range is from Nicaragua southward into Ecuador, and southeastward down the Amazon indefinitely far into Brazil. Its climatic distribution is mostly within the Aw and warmer parts of the Cw climates (map 9). The firm starchy fruits enclose a small oily seed which is wanting in many cases. The fruit is not eaten raw but is boiled; it is a staple food, with a chestnutlike flavor. O. F. Cook (1910, pp. 308–309) has good illustrations and quotations from A. R. Wallace and Spruce, the latter suggesting that it may have originated on the east side of the Andes in valleys of limited rainfall. The location of its cultivation may identify it with the proto-Arawak and proto-Chibcha areas as a quite old cultigen (account and illustrations in Popenoe and Jiménez, 1921).

Bromeliaceae.—The term "pineapple" (Ananas sativus) is a somewhat mixed assemblage genetically. In particular, it is not clear whether there is one species in the genus Ananas, or a number, nor do we know to what extent the uncultivated forms are wild or spontaneous. Small-fruited, long-leaved, spontaneously growing pineapples commonly called "piñuelas" occur at least from Panamá to Paraguay. Oviedo, in his lengthy discourse in praise of the pineapple (1851–55, bk. 7, ch. 14), having described the fine cultivated sorts in "Tierra Firme," adds that a lesser kind also grew wild in great quantity. This may be the Ananas magdalenae of Standley (1928) described by him as forming impenetrable thickets in the forests and yielding a red
fruit up to 15 cm. (6 in.) long, edible raw or cooked. Cobo (1893, bk. 5, ch. 17) described another such subs spontaneous form from Santa Cruz de la Sierra, where it was principally used for making wine. The extent to which these pitu elas are primitive pineapples or degenerate ones is not known. They are reported for the most part out of areas in which pineapples are cultivated of old. Cultivation has produced in the pineapple again a seedless plant, dependent upon vegetative division for reproduction. According to Oviedo, there were more and finer forms of it on the mainland than in the islands. It extended into México at least as far as Jalisco. Southward on the Pacific Coast it was and is very important in the lowlands to northern Perú. From Andean valleys of Ecuador, Popenoe records an extensive production to 1,500 m. (about 4,900 ft.) and an incidental one to 2,300 m. (about 7,500 ft.). To the Quechua it was known as “achu palla,” carried in from the eastern yungas and probably cultivated through a continuous strip of territory into Paraguay. French and Portuguese brought the name “ananas” and its fame from Brazil to Europe. Throughout northern and eastern South America it appears to have been a familiar fruit for all Indians, a common source of wine, and in many cases a principal source of cordage. It may have originated in some northern inter-Andean valley, along with other plants of the kinds cultivated by division. At any rate, it penetrated pretty far to the northward into the seed culture area of Central America and México and was adapted to cultivation at altitudes far above those of tropical climates. Its ecology points strongly toward origin in AW climates bordering on the semiarid.

Musaceae.—The plantains and bananas (Musa paradisiaca) originated in southeastern Asia and were there bred into a great variety of seedless cultivated forms. Their presence in the New World is considered by many as due to post-Columbian introduction. Nordenskiöld has marshaled strong arguments for this view, the most convincing being the absence of notice of this plant by the first explorers of the American Tropics. In view of its conspicuousness and usefulness, it should at least have been recorded by some of the early observers who took notice of lesser plants. The etymologic evidence collected by Nordenskiöld is inconclusive, there being a multitude of native names, in part of unknown meanings and derivation. The origin of the name “plátano,” applied by Spaniards in the New World, is obscure, and apparently was not derived by transfer from the name of the Old World plane tree (Platanus), but may be from the Arawak or another Indian language of the Caribbean mainland.

The species is commonly subdivided into two subspecies, the plantain proper (normalis) and the banana (sapientum). The former is nearly always cooked and served as a staple in the diet; the latter is
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eaten raw as a fruit, and prepared by cooking to a lesser extent. Oviedo's famous account, describing the introduction to the West Indies from the Canaries, refers to the banana, though not by name. Soares de Souza (1851) describes bananas under that name as introduced into Brazil from São Thomé. Some, perhaps all, of the bananas were brought from the Old World by the Spaniards and Portuguese.

The case is not so clear for the introduction of the plantains. (1) In contrast to the bananas, these are little used by Whites but are characteristically and intimately associated with Indian economy. (2) It is among them that most of the native names are found. (3) Their varieties differ, at least in part, from those of the Old World. (4) During the second half of the 16th century they were already widely distributed through the Tropics of the New World from southern Brazil to Jalisco, México, and were commonly a staple of Indian diet of diversified use. The multiplication of the plantains is more difficult than that of a seed-bearing plant. The mature rootstocks need to be dug up, divided, preferably dried for a while, and then replanted. This species is an extraordinarily poor volunteer, and its spread must have been almost entirely by deliberate and rather careful planting. (5) During the second half of the 16th century, the plantains were already considered a native crop. They are thus classed, without exception so far as I know, in the numerous Relaciones geográficas. Garcilaso de la Vega, Father Acosta, and Guaman Poma, all three of whom were attempting to distinguish aboriginal from introduced crops, stated that the plátano was of pre-Conquest cultivation in Perú. Thivet published in 1558 from observation a circumstantial description of plantains ("pacoba") as grown by Indians in the coastal area of Rio de Janeiro. The observations of Léry, made about 2 years later in another part of the French coast of southern Brazil, appear to describe under the name "pacoaire," a type of banana. Soares de Souza (1851), whose observations began some time later on the coast of Bahia, has left an account of three kinds of what he considered native "pacobas" and, in addition, of the bananas that had been brought from São Thomé and were eaten especially by Negroes (Hoehne, 1937, pp. 120–121, 150–152, 221–224).

