RACES OF MAIZE IN CUBA

by
William H. Hatheway

NATIONAL ACADEMY OF SCIENCES—
NATIONAL RESEARCH COUNCIL

Publication 453

Funds were provided for this publication by a contract between the National Academy of Sciences – National Research Council and The Institute of Inter-American Affairs of the International Cooperation Administration. The grant was made for the Committee on Preservation of Indigenous Strains of Maize, under the Agricultural Board, a part of the Division of Biology and Agriculture of the National Academy of Sciences – National Research Council.

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Published under the auspices

of the

Committee on Preservation of Indigenous Strains of Maize

of the

Agricultural Board

Division of Biology and Agriculture

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National Academy of Sciences – National Research Council

Washington, D. C.

1957

COMMITTEE ON PRESERVATION

OF

INDIGENOUS STRAINS OF MAIZE

Library of Congress Card Catalog Number 56-60047

Price: $1.50

ACKNOWLEDGMENTS

The present study is based on a thesis presented to the Department of Biology of Harvard University in partial fulfillment of the requirements for the degree of Doctor of Philosophy. The author wishes to express his appreciation to Professor P. C. Mangelsdorf for guidance and helpful criticism in all phases of this study. He is indebted to Dr. I. D. Clement, Dr. James R. Hay, Mr. F. G. Walsingham, and Sr. A. Valiente Martín for valuable suggestions, encouragement, and help in many other ways. Sincere appreciation is expressed to Merilyn D. Hatheway for help in the field and in preparing the manuscript and for many valuable criticisms and suggestions. Special thanks are due to the many Cuban farmers visited during the course of this investigation for their courtesy, generosity, and sincere interest.

Field work in Cuba was supported in part by a grant from the Atkins Garden and Research Laboratory and by financial assistance from the John Parker Fellowship Fund, of Harvard University. Publication of this study in its present form was made possible by a grant from the International Cooperation Administration to the Committee on Preservation of Indigenous Strains of Maize, of the National Academy of Sciences – National Research Council.

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INTRODUCTION

Recent studies by workers of the Rockefeller Foundation in Mexico and Colombia and of the Committee on Preservation of Indigenous Strains of Maize of the National Academy of Sciences – National Research Council elsewhere in Latin America have begun to demonstrate a wealth of diversity in maize not fully appreciated by earlier students. Utilization of this material in plant breeding and other crop improvement work has been aided by systems of classification emphasizing natural relationships. The most notable of such investigations is the monograph of Wellhausen *et al.* (*45*), in which twenty-five races of Mexican maize are described. An important contribution of this study was the demonstration that a natural classification leads immediately to considerations of origin and phylogeny, and that such problems, although difficult, can be analyzed by the techniques of the geneticist, the cytologist, and the agronomist. The success of the Mexican studies has raised the hope that all the New World's maize may be susceptible to similar analysis.

In Cuba, as in Mexico, a natural classification of indigenous strains of maize collected for plant breeding work led to the present study of the races of Cuban maize. In 1949 the Atkins Garden and Research Laboratory of Harvard University, near Cienfuegos, initiated a program of corn improvement as part of its continuing interest in local agricultural research. Exploration and testing constituted the primary phases of the Atkins Garden's work with maize. In February and March, I. D. Clement, now director of the Garden, and E. Hernández X., who had participated in the Mexican program of the Rockefeller Foundation, made fifty-seven collections of maize at nineteen Cuban localities. Hernández, in his report to the local director of the Rockefeller Foundation in Mexico (*24*), briefly described six races of Cuban corn and stated that five of these appeared to be related to Mexican types.

In 1952 W. L. Brown made collections of maize on eleven

Caribbean islands for the National Research Council's gene-bank program. His report on the maize of the West Indies (*8*) contained descriptions of eight races, five of which occurred in Cuba.

At the suggestion of Professor P. C. Mangelsdorf, of Harvard University, the writer began studies of Cuban maize in November 1952. His original purpose was simply to supplement Hernández' report with rather complete descriptions, additional collections, and perhaps some minor changes in taxonomy. The appearance of Brown's paper, the conclusions of which differed from those of Hernández in important respects, led to a reconsideration of these objectives. One basis for these differences appeared to be a somewhat vague concept of race in maize which had developed in large part from studies in Mexico, where geographical isolation had permitted the evolution of well defined entities. In Cuba geographical barriers to hybridization, apparently never strong, had been destroyed to a considerable extent by the construction of railroads and highways in the thirty years preceding this study. Thus populations of Cuban maize consisted to a large extent of probable hybrids between races, the pure forms of which had become rare. The problem therefore became one of separating putative pure types from a mass of mongrels, and unless reasonable rules for making such separations were established, the process would be purely arbitrary.

