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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.

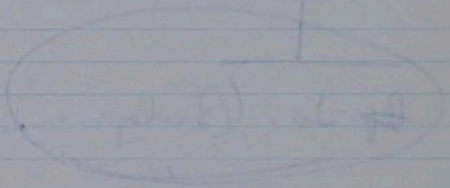
Beginning anecdote -

Get rid of 1st person pronouns -

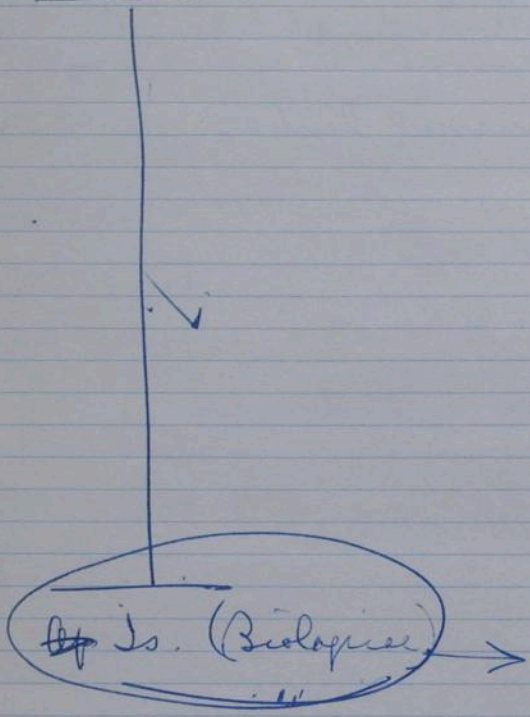
1st sent: Cassava is one of the least well known of all the food crops

Define cassava immediately

Get the name discussion back in 1st paragraph -



Origins



Uses.

THE SCIENTIFIC MONTHLY

SCIENCE

Author ROGERS, DAVID J.

Address Allegheny College
Dept. of Biology and Geology
Meadville, Pa.

Title CASSAVA, BREAD OF THE TROPICS

Comments: Author has a good start on a sadly neglected and important question. It is our hope that he will have the time and funds, as he has the ability and energy, to resolve it. This article is a preliminary announcement to a broad audience but seems to me not to do justice to himself nor to satisfy reader interest. I'd like to see you publish, but I'd like to see David Rogers recase his article:

1) Reader will be somewhat mixed up as to names. Properly cazabe is the name only of the baked bread or pancake of the bitter Manihot. I think it is only in the British colonies that cassava came to include root and plant as a whole. Both the latter in lands of Spanish speech are yuca, of Portuguese mandioca, of French manioc.

2) Tapioca is a by-product of the meal rasping of bitter manioc, the colloidal starch thus coagulated only in a limited aboriginal area of Brazil. He uses it to introduce Manihot to reader, and so explains later, but the introduction seems to me awkward; it is not bread and it is not cassava.

3) If bitter Manihot is "much more productive of starch" than the sweet ones, the point is important and should be established. It is new to me. The area of sweet is far greater than that of the bitter; I have heard it claimed that you cannot get good cazabe bread from the sweet and that it is too much trouble thus to prepare when you can throw the sweet into a pot and prepare by simple boiling. I'd suspect the bitter as culturally localized.

Index

(See over)

4) Greatest specific diversity of genus no argument for origin of cultigen in Brazil. There might be an ancestral relation in M. cartaginensis (Caribbean, west coast Central America and Mexico).

5) Post-1953 introduction into Africa by Portuguese has been assumed. If so, strangely rapid dispersal and variation. I have found no early African travel reference that considered it as a new plant. Note also recent competent claim of pre-Columbian maize in Guinea Coast archeology.

I'm anxious to see you publish him on this subject, but I think he should re-outline and rewrite, possibly pass around among his friends for suggestions, and resubmit. An attractive presentation in your magazine will be most important to him as announcement of his field of major interest. I have left my penciled notes on his copy; they and these remarks may be communicated to him as coming from me.

Dalton
Louisville
JW Ross 8341
Dalton
Kingshill
RD 3

SCIENCE the NEWSWEEKLY for scientists

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The SCIENTIFIC MONTHLY the LITERARY magazine of science

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12 May 1954

Professor David J. Rogers
Allegheny College
Department of Biology and Geology
Meadville, Pennsylvania

Dear Professor Rogers:

I am enclosing the report of the referee for your paper. It seems to me that he makes some excellent suggestions, and I hope very much that you will find it possible to take them into account in a revised paper.

The referee, I will admit, outlines quite a program for you. On the other hand, his attitude is certainly helpful and sympathetic. I have the feeling that he believes that you have a real opportunity here and should do what you reasonably can to take advantage of it.

If, however, you would like to have me send the paper elsewhere for an independent opinion, I shall be glad to do so. I feel, however, that you will want to see the present comments before this is done.

I will temporarily hold the illustrations here because of the chance they might be damaged in the mails.

