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About the Institute

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.

P3 - What linguistic group do Amalmeas belong?

P5 H2 - non poisonous and poisonous in same area? Suggest that distrib. of sweet ans in area where no bitter are. i. Not a matter of choice between.

P5 H2 - age + area hypothesis not valid.

P5 H3 - Evidence would seem to show that bitter not derived out of sweet, the an interesting hypothesis.

P6 - The sweet ans may have a considerable amt of [AH] in the peel or peltobium - also like say "they" rather than "it" when speaking of sweet -

P6 last H
"could" not "would."

P7 last H no reason why "sweet could not be quoted and the starchy parts utilized in the same way as the bitter.

P8 - Is there any real evidence that bitter was not present earlier in the mountains?

P9 - Why not put in the possibility of middle Am? S. Mex - Panama?

P9, last H - ancestors not singular.

P10. These plants

The problem of the origin of

manioc

INTRODUCTION

1. Questions asked by Dr. Carneiro:

- a. Where and when was manioc first domesticated,
- b. Which came first, bitter or sweet manioc, and
- c. How was domestication accomplished?

These are the same questions I put to myself when beginning the botanical study.

2. An attempt to survey the botanical problems to:

shed light on the cultural problems (of man's early history)

origins of
answers to questions of/cultivated plants

lessen the confusion now extant on the proper botanical classification of this cultivated complex.

BOTANY OF THE GENUS MANIHOT

1. Number of species of the genus is conservatively estimated as between 100 and 150 species of trees, shrubs and woody vines.

2. Distribution of native species is purely Western Hemisphere. Only species

~~are~~ in the Old World are those transported there in recent times (last 400

years). The transported species are *M. esculenta*, *M. Glaziovii*, *M. dichotoma*,

M. piuhuensis, *M. saxicola*, and perhaps a few others, all used for either

food or for latex (rubber).

3. Centers of distribution of the species seem to be a) Central America, (including southern Mexico), b) eastern South America (with greatest number of species in Brazil), and c) the eastern slopes of the Andes near the headwater rivers of the Amazon. Strangely, none but the cultivars (and one doubtful/^{wild}species) are found in the West Indies proper, excluding the islands of Trinidad, Tobago and other islands in close proximity to the South American continent.

Previous classifications of the genus.

1827--Pohl, a Viennese botanist did first study and established greatest number of species. Made division of cultivars into bitter (*M. utilisissima*) and sweet (*M. aipi*).

1866--Mueller, in Martius' *Flora Braziliensis* and in DC *Prodromus*, made first revision of Pohl's work, and added a number of new species

1910--Pax and Hoffman, in Engler's *Pflanzenreich*, made latest extensive revision, maintaining the bitter and sweet as distinct species.

Averaging about one revision per generation, or a little better. This being the case, I must soon publish the next revision to keep things on schedule.

Several botanists, in the meantime, ~~disagreed with the above taxonomists~~

~~on the~~ taxonomic division of the cultivated spp. Crantz was the first, in

*recognized that no sound
could be made.*

1766 to give a suitable name to the cultivated complex--*M. esculenta*, and this is the name preferred for all the plants now used as food.

Classifications of the cultivated species.

Zehntner, in 1919, and Ciferri, in 1938 produced extensive cultivar classifications, but these made no effort to related the cultivars to the related wild species, and further, they did not recognize the flexibility of the cultivars, and as a result have produced an artificial and completely useless classification.

PROBLEMS IN CLASSIFICATION

1. Lack of adequate herbarium materials from various parts of the distribution.
2. Bulky plants, difficult to reduce to adequate representation for museum specimens.
3. Previous lack of knowledge of the biology of the group.
4. Inaccessibility of the areas where plants grown.

THE CULTIVATED SPECIES

Description of the plant.

Perennial shrubs 0.5-3 m. tall. Roots variously clavate, elongated to ^{or spindle shaped} ₁ forshortened; pphello-derm of root easily separable from the starchy cortex; vascular strand at center \times more or less developed; [CN⁻] content variable, from cultivar to cultivar, from nearly none to very high percentages. Stems either straight and unbranched or variously inclined and much branched, with usually

quite prominent leaf scars; colors vary from very light gray to dark brown, orange or reddish;. Leaves palmately lobed, or in some cases simple, unlobed. Flowers, as for all species of the genus, either ♂ or ♀, ~~or hermaphrodite~~, monoecious or dioecious.; the monoecious habit predominating; ♂ fls discharging pollen previous to opening of ♂ fls, thus encouraging out-crossing between plants rather than selfing. Seeds contained in a dry capsul, shattering on maturity.