The rule proposed in the present paper consists in supplementing the morphological concept of race developed in the Mexican studies with that of the breeding population. The general procedure followed has been to examine large collections of maize for extreme forms which could have given rise by hybridization to the mass of intermediate types prevalent in Cuba today. Having determined in this manner the appearance of the pure forms of putative ancestral races, breeding populations of such types were sought in the field. Races consist of such populations, the progeny of which breed true to type in experimental plantings. In case no such populations are encountered, the extreme forms are considered chance segregates.

In the present study, therefore, emphasis was placed on studies in the field. Simultaneously, attempts were made to check the hypothesis that recent miscegenation among races has been im-

portant in the development of present types of Cuban maize. This has led to the inclusion of much data on how corn is grown in Cuba, as well as those prepared from collected specimens, such as descriptions, photographs, and spots on the map. The authors of the *Races of Maize in Mexico* state: "The variation in cultivated plants is frequently so bewildering that additional techniques including those of the geneticist, the cytologist and the agronomist are needed to bring a semblance of order out of apparent chaos." The modern social anthropologist might well have been added to this list.

PHYSICAL GEOGRAPHY OF CUBA

Cuba is a crescent-shaped island about 730 miles long and from twenty-two to 160 miles wide. Its area, exclusive of the Isle of Pines, is about 43,000 square miles. Cuba's topography is varied. Mountains over 2,900 feet high occur in three of the six provinces. The topographic diversity of the eastern province of Oriente is especially great. The Sierra Maestra, a massive range culminating in Pico Turquino, about 6,500 feet high, extends along much of the south coast, while the northeast corner of the province is dominated by the Nipe, Cristal, and Moa ranges and the high mesa of Baracoa. The Sierra de Organos, in the western province of Pinar del Río, is scarcely less spectacular, although not nearly so high as the ranges of Oriente. The Trinidad Mountains of Las Villas province, in central Cuba, are the island's other important range. About 65 per cent of Cuba is flat or gently rolling, and it is on such land that most of the country's corn and other crops are grown.

The soils of Cuba (5) are also diverse. The most productive are the Matanzas and Habana clays, derived from marine limestones. Serpentine rock outcrops sporadically from central to eastern Cuba; almost all the derived soils are considered highly infertile. In western Cuba, sandy soils are common and productive when fertilizers are added. Much sandy soil in central Cuba is uncultivated.

Cuba, which lies between the latitudes 19°48′ and 23°13′ north, is situated in the trade-wind belt. Since it is an island, extremes of temperature are not wide. Mean annual temperature is about

75°F.; ordinarily annual temperatures range from about 40°F. to 95°, but frost has been recorded (22). Average annual rainfall varies considerably throughout the island, depending largely on the topography (9). The chief agricultural areas, however, receive about 45 to 60 inches annually. Precipitation in Cuba is distinctly seasonal. The agricultural regions receive about 80 per cent of their rainfall between May and November. Rainless periods of thirty days or more are not uncommon during the winter dry season.

SURVEY OF CUBAN AGRICULTURE

Marrero (32) estimated the population of Cuba in 1949 at 5,200,000 persons, about 54 per cent of whom lived in rural districts or in towns with less than 1,000 inhabitants. The census of 1943 reported that 41.5 per cent of the working population of Cuba was engaged in agriculture (*fide* Marrero).

Approximately 17.2 per cent of the land area of Cuba was cultivated in 1945 (*11*). Sugar cane was by far the most important crop, occupying about 52 per cent of the cultivated area and accounting for almost 42 per cent of the value of agricultural production. Surprisingly, maize was the second crop in total area of land occupied, but its estimated value was only a little more than 15 million dollars, about 4.5 per cent of the total for all crops. Tobacco was valued at about 34 million dollars, about 10 per cent of the total. Pastures are also exceedingly important in Cuba. About 34 per cent of Cuba's land area was classified as pasture. In 1945, income produced from livestock was about 69 million dollars, the equivalent of nearly 21 per cent of total value of agricultural products in that year. Crops of less importance included coffee, rice, yuca (manioc), plantains, beans, and sweet potatoes.