Whether introduced before or after Columbus, the plantains became a foodstuff second only to manioc in the Tropics. In mesothermal highlands having sufficient rain, less warmth-demanding forms are much grown to the edge of the tierra fría, but many of these are of modern introduction, such as M. cavendishii.

Annonaceae.—The guanábana, or soursop (Annona muricata), is widely documented in early cultivation, from Nicaragua to the Coastal valleys of southern Perú and far through the yungas. It
was also reproduced many times in the Mochica pottery. It extends somewhat beyond tropical limits both as to altitude and latitude.

In the second subdivision of the genus the most important cultivated species is the chirimoya (*A. cherimola*). This is distinctively a nontropical tree, most at home in the temperate Andean valleys, but apparently also cultivated of old in Central America and perhaps in Brazil. Popenoe (1921, pp. 331–336) has described the apparent native home of the tree in the Loja area of Ecuador. Its wild habitat probably extends into similar valleys of north Perú. A considerable number of cultivated variants have been developed, and Safford recognized three such varieties in the graves at Ancón (Yacovleff and Herrera, 1934–35, 3: 276). The sweetsop, or anona (*A. squamosa*), is restricted to tropical climate and does best in areas with a marked dry season. The name “anona” is also often given to *A. reticulata*, the bullock’s-heart of the British West Indies and “mamon” of Cobo. It is easily distinguished from the former by its smooth surface and yellowish to reddish-brown skin. Both species occur wild or perfectly naturalized in many parts of the American Tropics of the *Aw* and *Amw* climates. Neither species appears to have been altered by selection to the degree of the chirimoya or even the guanábana.

**Lauraceae.**—The avocado (*Persea americana*) was already known to Father Cobo in its three principal races: (1) The green-skinned fruit with a rather thin, tough rind that peels easily and often has the size and shape of a citron, known to Cobo as grown especially in Yucatán; (2) the thick, rough-skinned, large-fruited form, especially in Guatemala; (3) the small-fruited Mexican pear-shaped type, with a green skin as delicate as that of a plum. The first is now called the West Indian group, the second the Guatemalan one. The third is the common Mexican avocado, the variety *drymifolia*, with anise-scented leaves (Standley, 1920–26, 2:290–291). The first is most nearly restricted to tropical lowlands. Popenoe says that it is grown in Ecuador in the lowlands, but extends rather commonly to 1,500 m. (about 5,000 ft.), whereas the third type is there cultivated mostly between 1,500 and 2,600 m. (about 5,000 and 8,500 ft.). Oviedo limits his description explicitly to the “Tierra Firme.” At his time the Spaniards of Panamá had not yet learned the *Nahuatl* name “ahuacate” and called the fruit a kind of pear. The ones Oviedo knew were large, big-seeded, and tough-skinned. In Nicaragua he found them planted in the “heredades e plazas o assientos de los Indios, e por ellos cultivados.” Apparently they were not known to Oviedo in the West Indies. Their derivation is undoubtedly from Central America and México, the anise-scented type being perhaps the basic form. To the north of Panamá the “ahuacate” is still a
more basic part of a native economy and culinary art than farther south.

Cieza, on passing southward through Colombia, first noted the use of the name “palta” in the upper Cauca Valley and Garcilaso later gave the explanation that it was thus known in the lands of the Inca because it had been introduced from the north by way of the Palta Indians of Ecuador. Apparently it had not been known in Perú long before the Conquest, for only a single Peruvian archeological find is recorded by Yacovleff and Herrera (1934–35).

**Rosaceae.**—The “capulí” (*Prunus serotina*) is one of the commonest fruits seen today about highland villages and markets from central Mexico to southern Perú. The name used throughout the Andes is derived from the *Nahua* “capulín,” the common black cherry of México that bears its fruit in racemes. The capulí is considered a cultivated form of the semicultivated Mexican capulín, and the latter as the southern equivalent of the common wild black cherry of the United States. It was introduced into the Andes by the Spaniards (Cobo suggests by way of Lima) and has now become characteristic of Indian settlements to an altitude of 11,000 and even 12,000 feet (about 3,400 to 3,700 m.). It is now grown more largely in western South America than in México or Guatemala, and the fruit is often larger and much finer than in the north (Popenoe and Pachano, 1922, pp. 51–62).

**Leguminosae.**—Various leguminous trees are protected in fields and about houses, and some of them, like the “guamuchil” (*Pithecolobium dulce*), are semidomesticated. Several species of the genus *Inga* rate as cultivated trees. They are grown chiefly for their great heavy pods that contain a sweet pulpy pith. Fresh, they are eaten out of hand and, dried, they are ground into meal. About the Caribbean the commonest native names are “guama” or “guaba”; in the Quechua country the usual name is “paca.” Both pods and leaves are abundant in Peruvian graves, and the pods were modeled both in the Mochica and Chimú pottery.