Variability of ~~the species~~ M. esculenta

1. Countless numbers of varieties (cultivars) maintained vegetatively. Seeds not normally used in replanting by farmers, but when used show the effects of hybridization, with many variations produced by the same from the same plant.
2. Leaves variously lobed--usually 5 - 9 lobed, though one plant has predominantly one number (5-lobed, 7-lobed, etc.), except that there is a reduction in number of lobes as the plant goes into its reproductive stages, the leaves associated with the inflorescence almost invariably reducing to either 3-lobed, or to entire, simple leaves.
3. In roots, [CN⁻] is extremely variable, and a good sample of the cultivars (even in the same field) will show a straight line curve of concentrations.
4. Local variations--in any one area, cultivars may hybridize with wild

species, and evidences are frequent of such.

5. Movement of the cultivars--evident the plants are very nearly universal in the world's tropics--verylikely that man has been largely responsible for present distribution in the West Indies, Africa, and other Old World tropics. Therefore, very difficult to pick up any one cultivar and determine its origin.

6. Sweet cultivars, if we can use the evidence in HSAI, seem more widely distributed in S. America than the bitter~~x~~, with which the sweets are also found.

For several of the above reasons, I prefer to maintain all of the cultivars, both sweet and bitter, as one species, though this may not be the finaly decision when more is known about the distribution and genetics of the cultivated complex.

DISCUSSION OF ORIGINS

With this background, it seems reasonable to speak of not one origin, but several. Some of the reasons are:

1. The "spirits' manioc" of the Amahuaca Indians (mentioned by Dr. Carneiro) could be one possible source of the cultivars, BUT this plant could as easily be ~~xxxxxxxxxxxxxxxx~~ a weedy species generated out of the cultivated complex. There are several species of Manihot in the same category as

t the "spirits manioc" in other parts of the distribution. These all have the capacity of regenerating themselves in a great variety of open, or disturbed, habitats, and all have great morphological diversity, as is true of any of the group of plants falling under the blanket terminology of weeds. We will have to make experimental studies of these plants--growing them from seeds and testing the progeny for variability, for cross-ability with cultivars, for HCN content, etc.--to be more certain of their relations to the cultivars.

2. It seems likely that in each of the three centers of distribution of the genus there may have developed varieties (cultivars) peculiar to that region. In contrast, the cultural practices (methods of preparation of the foods) may be the same from region to region, though the plants may have been significantly different. The differences are caused by the influence of the physical environment, and by hybridization with local wild species. The interplay of these environmental forces is so complex and the state of our knowledge of the nature of these influences on manioc so incomplete ~~that~~, we cannot as yet hazard a guess as to ancestors, points of origin, or time of origin of the cultivars.

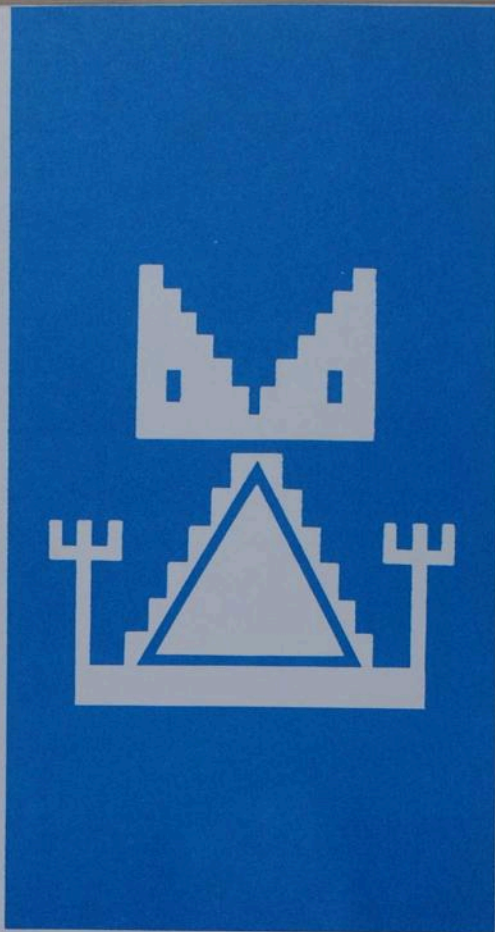
CONCLUSIONS

All of the above sounds rather speculative. It is, to a point, though the picture is not as black as I may have painted it. We have made quite a

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number of adequate herbarium specimens of the cultivars (some 400 in all) from various parts of the range, have begun systematic studies of them using computers to analyze the complex, and have projected a number of activities which will shed light on the problems.