Sincerely,

Duane Roller

Duane Roller
Editor

DR/yk
Encl:

CASSAVA: BREAD OF THE TROPICS

Mention tapioca to a wide range of "norteamericanos" and immediately the picture of "fish-eye" or "pearl" tapioca appears. If tapioca were to be dropped entirely from our diets, no one in the United States would become unduly alarmed. Not so for millions of tropical peoples, where the removal of the products of the plant Manihot utilissima would mean starvation.

In areas of production, and these areas cover large parts of the tropics, cassava, yuca, or mandioca, is the only bread; not bread in the sense of the leavened wheat loaf, but nevertheless a product which in part takes its place. Only partially does cassava take the place of wheat since it is largely starch with very small amounts of protein. But wheat is an expensive commodity to these peoples who cannot find suitable acreage for the production of wheat, the most valuable crop in the world. Why bother, however, when there is this cassava plant so admirably suited to the habitats found over most of the areas between latitude 27° North and South?

Actually, the packaged food known in the United States as tapioca is a derived product, not commonly consumed among peoples dependent daily upon the plant. Many of the plants, rather loosely classified as one species, contain an extremely potent poison--hydrocyanic acid, and processing to remove this poison requires both pressure and heat. There is enough processing required in making the baked or boiled food without going through the even more laborious heating and drying process required for packaged tapioca.

The edible portion of cassava is the root. (Mention will be made later to the use of foliage as a green vegetable.) Large fleshy roots resembling those of an over-grown sweet potato (see cut) are produced just below the soil surface and at time of harvest, a steady, gentle pull on the woody stems brings out

anywhere from three to fifteen enlarged structures with a total starch content of from 20 to 40% of total weight. Since cassava is a root crop, it is of the type which many (ethnologists) consider one of the oldest kinds of plant domesticated by man. Cultivation is simple, and the return is great, so primitive man without advanced agricultural practice could easily derive his food requirements from such plants. But how did primitive man learn the relatively complex process of removing the poisonous materials from his yuca plants? Even more fundamental a question--why bother with such plants when it is fairly certain that other starchy, more attractive, food plants were available?

The plants which produce cassava are generally subdivided into two categories: the "sweet" and the "bitter" cassava. The sweet cassava can be eaten with very little preparation; peeling and boiling produces a vegetable dish something like a (slightly stringy) Irish potato. The bitter cassava must go through a much more extensive treatment before it becomes safe for eating. First the root is ground or grated into a pulp, then the pulp is placed under fairly high pressures to express the water; after this treatment, the pressed cake can be either baked or boiled to remove the "bitter" principle, hydrocyanic acid, making a hardened loaf or a mush. If the bitter types require so much more work, why did people cultivate them? The answer lies in the fact that the bitter varieties are much more productive of starch than are the sweet ones. Or, as one facetious remark has it, the prehistoric peoples had in-law troubles the same as today, only they did something positive about it, like feeding innocent looking but potent bitter cassava to the troublesome ones.

Another factor which no doubt influenced the continued cultivation of yuca, bitter or sweet, is the remarkable adaptability of the variants.

During the dry seasons, frequently the only crops with any foliage left are M. utilissima and other root crops, such as sweet potatoes. The cultivation techniques allow plantings on steep hillsides where no "clean crop" cultivation is possible. It is not necessary to remove all the stones and tree stumps to get a good production. As a result, cassava cultivation is usually relegated to those places which do not interfere with "cash crops" which must be planted in straight rows, with room for teams of peons or plantation workers, or tractors. Yuca does almost as well in areas where there is high rainfall the year'round. One of the putative barriers to its cultivation is low temperatures. The areas of greatest production are below 3000 feet, although some variants are grown at higher altitudes. Even for the most cold resistant types, the confining factor seems to be the lower temperatures.

Where did Manihot utilissima originate? Outside of saying in the lowland tropics of the New World, we can find little agreement amongst people who have tried to answer the question. Sauer (1), using evidences of agricultural origins in general, prefers the rather dry shores of the Caribbean Sea in South America. Others, basing their theories on the fact that the greatest numbers of species in the genus Manihot and the fact that the greatest variation of the species M. utilissima occur in the uplands of eastern and southeastern Brazil, would have that region as the place of origin.

Before good answers to the question of origin can be produced, we must first ask what is Manihot utilissima. Is it a single species complex, or is the tremendous variation which exists under this name the result of hybridization amongst two or more species? That fact that sweet and bitter races exist, with intermediate concentrations of HCN, suggest that the latter possibility is more likely. Unfortunately, few, if any, morphological

characteristics for seperating the two races can be found. Have the wild progenitors of the two "species" been lost, or has the process of selection of variants in cultivation taken us so far away from the wild state that we would not recognize some non-cultivated plants which are the actual forebears? Geographical diff. Before an "origin" may be postulated, however, we must have answers to the foregoing questions.

How can we answer these questions? I use techniques of taxonomy. The older methods of the taxonomist, coupled with more recently developed techniques for critical examination of minor differences will be most useful in approaching a problem of this nature. For example, one of the criteria for distinguishing species might be the ~~presence or absence of an indentation~~ number of ~~uniform~~ nodes in a certain length of stem, a small number for one species, a high number for another on a leaf margin, and if intermediate ~~conditions~~ numbers existed ~~(slightly indented)~~, these were accounted for as "possible hybrids" in older taxonomic studies. Starting with the "possible hybrids" it is now possible to evaluate what parent species must have looked like by making quantitative studies of the intermediate condition between ~~complete absence of indentation and markedly deep indentation of the leaf margin~~ low + high number of nodes. Obviously, evaluations of many additional intermediate structures must be made prior to any definite conclusion as to the original parental types*.