**Malpighiaceae.**—Species of *Byrsonima, Malpighia,* and *Bunchosia* are grown for their fleshy and often somewhat acid fruits. Locally, they are most commonly known as “cerezo,” “manzanita,” or “ciruela.” In Central America the probably Mayan name “nanche” is commonly used. Some of these tropical shrubs yield a tarter fruit than do most tropical plants and, poor as they are, give an appreciated change.

**Anacardiaceae.**—The cashew or caju (*Anacardium occidentale*), became known from Brazil, though it is now quite widely distributed in many parts about the Caribbean. It is not known whether it existed in any of the areas of high culture. Its association is probably with the tribes of the Tropical Forests, especially the Amazonian area. The fruit is the cashew nut which must be roasted before becoming edible;
the cashew apple is the juicy peduncle that partially encloses the fruit, and it has served both as a fresh fruit and a source of wine.

The genus *Spondias* is in uncertain classification. Following Standley, *S. purpurea*, the purplish-flowered, scrubby, sprawling species is the better form more commonly grown for its pleasantly acid red and yellow fruits, undoubtedly the "ciruela" de Nicaragua of Cobo's account. The arborescent species of the yellow flowers and coarser fruit, then, is *S. mombin* or *lutea*, the hog plum of the West Indies. It, however, is also often planted, and there are superior strains of local reputation. It, probably, is the "hobo" or "jobo" of early accounts from the West Indies and the mainland. The *Nahua* term "jocote" is applied through Central America to both. The common Spanish term is simply "ciruela," and if a fruit is called a plum in the Tropics it is likely to be a *Spondias*, unless it happens to be a shrub of the *Malpighia* family. Both species of *Spondias* are commonly planted from cuttings, the small one often used to enclose fields. Both species are quite drouth-resistant and are very common in the *Aw* lands of Central America and México, constituting one of the most characteristic elements of the scene in native villages.

**Bombacaceae.**—*Matisia cordata* is a common fruit tree in the hot valleys of Colombia and Ecuador. Its leathery-skinned, sweet fruit has a slight resemblance to the true sapote, and in some fashion that has become its popular name, resulting in some confusion to the visitor and to the literature.

**Guttiferae.**—The mamey (*Mammea americana*) is grown for the most part to the north of the Equator. It was praised by Oviedo as the best fruit found in Haiti, but he thought the island mameys much inferior in quality and size to those on the mainland. Especially the Pacific Coast of Panamá and Nicaragua and northern Honduras were credited by him with superior fruit. Cobo, for his part, singled out the mameys of Cartagena and of Sonsonate as the best races of this fruit. Therefore, a fair amount of pre-White horticultural selection seems to have taken place.

The madroño (*Rheedia madruno*) is a common village tree in the warm valleys of northwestern South America. The pleasantly acid fruit is eaten fresh.

**Passifloraceae.**—Fruits of passion flowers of many kinds are consumed in quantity through most of the tropical latitudes of South America. A very common tropical species is *P. edulis*, of Brazilian origin, the purple-flowered, hard-shelled *granadilla*. In the warm valleys of Colombia and Ecuador, *P. maliformis* is grown for a similar fruit. From early times the *granadillas* de *Quijos*, from a once flourishing Indian land on the east slope of the Andes in Ecuador, have been noted for their quality; these are probably the species *P. popenovit.*
The giant tumbo of northern Perú, called "badea" in Ecuador and Colombia, is *P. quadrangularis*. It also is restricted to warm climates and is of very different appearance from the preceding, bearing delicate-skinned fruits a foot long. A characteristic form of the temperate zone in the northwestern Andes is *P. ligularis*, the *apineoya* of Cobo (Cobo devotes bk. 5, chs. 12–15, to accounts of several species). The higher altitudes of the northern Andes have a number of species that are grown for fruit and flower, commonly called "taesco" or "curubo": here may be mentioned *P. mollisima* and *pinnati-stipulata*. (Popenoe (1924) has given much study to the fruiting passion flowers and has presented a good summary.)

**Caricaceae.**—The papaya (*Carica papaya*) appears to be a late prehistoric immigrant into the high cultures of México and Perú: (1) There is neither a Nahua nor a Quechua name for it. (2) There is no certain archeological knowledge of it in Perú. The general name is of uncertain origin, possibly Arawak, and has not penetrated to the remoter parts of México where it is commonly designated by the bastard name "melón zapote." On the other hand, from the Maya south through Central America there are native names. Oviedo is positive in his assertion that it was first encountered by the Spaniards in Panamá and designates the "Tierra Firme" beyond Nombre de Dios as the first area in which it was seen, adding that its cultivation was important in Nicaragua and Honduras. Probably, therefore, it is a Central American domesticate associated with *Chorotegan* and Mayan culture.

From northern Colombia to northern Chile there is an interesting and poorly known lot of Highland cultivated species. These are generally reduced in size of trunk, fruit, and leaf, and the majority are eaten only after cooking. Here belongs the mito of the Peruvian Andes (*Carica candicans*). A number of species, all of which bear local Indian names, are very common through the Highland settlements of Ecuador and Colombia and well into the tierra fria. Popenoe (1924, pp. 126–127) describes and illustrates three of them: (1) *C. candamarcensis* growing to 3,000 m. (about 9,750 ft.) and reported by him as wild in Loja; (2) *C. pentagona*, to 3,000 m., usually seedless and only known in cultivation, and (3) *C. chrysopetala*.