There is no doubt that with considerable new interest in manioc, there will eventually be a body of knowledge developed botanically as is now available for maize. Countless numbers of botanists, anthropologists, geographers, and others made it possible to decipher with a fair degree of accuracy the complexities of Indian Corn. We must approach the subject of manioc with the same intensity. After all, this crop is one of the worlds greatest producers of calories, and it ~~xxxxx~~ is from this standpoint rather hard to understand why we have not been able to attract greater numbers of contributions to its study. There are any number of valid reasons for a much expanded interest in manioc in addition to the intrinsic scientific problems.



American Anthropological Association

60TH ANNUAL MEETING PROGRAM
PHILADELPHIA, PENNSYLVANIA • NOVEMBER 16-19, 1961

NEW YORK UNIVERSITY

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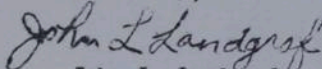
David J. Rogers

Dear Participant:

Enclosed is a program session sheet which provides details of your appearance at the coming annual meetings of the American Anthropological Association in November, 1961. Unless changes are made by the speakers or by the Chairman of the session, this is the way the material will appear in the final Program.

Please make any corrections or additions which seem necessary to you. We need this sheet returned to us by August 15th. If we do not hear from you, we will assume that you have agreed to your listing.

Sincerely,



John L. Landgraf
Program Chairman
AAA

Thursday, November 16
~~Commodore Barry~~ Room
Lafayette

Area Session; 2:30 P.M. to 5:00 P.M.

PROBLEMS OF ECONOMY IN THE NEW WORLD

Chairman: Sidney Mintz (Yale University)

William C. Lawton (University of Arizona)
THE PRIVATE BUSINESS CORPORATION: A
KINSHIP INSTITUTION IN TRANSITION

Robert L. Carneiro (American Museum of Natural History)
THE ORIGIN OF MANIOC: THE ETHNOLOGICAL
PROBLEM

David J. Rogers (New York Botanical Garden) *10 min.*
THE ORIGIN OF MANIOC: THE BOTANICAL
PROBLEM

Henry F. Dobyns (Cornell University)
MONETARY CREDIT AND TRANSCULTURATION

Alfredo Mendes (Instituto de Nutricion de Centro
America y Panama)
THE ROLE OF SOME SOCIO-ECONOMIC VARIABLES
ON ANIMAL PROTEIN INTAKE AMONG GUATEMALAN
INDIANS

Oriol Pi-Sunyer (University of New Brunswick)
THE REGIONAL COALITION ECONOMY OF ZAMORA,
MICHOACAN

David Kaplan (Brandeis University)
THE MEXICAN MARKETPLACE: MARKET EXCHANGE
SI, PENNY CAPITALISM NO

Discussion:

THE ORIGIN OF MANIOC: THE ANTHROPOLOGICAL PROBLEM

Preliminary Draft

by Robert L. Carneiro

Manioc is the staple food plant of most Indian tribes of the Amazon basin. Yet despite its preeminent role in the subsistence of this huge culture area, nothing is known with assurance of its place of origin or of the circumstances of its domestication.

The ethnological, archeological, and botanical evidence available is still too meager to provide us with definite answers. Nevertheless it seems worthwhile to try to bring together some of this evidence, such as it is, and to see to what conclusions they point. In this paper I will consider some of the ethnological and archeological evidence; in the paper to follow, Dr. Rogers will take up the botanical evidence.

Several questions about the origin of manioc interest us: Where was manioc first domesticated? When did this event take place? Was bitter or sweet manioc domesticated first? How was this domestication accomplished?