THE ABORIGINAL INHABITANTS OF CUBA

Three groups of aborigines inhabited the West Indian Islands when they were discovered by Columbus in 1492 (Rouse: *39*, *40*). Arawak tribes occupied most of Cuba, Jamaica, the Bahamas, Hispaniola, Puerto Rico, and part of Trinidad. The Ciboney lived in caves in the extreme eastern part of Cuba. The

Lesser Antilles and much of Trinidad were under the control of the warlike Carib, well known for their cannibalistic habits and slave raids on neighboring Indian groups.

The Ciboney are believed to have entered the Antilles from Florida in Rouse's "Period I," before 930 A.D. These Indians, lacking agriculture, grubbed out a meager existence along the coasts of the Greater Antilles, gathering shellfish and living in caves.

Rouse's "Period II" was ushered in with the invasion of Trinidad and the Lesser Antilles by Arawak tribes formerly based along the north coast of South America and near the mouth of the Orinoco. The Arawak introduced agriculture into the West Indies; among the plants cultivated by them were manioc, sweet potatoes, maize, beans, cotton, tobacco, papaya, pineapples, and peanuts (38). This early Arawak tradition, distinguished as "Igneri" by Rouse, spread through Puerto Rico to eastern Hispaniola before the end of "Period II."

Further expansion of the Arawak through Hispaniola and into Cuba, Jamaica, and the Bahamas, together with development of new culture types, was characteristic of Rouse's "Period III," which began about 1200 A.D. The Taino tradition, centered in Puerto Rico and extending into the Virgin Islands and eastern Hispaniola, became the most advanced of West Indian cultures. In Puerto Rico, stone sculpture was highly developed; stone "necklaces" are a spectacular feature of its archeology. The somewhat less advanced "Sub-Taino" culture developed in the western Antilles. In Cuba it expanded at the expense of the primitive Ciboney.

Carib invasion of the Lesser Antilles from South America ushered in "Period IV," the beginning of which Rouse dates as about 1440 A.D. At about the same time the Taino Arawak expanded westward as far as the Baracoa region of eastern Cuba at the expense of the less advanced Sub-Taino tradition. Carib raids must have occurred as far north as the Bahamas, for a perusal of Columbus's Journal gives the impression that those Indians lived in mortal fear of their cannibalistic neighbors to the south. The Igneri tradition, however, was able to survive on a part of the island of Trinidad until the European conquest.

Oviedo (*34*) and Las Casas (*27, 28*) give vivid, although frequently conflicting, descriptions of the Indians of Cuba and Hispaniola. Oviedo attributed the rapid disappearance of the Cuban Indians to smallpox, which he interpreted as divine retribution for their sins, crimes, and idolatry. Las Casas, to whom can probably be traced many later ideas about the nobility of savages and the glory of a state of nature, strongly defended the West Indian aborigines against Oviedo's accusations.

Although Oviedo's accounts of Arawak morals were probably distorted, his lively descriptions of their agricultural practices seem accurate. His account of how the Indians planted corn on Hispaniola is especially interesting because it agrees in nearly all respects with a description (*23*) of Arawak corn planting in Venezuela written by Padre Jose Gumilla, a Jesuit missionary who worked in the Spanish American colonies from 1702 to 1738. According to Oviedo the Hispaniolan Indians always selected wooded areas for planting, land covered with herbaceous vegetation being considered less fertile. After cutting and burning the trees, shrubs, and canes and waiting for the new moon to appear, five or six Indians placed themselves in a row a step apart. Each made a small hole with a planting stick, threw in it four or five grains of maize taken from a small sack tied around the waist or slung around the neck, covered the hole with earth, then moved forward a pace and repeated the process. The planting thus was done in hills placed in regular rows separated by two to three feet. The cornfield was weeded until the maize plants were taller than the competing vegetation. When the ears began to develop, the Indians stationed boys in trees and on specially constructed platforms, called *barbacoas*, to frighten away parrots and other birds which might eat the corn.