**Myrtaceae.**—All of the New World species are poorly known as to the age and extent of their cultivation. Fruits called "arrayan" are widely eaten and used in refrescos from temperate Perú up to central México and in part belong to the species *Myrtus arrayan* or *foliosa*. From eastern South America, the Surinam or Cayenne cherry (*Eugenia uniflora*) has been spread rather widely through the Tropics. (Is this also the "pitanga" of Brazil?)

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The guayaba (*Psidium guajava*) is corrupted in English to guava (which in Spanish America is applied to *Inga*.) There is no question that swine and cattle have spread largely the range of this fruit. Oviedo says that it existed in the islands and in “Tierra Firme” in red, rose, and white-fleshed forms, that it was commonly planted by the Indians, and that the wild fruits were smaller than the cultivated ones. It has native names in abundance from México to Perú. There are frequent references throughout this range of territory to superior kinds of guayabas, and it is safe to assume that this heavily yielding fruit is of ancient cultivation in the tropical and temperate areas of high culture.

**Sapotaceae.**—*Achras zapota* is most properly called “chiclezapote,” by mistake “chico zapote,” and hence further corrupted into “sapotilla” or “sapodilla.” In northern South America and in Central America it may be known under the Spanish name of the European medlar, “níspero.” The tree is indigenous to Yucatán and tropical Guatemala, where it is an important source of chicle. It spread of old, however, as a fruit tree yielding heavily its harvest of egg-sized, very sweet fruits. The tree is distinctly limited to tropical climates, and its aboriginal spread perhaps was not south beyond Central America.

*Calocarpum mammosum* is the zapote proper of the *Nahuatl*. Its popular names also have become much confused. Southward in Central America it is known as “mamey zapote,” i. e., zapote that resembles a mamey, as “mamey colorado,” and even as “níspero,” further distorted in British colonies into naseberry. Its original home probably is southern México and northern Central America. Oviedo said that it was especially proper to the *Chorotegan* Indians, and he also knew it in Honduras. The fruit grows to a diameter of 15 cm., the salmon-red flesh including often only a single large seed. The seed is ground and mixed with cacao. It also is restricted to full tropical climates.

The closely related genus *Lucuma* in its species *L. obovata* has provided one of the commonest motifs of Peruvian archaeology (Yacovleff and Herrera, 1934–35), and though of poor quality is widely grown in the warm valleys of the northern Andes. Popenoe (1924, p. 131) thinks it may be indigenous to the Oriente of Ecuador. There probably exist other cultivated species of *Lucuma*.

*Pouteria caimito* may be of aboriginal cultivation. It is known as “abiu” in Brazil, “cauje” in Ecuador, and “caimo” in Colombia. Its diffusion may have been effected by Amazonian tribes between the east and west coasts of tropical South America.

*Chrysophyllum cainito* is the common caimito or star-apple found all about the Caribbean, but not of old extending far beyond.
Aboriginal cultivation of cotton extended from the Hopi and the Rio Grande pueblos of New Mexico to Central Chile, Tucumán, and Paraguay. Latcham (1936 b, p. 223) gives particulars of its cultivation at the time of the Conquest of Chile and includes the valleys of Copiapó, Coquimbo, and Aconcagua, far to the south of the present-day limits. Acosta noted the importance of cotton growing in Tucumán, Santa Cruz de la Sierra, and Paraguay (1590, p. 165; also the relevant areas in Jiménez de la Espada, 1881–97, vol. 3). Only in North America did the limits of its cultivation fall significantly short of the areas climatically suited. (It may be noted, however, that archeologically cotton is known from the high Colorado Plateau, such as Tsegi Canyon in northern Arizona.) There were, of course, the parts of Brazil occupied by Ge tribes of rudimentary agriculture or of none at all. Predominantly a crop of the hot lowlands, its cultivation extended also into intermediate altitudes where there were suitable warm sunny valleys (e. g., north of Otavalo in Ecuador the people of Las Salinas were noted for their cotton, Jiménez de la Espada, 1881–97, 3:116).

Andean populations were supplied with cotton in quantity from both flanks of the Andes. In the arid Coastal lowlands much cotton was grown by irrigation. In both Inca and pre-Inca Coastal sites there is found, in addition to the cotton textiles, a good deal of cotton in the seed (both the large naked and tufted seeds, probably barbadosese at Ocuaaje, for instance). On the eastern flank the yungas of the Antisuyo were noted producers, as were, farther north, the Chachapoyas-Moyobamba and Quijos-Canela regions. In aboriginal Venezuela the district of Tocuyo produced coarse cotton piece goods, from which the name “tocuyo” passed into wide Spanish usage for coarse cotton cloth (Latcham, 1936 b, p. 223). Very fine thread is found in Peruvian textiles; at the other extreme twine and cordage were made from cotton; especially in areas lacking the coarser fibers of cabuya and maguey. The natural fiber colors, white, tawny brown, red, and green are known. Seeds were not generally used for food, but had medicinal uses. Soares de Souza, referring especially to the Bahia region (1851, ch. 62), however, noted that “the natives eat the seeds of cotton crushed and thereafter cooked, making thereof a porridge called mingau.”