If two species be involved, we must find their geographical distribution, find the place or places where these distributions overlap, and look in these regions for evidence of greater variability. This is no simple matter with plants which man has found useful. He carries his plants about with him, far beyond where the plant would be carried were it of no economic value. In such movements, it is very likely that there be some mixing or hybridizing, either by conscious effort or by purely accidental crossing with nearby closely related species. If these hybrids have some peculiar advantage that the parents lacked, it is quite possible that the parents may be discarded in

* For a full discussion of methods, see Anderson, E., "Introgressive Hybridization", John Wiley & Sons, 1949

favor of the more desirable traits of the hybrid offspring. The favorable characteristics can be maintained year after year in the case of cassava by vegetative propagation, using cuttings of mature stems.

The selection of better hybrids, or mutants, has not always been under "scientific" control, but has been done with a great deal of practical knowledge by the peoples whose lives depended on the crop. Hybrids have been selected for varying factors in addition to high yield of starch, or flavor, or low fiber content of root. These factors are, no doubt, the ones uppermost in the minds of the farmers, but other factors such as drought-resistance, rate of maturity, and others have entered the picture. A variety of "bitter" cassava which has high favor in Jamaica is locally known as "Catch Thief". This particular form resembles closely one of the "sweet" varieties, and is considered by the farmers as valuable in preventing praedial larceny which is too common on the island. I doubt that the set of characters included in "Catch Thief" are entirely fortuitous, but rather were selected to give the incautious thief a serious tummy ache.

Today, there are few tropical areas of the world where cassava is not of major importance. Any area which is frost free all year, or which has a few light frosts per year is suitable for the plants. Central Africa, where the plants were introduced from the New World after the 15th century by the Portuguese, has few areas in which the roots do not provide the staple starch. The Pacific Islands are great producers of cassava. The islands of Java, Sumatra and Borneo, prior to World War II, were the main source of tapioca utilized in the United States. Like Brazilian Rubber, which is in the same plant family, Manihot seems to have caught on and become more important in its adopted land than at its source.

Manihot utilissima has been the step-child of research agriculture until very recently. Since it was largely a home-consumed product, without too much importance in our own or in European economy, no intensive work has

been done towards its betterment. Compared with the knowledge of wheat, cassava is about one hundred years behind. There has been an upsurge of activity, however, and today, many aspects of the study of the plant are being carried out(2), (3).

My own part in the study of these important plants is that of classification. Several years ago, I was in the process of "ordering up" the specimens representing the genus Manihot in the herbarium of the Missouri Botanical Garden. Many of the species of this genus are well defined, and these offered no problem in classification, but when I got to the forty or fifty sheets labelled rather cautiously as M. utilissima, or M. esculenta, I found a veritable mare's nest. No taxonomist had tackled the intraspecific variation of this group, and I could not do anything with the material at hand. The specimens were fragmentary, from widely scattered localities, and usually poorly prepared. Surely, however, if I had the material from several of the country's herbaria, I could work out some sort of classification system. I was soon disappointed in this hope. No specimens, or a very few, existed in the herbaria I visited. These plants bear the stigma of cultivation, and are for this reason beneath the dignity of many taxonomists and botanical collectors.

In some ways, it is fortunate that I cannot begin immediately to study the herbarium material in order to set the plants aright. I must collect my own material, being careful to make such specimens as will reflect the morphological structures which can be used in classification. For a plant which at maturity is between seven and twelve feet tall, this requires some effort and thought, rather than indiscriminate "hay baling". In making such specimens, a great deal more information is gathered than could possibly be found by studying the prepared material. I have just begun this work with a total of twelve week's field work* on the fringes of the areas where

* Supported in part by a grant from the Penrose Fund of the American Philosophical Society, and in part by a Grant from Allegheny College.

cassava is important. It will take many more trips, at various periods during the growing cycle of the plants in order to have good material to study.

Very recently it has been shown that the tops of the plant are valuable as sources of proteins, and as such may be used either fresh for human consumption or dried and ground as a meal for cattle. For many years, natives of Africa and Australasia have eaten the young green foliage as a vegetable, but curiously enough this is little if at all practised in the New World. Tests in Central America have shown that cattle produce nearly as much milk from a diet of meal from dried yuca leaves and stems as from the best known source of protein, alfalfa. Alfalfa has so far been a failure as far as growth in the tropics is concerned. Similarly, products from one part or another of the cassava plant have been found to be satisfactory food for horses, hogs and chickens. Other valuable uses of the plant including production of alcohol, lactic acid, paper pulp, and sauces show that in Manihot utilissima we have one of the most versatile of crops, and one whose full value has not been appreciated.

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(3) 1949, Congres du Manioc, Institut Colonial de Marseille.