Before dealing with these questions directly let us first look briefly at some recent discoveries pertaining to the history of plant cultivation in aboriginal America which bear on the problem of the origin of manioc. After temporarily abandoning the view that maize had been domesticated in Mexico, anthropologists and botanists once again look to that country as the most probable homeland of that plant. The principal reason for this change of opinion was the discovery in Tama-

lipas by McNeish of cultivated maize dating back to about 5000 B.C., a good 4000 years earlier than its first known appearance in South America.

The earliest agricultural site yet excavated in South America, that of Huaca Prieta on the north coast of Peru, dates from about 2500 B.C. At its lowest levels, Junius Bird found evidence of the cultivation of squash, peppers, jack beans, and other plants, but not of maize. Maize does not appear at this site until about 800 or 900 B.C. It seems reasonable to deduce from this evidence that while the earliest plant domestication in South America probably took place considerably later than it did in Mesoamerica, it may nevertheless have been independent of it, since it seems to be based on different food crops.

While not represented in these earliest levels, and thus perhaps not the earliest cultivated plants in South America, root crops assuredly form the basis of most South American cultivation. Carl Sauer is of the opinion that South American agriculture began in the warm and humid lowlands of the continent with the domestication of such tropical root crops as manioc, sweet potatoes, yams, aroids, and arrowroot. Later, Sauer, believes, these pioneer tropical farmers expanded into the temperate valleys of the Andes, moving as high as their root crops would grow. Here they brought new tubers under cultivation--potatoes, oca, ulloco, and añu--and with these cold-resistant roots to rely on, continued their spread into the highest valleys of the Andes.

Whether or not Sauer's entire thesis is correct, it is now generally accepted that the domestication of a number of starchy tubers took place in South America prior to the intro-

duction of maize into that continent. Gordon Willey, for example, sees "centuries, or even millennia, of prior incipient rootcrop cultivation in tropical northern South America" before maize came upon the scene (Science, Vol. 131, p. 79, 1960).

Of the various tropical root crops of South America, manioc is by far the most important. This of course does not necessarily mean that it was the first South American tuber to be brought under cultivation. Indeed, because the better-known form of the plant has lethal concentrations of prussic acid in its roots, students have sometimes wondered that it was brought under cultivation at all. Let us, therefore, proceed to examine how this might have come about.

Undoubtedly the native peoples of the Tropical Forest must have made use of wild tubers as food from pre-agricultural times. Even today wild tubers constitute an emergency food source for some tribes. The Amahuaca of eastern Peru, for example, claim that they could survive on wild tubers and other plants growing in the forest should their customary sources of food suddenly fail them. With wild tubers known and utilized as food for thousands of years, it is reasonable to suppose that the first simple efforts toward plant domestication in this part of the world should have been applied to roots. One of those roots was, in all likelihood, the forefather of manioc.

It is generally believed that bitter and sweet manioc are distinct species, and they are usually referred to in the literature as Manihot utilissima and Manihot aipi (or palmata) respectively. But, as Dr. Rogers will explain in his paper, all forms of manioc belong to a single species. Nevertheless, regardless of their taxonomic status, bitter and sweet manioc

are sufficiently different in the practical matter of toxicity to have presented quite different problems to incipient cultivators. Thus the question of how manioc was domesticated is very closely related to that of whether bitter or sweet manioc was domesticated first. Both alternatives possibilities have had their advocates.

The theory that bitter manioc was cultivated before sweet was favored by Erland Nordenskiöld, who wrote: "It is hard to prove which kind was first cultivated in S. America But the probability is that, where both kinds were cultivated, the sweet followed the other" (CES, No. 3, p. 36)

In attempting to explain why a deadly poisonous root should ever have been looked upon as a potential source of food, Nordenskiöld suggested that "there is always the possibility of it having been the poison itself that ... [the Indians] wanted to get at in the first instance, and that the bitter manioc was originally used for some other purpose before it was used as food" (p. 36). To substantiate this, Nordenskiöld cites von Martius' statement (p. 615n.) that the crushed foliage (?) (Krout) of the manioc plant can be used to poison fish. However, von Martius does not cite any instance of this, and it appears that the use of poisonous manioc for fish drugging is extremely unusual, many other plants being preferred.

