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The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

Origins and Development of Manihot esculenta and Allied Species

Manihot esculenta is one of the major sources of carbohydrates in the lowland tropics of the world. According to FAO statistics, it ranks as the eleventh largest crop in the world. I suspect that if the real statistics of productivity were known, the crop, variously known as cassava, manioc, yuca, or mandioca, would be found to be about eigth in the world's crop productivity.

Without doubt manioc was first known as a cultivar in the tropics of The New World, but where in the New World is still debatable. We have learned from the study of Zea mays and other crops that we do not look for a single point of origin, for the complex known as "a crop" is the result of hybridization and selection in many areas wherever the species is raised, and wherever it may come in contact with wild relatives.

With this rather negative introduction, let's see if there is any way to point to the areas of original cultivation, both the botanical and the ethnological aspects.

Very obviously, we must know the range of variability of the cultivars in order to know the species.

Manihot esculenta is a shrub, with considerable variation in habit, from less than one meter tall to more than three meters. The plants may be either low and frequently branched, or tall and unbranched. The mature leaves may be ~~either~~ five, to nine-lobed, the median lobe from 10 cm. to 30 cm. long. Leaves associated with the inflorescence are most frequently 3-lobed, but may be simple, and undivided ~~leaves~~. The roots may be elongate or shortened, dark brown and rough-surfaced or light tan and smooth-surfaced. The coloration of various parts ranges from green to dark yellow to orange to red, or purplish. The flowers and fruits, by contrast are markedly similar, except in color variation. Physiologically, there is a great range in the concentration of a cyanogenetic glucoside, those of low concentration referred to as "sweet", or "dulce", or in Brazil as "macachiera", while the higher concentrations are referrred to as "bitter", "amarga", or again in Brazil, as "mandioca".

= In each area of cultivation, a different set of cultivars may be found, with naturally much over-lapping between areas.

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What is the source of this variation, and where would we look for the original types, if such can be discerned? To study this problem it is obviously necessary to know the range of variation in the whole genus Manihot.

The genus Manihot has 100 to 200 species depending on definition and viewpoint. There are perhaps 350 available species names, but these are very obviously in need of close study as many are synonyms. In the genus we find trees up to 50 feet

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tall. Among the tree species are several that produce rubber of minor commercial value. Preponderatly the genus is shrubby, but we also find subshrubs and occasionally species that are scandent or clambering vines. The genus is, to my knowledge, confined to the Western Hemisphere ranging from Arizona to Argentina. I have no record of a species native to any other part of the world.

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Most of the species of the genus are heliophiles and occur as members of open vegetation types. Few species are shade-tolerant. The moisture relationships of the species are quite variable, but the preponderant number of species are found in more arid regions.

The preponderance of species are monoecious, the male flowers opening much later than the pistillate flowers of the same plant. Such a circumstance enhances the possibility of cross-pollination and the likelihood of hybridization. A few experiments in hybridization of Manihot species, largely between manioc and other species, indicate that there are few barriers to successful hybridization. In populations from various parts of the range of manioc it is rather easy to discern the effects of hybridization between the cultivars and the locally occurring wild species. In the genus there are many species that have some enlargement of the roots, whether the plants be trees or shrubs. So far I have found no vines with enlarged roots. Apparently the enlargement of the root is not confined to the species of the drier habitats, but is also found frequently among those in mesophytic conditions.

A number of "species" as presently recognized, seem to be derivatives from the cultivated complex. This is a concept recently developed by Harland for a group of weedy grass species, and seems to fit nicely here. There are a number of members of the genus that are found only in hedge-rows, or along roadsides, or sometimes even growing between the rows of cultivated manioc. These "species" exhibit in any one population all of the heterogeneity one might anticipate in a weed.

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Some of the species of Manihot are deciduous, dropping their foliage during the dry season, and some of the cultivars raised in the south of Brazil also drop their leaves in "winter."

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We have then a sufficient number of variations in types of plants in most of the native ranges in all of the geographic areas from which a cultivated complex could arise. Where then must we look for the origins? My conclusions are that no one center is responsible for today's cultivated complex of Manihot esculenta. I would not, as most previous workers have done, place the center of origin or the beginning of cultivation in northeastern Brazil. This seems to be a secondary center.

Why? Inasmuch as the botanical evidence is rather inconclusive as to a logical point of origin, we must turn to the records of people and their utilizations of the plants. Unfortunately, the archaeological records and researches for Latin America are scanty. I have found no archaeological references to manioc in Brazil. Therefore, we cannot make any statements about the age of cultivation there. Eduardo Galvão, anthropologist of the Museu Goeldi in Belem, in a personal communication, states that a sizable culture occupied the island of Marajó in the mouth of the Amazon River and that there is indirect evidence of manioc cultivation some time between the years 600 to 1000 A.D., a fairly recent culture, but one that has completely disappeared. In Colombia, near Barranquilla, Reichel-Dolmatoff has found flat clay baking plates that he states were probably used for the preparation of cakes from manioc. These he dated at about 1000 B.C. In Peru many pottery pieces with beautiful representations of manioc roots from the Mochica and Chimu cultures have been found. These are 500-800 years old. Junius Bird has uncovered some bits of roots, probably manioc, along coastal Peru.

Perhaps one of the most surprising finds is that of MacNeish

in caves of the Sierra de Tamaulipas in northeastern Mexico. He reports finding seed and leaf remains referable to manioc in the "Laguna" culture about 2100 years old. This is the only reference to actual vegetal remains of the plants. This last rather surprising find adds some basis to my increasing impression that Mexico and its earlier peoples must be considered as one of the important areas for the original cultivation of M. esculenta.

There are other bits of evidence that manioc has a long cultural history in Mexico. The Mayan and Aztec cultures must have known the plants and used them, as the earliest chronicles mention manioc, and the Mayan word "camote" is generally used to indicate an enlarged root, for example, the sweet potato. "Qua-camote" derived from "camote," was the specific word for manioc. Present-day Indians still use this term, according to Hinton, on a collection made not far from present-day Mexico City.

In conclusion, then, from cultural history, I would suggest that Mexico and Central America were areas more likely to be the beginnings of cultivation of M. esculenta, and that as people migrated south and east, they carried the culture with

them, and found new variants that occurred by natural hybridization as they moved into new areas where previously existing wild species occurred.