The classification of cottons has been put into order only in the last 20 years, the beginning being made by Russian studies, but the major work carried through by scientists of the British Empire Cotton Growing Corporation, based especially in India and Trinidad. A general genetic classification and thesis of origin and diffusion was
presented by Harland (1939), followed by the more definite work of Hutchinson, Slrow, and Stephens (1947). Important contributions to the origin of New World cotton were made also by the American Beasley (1940) and the Peruvian Boza Barducci. The result has been to reduce very greatly the number of species of cotton, and to discard numerous criteria previously used in classifying them. The valid phenotypic distinctions are so different from those applied by prior taxonomic studies that the earlier published determinations and herbarium labels can be accepted only after reexamination. I know no genus of cultivated plants in which the species and forms are as commonly mistaken, yet no genus is now more satisfactorily known as to origin and differentiation.

The distinction between annual herbaceous and perennial woody cottons now appears to be minor. Both in the New and the Old World the cottons grown before the industrial revolution were mainly perennials, annual forms making their appearance where seasons did not admit of perennial habit. In higher latitudes, with long summer days, an annual, more herbaceous form tended to replace the perennial form. Where winter cold was encountered, only the annual forms, it appears, could exist. In the polar parts of the range, therefore, annual forms should have prevailed, and it is from such margins probably that our sea island and upland cottons were selected. Early historical references to annual cottons in the New World are curiously wanting. Oviedo has a somewhat obscure statement that for best results annual planting and harvesting was practiced on the Caribbean mainland. For tropical latitudes old historical statements referring to cotton as growing on trees are likely to mean precisely that. Soares de Souza even speaks of cotton orchards in Bahia. In older writings shrubby habit may be referred to by comparison with the growth of quince or elder.

Geographically, there are two large species of New World cultivated cottons: *Gossypium barbadense*, and *G. hirsutum*. Genetically, there is a third, *G. tomentosum*, endemic to Hawaii, which is “genetically further removed from *G. hirsutum* than *G. hirsutum* is from *G. barbadense*” (Hutchinson et al., 1947, p. 99).

There is no technical difficulty about crossing the *barbadense* and *hirsutum* groups, but natural crosses are rare and do not persist. Harland calls attention to the custom followed by Indians on the Caribbean mainland, that of mixed planting of *barbadense* and *purpurascens*, adding that where these grow “side by side in cultivation in approximately equal numbers, there is little evidence of connecting forms.” Such chance hybrids do not appear to have the capacity of competing with the plants of either species and shortly are eliminated. The division between the two groups is clear and ancient.
With regard to *barbadense* the situation has been well clarified. Here belong Peruvian, some woody Brazilian cottons, and the annual sea island and Egyptian cottons. Its aboriginal range included the West Indies, the Caribbean mainland, Coastal Perú, and the Brazilian lowlands. Information is still needed as to what cotton was grown in the extratropical parts of South America. In its most ordinary form, that of a vigorously branching shrub, *barbadense* is restricted to low latitudes (short-day habit). How and where the long-day (annual) forms, such as sea island, were established, are not known. Was there an annual *barbadense* in southern South America and another in the West Indies? Harland favors the Cauca Valley as place of origin, because of the massing of dominant genes which he noted there. Hutchinson et al. (1947), on the basis of further collections, emphasize the great variability of *barbadense* forms for the west coast area, and hold its variety *brasiliense* to have been developed by the inhabitants of moist forests in Brazil. Prehistorically, the *barbadense* complex appears to have been almost wholly South American, meeting the North American *hirsutum* complex only in lower Central America and in the West Indies.

*G. hirsutum* in the large sense extended aboriginally from the Colorado Plateau at the north (archeologic) southward along the Pacific coast to the Tumbe area of Perú (Boza), across the West Indies and along the northern shores of South America into northeast Brazil (Hutchinson et al., 1947). Its major area was Middle America, both mainland and island, and its South American penetration appears to have been principally from the northern shores southward, and coastwise.

Two main varieties of *G. hirsutum* appear to be well recognized: var. *punctatum*, and var. *marie-galante* (var. *purpurascens* of Harland). The former is chiefly Mexican and Central American, the latter northern South American. The only area in which both are widely associated is in the West Indies. The *punctatum* variety is usually a woody perennial of markedly bushy habit, branching from the base, with the small bolls setting in the dry season. The forms known to me are markedly xerophytic in habit, the dooryard cottons of México and Guatemala, but Hutchinson reports also a mesophytic type in Central America. The lint most commonly adheres to the seed, but there are tufted and naked seeded forms. The variety *marie-galante*, restricted to lower latitudes, is markedly photoperiodic, flowering only during the shorter days, and in growth is the largest of the cottons, often a small tree, with one branching trunk. The third recognized variety of *G. hirsutum* is annual, herbaceous, and has become the great upland cotton of modern commerce. It is probably the latest of the cotton cultigens; older historical references to it are nearly
lacking. Apparently it came from the highlands of southern México, but how and when remains uncertain.

The genus is widely distributed about the dry tropical margins of the world, its sections morphologically, cytologically, and geographically clearly distinct, an indication of their geologic antiquity. All the certainly wild species are diploids and lintless, and all the American wild ones form a single cytologic group. The Old World has two lint-bearing cultivated diploid species, for which Hutchinson et al. (1947, pp. 65–70) have developed the argument that these were formed as fiber plants by the intervention of man.