Of course, it is still possible that bitter manioc may have been brought under cultivation first, even if it was not its poison which attracted Indians to it. Von Humboldt, who also thought that the use of bitter manioc may have preceded sweet, suggested that the domesticators of manioc might previously have grown other tubers, such as aroids (Xanthosoma),

whose juice was bitter without being poisonous. Observing that the starch extracted from this root tasted better the more carefully it was washed of its milky juice, the idea may have occurred to them to apply the same technique to the poisonous manioc root.

Now let us present the arguments in favor of the theory that sweet manioc was domesticated before bitter. The most obvious argument of course is that it would have been much easier to do so. It seems unlikely that incipient cultivators would have bothered with a poisonous root that could not have been rendered wholesome by simple roasting or boiling when a non-poisonous form of the same ~~manioc~~ plant was available.

Another argument in favor of this hypothesis is that from distribution. Sweet manioc is cultivated over a considerably wider area than bitter, especially in western South America and in Central America. Thus, to the extent that age is proportional to area, we can infer that sweet manioc is probably older than bitter.

Indeed, perhaps the best way of accounting for the very existence of bitter manioc is to conceive of it as a development out of sweet manioc. Although sweet manioc is perfectly safe to eat after being roasted or boiled, it is nevertheless not entirely free of prussic acid. The tubers always contain at least a few parts per million of this poisonous element. Thus in this regard the difference between bitter and sweet manioc is quantitative and not qualitative. It is possible that through centuries or millennia of cultivation the concentration of prussic acid in the roots of certain varieties of manioc has unintentionally been increased at the same time that some favored botanical characteristic, such as a high

starch yield, was being selected for, and that this is the way in which bitter manioc arose. The fact that bitter manioc produces more starch in its roots than does sweet certainly points to its having undergone further evolution than the latter.

When South American Indians first became interested in manioc as a source of food the roots of this plant were probably small with hardly any tuberous engorgement, had a starch content of perhaps only 3 or 4 per cent, and contained negligible amounts of prussic acid. The reason that manioc continued to receive attention from its early cultivators is assuredly its quick response to cultivation in terms of increase in starch content of the roots. There is experimental evidence of this. In the 1860's the botanist Peckolt was able to increase the starch content of the roots of one wild species of Manihot (M. paviaefolia) from 3 to 9 percent in one year of cultivation, and that of another wild species (M. flabelifolia) from 5 to 13 per cent in three years of cultivation (Ferreira Filho, p. 129).

As its great potential as a food plant became recognized, manioc must have diffused rapidly from its center of origin. If this early spread occurred before the plant had acquired a dangerously high concentration of prussic acid, as seems likely, this would account for the wider distribution of sweet manioc.

Somewhere in the area of its distribution, and as likely as not in a region near its center of origin, the continued botanical evolution of manioc would have led to the accumulation of a significantly large amount of prussic acid in the roots. So long as the tubers could be made edible by simply roasting it whole or boiling it cut into big chunks, there

would have been little reason to treat them any differently. But once the increase in prussic acid reached a point where the poison could no longer be dispelled by these means, new techniques of dealing with the root would have had to be developed if the root was to continue to serve as a source of food. At this point the first steps would have ~~likely~~ been taken that led to the series of ingenious techniques so characteristic of bitter manioc growers today.

Parenthetically, it may be noted that the invention of techniques for detoxifying manioc is much easier to explain if the problem of toxicity arose gradually in a root which was already a traditional item of the diet than if these techniques had to be invented abruptly in order to make edible a plant poisonous in its wild state.

The techniques developed to cope with the problem of toxicity amounted essentially to breaking down the root structure and removing the juice containing most of the prussic acid. At first this was probably done by soaking or grating the root, and then squeezing the pulp with a strip of bark wrapped around it. More efficient techniques were later evolved culminating in the invention of the familiar tubular press known as the tipiti.

The use of these techniques had other advantages besides making possible the continued utilization of the manioc root in the face of its increasing prussic acid content. In the first place, it added variety to the diet: manioc could now be served as a gruel or in the form of cassava cakes baked from loose flour. Of even more importance was the fact that, transformed into flour or cassava cakes, manioc could be preserved for long periods, something impossible to do with the

untreated roots. The feasibility of preserving manioc flour made possible the accumulation of considerable seasonal surpluses. The advantages inherent in bitter manioc processed in this way were reflected in the ~~xxxxxxx~~ increasingly greater reliance that peoples seem to have placed on manioc after the development of the flour-making complex. It is very evident today that among those tribes who grow it, bitter manioc is almost invariably the staple crop, whereas societies that have only ^{the} sweet form do not depend on it nearly so much.

As one would expect, the superiority of the bitter manioc complex has given impetus to its spread. In the Montaña, an area which formerly had sweet manioc alone, there are recorded instances of the adoption of bitter manioc by tribes learning about it from their neighbors (Steward, HSAI, Vol. 3, p. 517).

So much for the question of priority of one form of manioc over the other. Let us now turn to the problem of where manioc might first have been domesticated.

A few students, such as Wendell Bennett (HSAI, Vol. 2, p. 73) have suggested that manioc may have originated in the Andean region. Most writers though agree that its home is to be sought somewhere in the tropical lowlands east of the Andes.

De Candolle thought eastern Brazil the most likely homeland for cultivated manioc, since more wild species of the genus Manihot are said to be found there than anywhere else. Whatever its merits botanically, this theory is not strongly favored by the ethnographic evidence. To the best of our knowledge, eastern Brazil seems to have occupied a marginal rather than a central position in the development of lowland South American culture. Had it been the region of origin for manioc, we would expect it to have been something of a culture

center as well.

Carl Sauer has argued that the best place to look for the origin of manioc is ⁱⁿ the Venezuelan savannas. He bases his contention on the fact that manioc is highly resistant to drought, and that therefore its immediate wild ancestor should have been native to a region with an especially long dry season. Certain evidence appears to favor this hypothesis, including the considerable antiquity that manioc is known to have in the Orinoco basin. Yet it is not altogether convincing. The drought tolerance of manioc arises from the large ~~starch~~ store of starch carried in its roots. Now if this starch accumulation has arisen only as the result of human selection following the domestication of the plant, it would not have been a characteristic of the wild ancestor. And if not, we have less reason to suppose it to be native to a region of dry savanna.

Another possible homeland for manioc is the Montaña. The line of reasoning is as follows. While manioc is pretty surely of lowland tropical origin, the stimulus which led to the first Amazonian experiments with agriculture may well have come from somewhere in the Andes, since it is here that we find the earliest evidence of plant cultivation in South America. If this was the case, we would expect to look for the origin of tropical root crop cultivation in areas immediately adjacent to the Andes. Thus, we should look to the Montaña as the most likely homeland for manioc, and probably for other specifically tropical crops as well.

One important difficulty involved in determining the cradle of cultivated manioc is that its wild ancestor has not yet been identified. This may, however, reflect more a lack of systematic botanical survey work than the absence of any suitable candi-

dates. While working with the Amahuaca Indians of the Peruvian Montaña earlier this year I was made acquainted with a plant growing wild in the Amahuaca habitat which these Indians call "Spirits' Manioc." In many respects this plant appeared to me remarkably like what I would have expected the wild ancestor of manioc to be like. I will leave it to Dr. Rogers to present his conclusions regarding the botanical status of this plant.

Since our ideas about the place of origin of manioc are still so unsettled, our knowledge of the time of its first domestication must also be vague. We are beginning, however, to obtain some archeological evidence that permits us to give at least a minimum figure for the time it has been under cultivation.

At a site called Momil on the lower Sinú River near the northwest corner of Colombia, Reichel-Dolmatoff found pottery griddles which he interprets as having been used to bake cassava cakes, and therefore as indicating the presence of bitter manioc. The griddles occur at the lowest horizon of the sequence, and are estimated to date from about 1000 B.C.

In various sites in eastern Venezuela, Cruxent and Rouse have found griddles which they too believe to indicate the presence of bitter manioc. Radiocarbon dates show that the earliest of these date from at least 800 B.C.

There is evidence that manioc was cultivated on the north coast of Peru during the Cupisnique period, which would place its appearance here at about 1000 B.C. or perhaps a little later.

The archeological evidence available so far seems to establish the fact that by around 1000 B.C. manioc was not only under cultivation, but already had diffused rather ex-

tensively over northwestern South America. How long before then the first domestication was made is still a matter of conjecture.

This, briefly, is the rather inconclusive picture of the origin of manioc as it looks to me on the basis of anthropological evidence. Now we will hear the botanical side of the story.