The New World lint-bearing cottons (including the Hawaiian G. tomentosum) are tetraploids and are the only tetraploids in the genus. Moreover they are allotetraploids, consisting of the genom common to all American species, plus the genom of the Old World cultivated species. They are, therefore, of hybrid origin, probably constituted by the fertilizing of lint-bearing Old World female parents by a wild New World male plant. This male parent may well have been G. raimondii of North Perú, which species has a restricted range along arroyos in the Pacific base of the Andes and extending out across the coast plain, roughly the area occupied by the Mochica and Chiiou cultures. It is a vigorous, handsomely flowering shrub with larger flowers than any other wild Gossypium, and it looks more like the domesticated cottons than any of the wild species, is unique in having seed hairs, and is at home in the middle of one of the major archeologic centers of the New World, an area of remarkable diversity of cultivated plants and wild relatives. (Reference again is made to the excellent monograph of Boza Barducei and Madoo, 1941.)

There are further interesting occurrences of tetraploid cottons in the Pacific Islands. A supposedly endemic cotton in Tahiti and other Polynesian Islands has been found by Hutchinson et al. (1947, p. 43) to be indistinguishable from the xerophytic "algodon brujo" of Puerto Rico, a form of the punctatum variety. The endemic cotton of the Galápagos has been reduced to a variety of G. barbadense. The shrubby, endemic cotton of the Hawaiian Islands remains as a tetraploid species, having the genom of the New World cottons and the one of the Old World cultivated cottons. It may be an early divergent from the ancestral hybrid cotton of the South American mainland, carried to Hawaii before the barbadense and hirsutum species formed. No tetraploid cottons exist anywhere else in the world, and the whole lot has a common origin. How then, may we explain the connection between Perú, the Marquesas, and Fiji, with no such cottons existing west of Fiji?

The situation is complicated still further by the discovery that in all 26 chromosome cottons there is one Asiatic and one New World
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The 26 chromosome group is therefore considered as having arisen by the combination of a 13-chromosome Asiatic with a 13-chromosome American ancestor. No 26-chromosome species being on the continents of the Old World, the following, therefore, appear to be implicit: (a) The migration of an Asiatic cotton to the New World, (b) the forming of a new (26-chromosome) group in the New World, (c) the extinction of the immigrant Asiatic parent (there being no 13 diploid *Gossypium* of the Asiatic forms in the New World), and (d) finally the dispersal of the new group most of the way west across the Pacific Ocean. Harland (1939) offers an alternative explanation, namely that a land bridge connected America and Asia in low latitudes and that Asiatic and American 13-chromosome *Gossypiums* there met and mingled. The island species therefore would have been left marooned with the collapse of the bridge. Structural geologists have combatted with growing success the readiness of biologists to construct land bridges whenever a troublesome biotic distribution was encountered. A land bridge across the mid-Pacific is one of the unlikeliest things of all unlikely things to have happened in the crustal history of the earth. The land bridge thesis also involves a respectable geological age for the tetraploid cottons far antedating the origins of agriculture and even of man.

The question is raised, therefore, whether 26-chromosome cottons (excepting *hirsutum*) can be considered as truly wild species, the cultivated plants then being simply improved wild ones. There is no question that the cultivated cottons also "grow wild" in the New World. So do limes and oranges. The distinction between originally wild and escaped forms is difficult to establish and has received pitifully little attention from systematists in the field. The usual notations on "wild cotton" are from places where escape is to be expected. Having diagrammed the gene composition of all American and Pacific Island tetraploid species, and noted the high incidence of recessives throughout, Harland states "there is no definite 'wild type' in any of the species" (1939, pp. 172–173). For the present, therefore, the evidence favors considering the American tetraploid cottons as cultigens, and probably also those of the Pacific Islands, even though forms are known that have only short seed hairs.

The cotton genes and chromosomes in their geographic distribution point to a trans-Pacific passage from west to east by an Asiatic parent, and an incompletely return movement of the tetraploid progeny. This is a remarkable dual task to assign to birds, which do not eat *Gossypium* seeds, or to the slight currents of the tropical Pacific, with *Gossypium* being most unsuited to dispersal by floating. A dispersal by land around the North Pacific may have taken place in that remote time when the genus originated. (The thesis of continental drift


would provide an avenue from Africa to South America that obviates the problem of a migration through high latitudes.) Neither the way of Alaska nor continental drift could apply to the much later time when the tetraploid group originated. Nor does such a hypothesis help to explain the occurrence of cottons with strong American parentage, ranging from the Galápagos to Fiji. Perforce then we must consider human agencies in the geographic distribution of the *Gossypium* genus. The problem relates entirely to the lint-bearing forms useful to man. At the present state of evidence (and the evidence is varied and much of it precise) there are fewest difficulties in the human explanation. The trial hypothesis then would be that a lint-bearing Oriental cotton (*G. arboreum*?) was brought from southeastern Asia to the New World (Perú?). There hybridization took place with an American cotton (*G. raimondii*?) and the tetraploid series was formed. However, J. O. Beasley (1942, pp. 44-48) comes to the conclusion that the behavior at meiosis "sharply supports the idea that all the natural tetraploid (i.e., 26-chromosome) *Gossypium* species came from one original tetraploid plant."

The immediately preceding paragraphs were written before the publication of the Evolution of Gossypium, in which Hutchinson and his associates present an exceedingly strong case for the origin of all lint-bearing *Gossypium* species at the hands of agricultural folk, and for the introduction by such folk of an Asiatic cotton cross the Pacific into the New World. A new hybrid formed, probably in North Perú, and became differentiated into a South American species (*G. barbadense*) and a Middle American one (*G. hirsutum*). Late archeologic finds have established the presence of cotton in the lowest agricultural (precerald) horizons of desert Perú and Chile. (See Hutchinson, Silow, and Stephens, 1947.)

**MISCELLANEOUS PLANTS**

Cacao (*Theobroma cacao*) was a cultivated tree of the Northern Hemisphere, grown throughout the tierra caliente of the Pacific Coast from the Province of Nicoya (Costa Rica) to the Río Grande of Tepic. On the Atlantic side it had a similar latitudinal extent, but its cultivation was in fewer localities and in general less significant. Oviedo's lengthy account of cacao begins with the statement that it was not a tree of the West Indian islands but of the "Tierra Firme," especially of New Spain and of Nicaragua. He describes the manner of its preparation among the Chorotegan Indians of Nicoya, but apparently had not seen it south thereof, among the tribes of Chibchan speech. His most detailed account of native life is for the Province of Cueva (Panamá), yet he made no mention there of cacao. From the Chorotega northward cacao was everywhere an important element
in native culture. Southward and eastward, however, it was used little or not at all. This sharp break has nothing to do with climate, nor probably with the native range of the tree.

Selection by aboriginal cultivators resulted in improved types, with fine-flavored, tannin-poor seeds, yielding the fine criollo races of the commercial plantations. In addition there was formed in Nicaragua the lagarto cacao, so-called because the long, pointed, rough-skinned pods resemble the body of an alligator. This variety, which seems to be a cultigen, carries the botanical name *pentagona*. Its distribution coincides roughly with the old Chorotegan land. There is disagreement as to whether the famous Soconusco cacao is botanically distinct. The best present opinion is that all cultivated cacao is of one species. The white-seeded pataste (*Theobroma bicolor*) belongs to Central America and South México, but is probably not to be considered as a cultivated species.

Cacao is the only crop grown between Perú and Sonora for which irrigation is certainly known to have been employed. The principal centers of cultivation lay on the Pacific slope, commonly in small valleys and on cones at the foot slopes of the mountains. Most of these old cacao areas have a limited period of summer rainfall, but the trees require wetting at intervals through most of the year. Characteristically, therefore, water was carried by small ditches through the groves. In general the stubby cacao trees were provided with a canopy of partial shade by interplanting a somewhat taller tree, usually a feathery leafed leguminous tree, such as a *Gliricidia* (madre de cacao). Both irrigation and canopy planting were artifices to simulate the natural habitat of the cacao tree.

In northern South America cacao cultivation was probably introduced by the Spaniards, as the criollo cacao of Venezuela, traced to Franciscan monks who brought seed from Nicoya. Possibly, however, a kind of cacao was grown in the Mérida area of Venezuela before the Conquest. In modern plantations of the West Indies and Venezuela an ordinary or forastero cacao is widely grown, often called 'calabacillo' from the gourdlike shape of its pods. The botanical designation is *leiocarpa*; it is possibly a species but more probably only a variety (freely cross-fertilizing with criollo types). This calabacillo cacao has closely related and perhaps truly wild forms widely spread throughout northern South America.

Little is known of the wild cacao and the manner of its domestication. I have not been able to find any satisfactory record of wild cacao in México or Central America or of the distinction between such trees and the criollo and lagarto forms. It seems impossible to say at present whether the latter had a wild local ancestor or whether they were derived from wild forms in northern South America. The
**calabacillo** of South America seems to be more primitive and less specialized than the northern forms. Yet if we suppose that the Central American cacaos were introduced there, we lack all knowledge of a culture that might have brought them from South America. However, in addition to the apparent primitiveness of cacao in northern South America we must regard the favorable climatic conditions widely prevalent there and lacking in Central America. These include, in association, the following: lack of marked dry season, moderate rainfall, little wind, lack of low humidity, tropical temperature values with minimal seasonal and daily range. The habits of the cacao would seem to point to a near-equatorial origin, of less rainfall than is proper to the tropical rain forest. (Good systematic notes on the species are by Kaden, 1935, and Pittier, 1935.)

Coca (*Erythroxylon coca*)—The use of masticatories was very widespread in western and northwestern South America, and it is not possible to distinguish everywhere between the cultivated coca and other species of the genus or plants of other genera, chewed similarly. The use of lime to activate the leaves chewed was general, but in the north precise data on what was chewed are lacking, and in part information about cultivation. It would seem, however, that the use of coca extended through the northern Andes and their adjacent lowlands. Peter Martyr (Anghiera, 1912, Decade 8, bk. 6) cites Dominican monks for an account of growing and chewing what probably was a coca in the Cumaná region of Venezuela. Oviedo described cultivation and chewing of a coca in the country behind Lake Maracaibo, and again its use in old Nicaragua.

An especially important statement on coca is from the pen of the Oidor Juan de Matienzo, about 1567 (1910, chs. 44–51). Beginning his account in Colombia, he speaks of a “coca menuda” in Antioquia, of other plants thus used in the Province of Arma, and in the Provinces of Quimbaya and Anzerma of “árbores medianos tiernos,” which always are very green, from which they cut twigs that were chewed against fatigue. In the pueblos subject to Cali and Popayán the coca menuda was used, together with a lime preparation that was kept in small calabashes just as was done, he said, from Venezuela to Quito and Los Charcas (Sucre). (Coca is still cultivated in Indian villages in the Province of Popayán, but otherwise appears to have faded out in the north of South America.) Referring to the area of *Inca* domination, Matienzo continues with a statement of the cultivation of the plant as carried on especially in the warm valley of the Andes from Guamanga to the vicinity of Sucre:

It is the money of the Indians, and with it they carry on business among themselves; and to ask there should be no coca is to desire that Peru should cease to be and the country given up. [At the time of writing the restriction of use under
the *Inca* Emperors had given way to a general addiction to coca chewing by the Indians.] Ordinarily it is planted in the same montaña in which the forests had been cut down and burned, by sowing at first in nursery plats after the manner of lettuce beds for the purpose of transplanting, these beds being called *colchas* . . . Here they remain for a year or a year and a half, and in some parts it is better to leave them two years . . . The leaves are gathered three times a year or four times in fourteen months and each harvest is called a *mita* . . . At each harvest it is necessary to cultivate the soil which (?) is called *cora* for it must always be kept clean . . . In order that the coca after picking be not spoiled it must be carried to the sierra without delay.

He emphasized that coca continued to be grown in the plantations that had been made for the *Inca* Emperor, but that a planting boom under the Spaniards had spread to numerous new areas.

The *Inca* rule, puritanical in the handling of its subjects, restricted cultivation to a limited number of carefully managed tracts in the eastern yungas. Before its time perhaps no such stringent rules governed production and use. That this stimulant and narcotic was anciently prized is shown by the bags filled with coca leaves found in the burials of Coastal Perú and by effigy pottery of Nasca and Mochica origin (Yacovleff and Herrera, 1934–35, 3:297). The old use of coca in the coast also indicates an early trans-Andean trade. The situation in aboriginal Colombia also suggests an old and widespread habit of chewing narcotics with the aid of lime.

The habitat of the coca plant is in Andean valleys of the upper tierra caliente, in short-day latitudes. Its ecology appears quite similar to that of cacao, yet culturally the two scarcely overlap. The culture of the masticatories seems to have held a great exclusive terrain in the west and northwest of South America, adjoining that of cacao at the north as it did that of smoking at the east and south.

*Bixa orellana* takes its generic name from *Arawak* or *Carib*. In Central America the *Nahua* name “*achiote*” prevails. Its northern area of cultivation coincided well with that of cacao, and here it had an important use in the coloring of drink (chocolate) and food (tamales). Oviedo gives as a reason the Indian liking for blood color; its use in food and drink may at least have had a ritualistic origin. Southward into South America its use was chiefly for face and body painting, which gave satisfaction not only for ceremony and war, but was a protection against insects. No information is at hand as to the distinction between its wild range and the extension by cultivation.

*Genipa americana*, possibly including other species, is distributed pretty well through the Tropics of America, in part cultivated and in part wild. The fruits are edible and have been used for making an intoxicating drink. Their greatest use, however, was for dyeing the skin black. It is probable that the distribution both of *bixa* and *genipa* was carried into numerous areas beyond their wild range for
body painting. Both were used also in dyeing textiles. “Genipapo” is the vernacular Brazilian term derived from the Tupí; the West Indian name is “jagua” or “xagua” (descriptive chapters under this name by Oviedo and Cobo).

Indigo was produced from Indigofera suffruticosa, the common añil of Central America. It appears to have been the main source of blue dyes in native weaving. All the blues in Paracas textiles have been referred to this plant (Yacovleff and Muelle, 1934, 3:156-159). It was grown probably as far south as the Urubamba Valley.

The cultivation of an Opuntia cactus for the feeding of cochineal-yielding insects apparently was also spread from México to southern Perú. In the valley of Guamanga this practice is said to have been followed with much care (ibid.).

Crescentia cujete, the more southerly of the two calabash trees, has a distribution from the Antilles to southern Brazil, over nearly 50 degrees of latitude. It was known to the Spaniards about the Caribbean as “hibúera” or “higuera.” It is considered by Hartman (1910) as a tree definitely taken under cultivation by the Indians for its excellent gourds.

The pepper tree of Perú (Schinus molle) was planted in the Inca lands along roads and in towns. It was used in making a strong chicha, for embalming and medicinal purposes. The spread of the Inca state apparently caused the diffusion of this tree to areas where it was not native, such as in central Chile (Latcham, 1936 b, p. 53). The other commonest shade tree of Andean lands is a single species of willow (Salix humboldtiana) which was noted by early Spanish conquerors from Colombia to Chile, planted about the fields and settlements, and probably carried southward from northwest South America.

In varying degrees, Indian settlements used enclosures, ranging from the formidable stockades surrounding compounds among the Chibcha, to living fences protecting garden plots. Various plants were used for such purposes, especially if they had some additional utility. Here may be mentioned Yucca elephantipes in Central America, the flowers of which are an important food and which is said to be unknown wild. From México to northern South America species of terrestrial Bromelia (B. pingüin and B. karatas) are much planted for their spiny leaves, strong fiber, and abundant acid fruits. In the lowlands of Colombia and Ecuador the guadua (Guadua angustifolia), a giant American bamboo, was used for stockades and construction. Possibly some of the great clumps of it that are to be seen in these lowlands, often far removed from each other, date back to Indian plantings. This giant grass, except for food, was almost as varied in its uses as is bamboo in the Orient, and attracted the
attention of the early Spanish recorders. Curiously, it seems not to have been carried beyond northwestern South America.

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