Oviedo, Las Casas, Gumilla, and such later field students of cultural anthropology as Farabee (*21*) agree that the Arawak consumed their corn before it had fully matured, either uncooked, roasted on the cob, or in a kind of stew or soup. Oviedo reported that the Indians of Hispaniola applied the special term *ector* to corn in the early milk stage. Mature grains were parched before eating. Rouse (*39*) states that it has been assumed that because the Tainos lacked metates, they possessed only soft

varieties of corn. Lovén (*31*) believed that the metates found in the Greater Antilles might be post-Columbian introductions. If they were in fact pre-Columbian, however, Lovén concluded that both metates and hard varieties of maize must have come to the Greater Antilles from Yucatan. Such arguments assume that hard corns are virtually inedible unless ground to a meal. Immature kernels, however, are used in most Cuban country dishes prepared from corn. The only variety generally available is Maíz Criollo, a hard (semi-flint) variety. Many dishes of today are suggestive of those described over four hundred years ago by Oviedo and Las Casas. Thus there is no good reason, botanical, ethnological, or culinary, to believe that the Taino Arawak had only soft corn. In fact, the botanical and historical evidence presented below suggests that the Sub-Taino group possessed only hard corn, and that the Taino had both hard and dent varieties.

Oviedo and Las Casas agree that the word used by the Indians of Hispaniola was "mahiz" or "maiz." Birket-Smith (*6*) has compiled an interesting list of words for corn used by Indians of South America. Among those used by the South American Arawak tribes are "maritchi," "marisi," "mariki," "maik," "maiki," "mai," "mahiki," and "makanatsi." Although it is often cynically concluded that anything can be proved by linguistics, the West Indian and South American Arawak names for maize are clearly cognates. This in turn suggests that the West Indian Arawaks must have introduced at least one variety of maize into the Greater Antilles. As is shown below, the botanical evidence supports this conclusion.

The post-conquest history of the Indians of the Greater Antilles is an unhappy one. The Spanish very early instituted the system of "repartimientos" in which the Indian population was divided up and assigned to "encomenderos," or estate-holders who were charged with providing for their welfare and religious instruction. The Indians, as is well known, were forced to work in the Spanish gold mines and on plantations under difficult conditions and frequently were not allowed sufficient time to sow and harvest their own crops. Many are said to have died from starvation, and suicide seems to have been not uncommon.

Oviedo, however, is probably correct in attaching considerable importance to "viruelas" (*Historia*, Lib. XVII, Cap. IV) as a primary cause for the decimation of the Cuban Indian populations. Smallpox probably caused many more deaths than the system of *repartimientos*, however brutal the latter may have been.

Rouse (*39*) states that over 2,000 Indians remained in Cuba in 1550, after the system of *repartimientos* was abolished. Thereafter they prospered in farming and trade. Gradually, however, the Cuban Indians intermarried with the Spanish and abandoned their old modes of life. Culin (*13*) has well described the Indians of modern Cuba. At El Caney, supposedly a flourishing Indian village not many years ago, he found one man 112 years old who claimed Indian ancestry. The well known Indians of Yateras were found to have come there about 1840 from Santo Domingo. At Yara, near Baracoa, Culin interviewed several families of mixed Indian ancestry who were growing coconuts and bananas for the city markets. Culin's report on items of material culture obtained from the Indians at Yara well summarizes the situation as it existed in 1901:

I had secured a representative collection of the objects used by the existing Indians of Cuba. Reviewing them carefully, I can see nothing among them that is not equally the property of Cubans generally in the province of Santiago. The same is true of the Indian words, which were long since incorporated into the everyday speech of the people.

The experience of the present author was no different. A few people in the hills of Oriente province claimed Indian ancestry, but their houses, clothes, and corn were no different from those of their neighbors, who were mostly of European or African descent.

HISTORY OF CUBAN CORN

The history of Cuban corn begins in 1492 with Columbus' first voyage to the New World. Morison (*33*), who carefully retraced Columbus' route in a 45-foot ketch, has made it possible accurately to determine the place where Cuban corn, misidentified in the admiral's journal as millet, was first discovered. Columbus arrived at Puerto Gibara, on the north coast of Oriente province,

about dawn on November 1, 1492. Convinced that Cuba was the mainland of Asia, he sent an embassy up the Cacoyuguín valley to Holguín to pay his respects to the Emperor of China. The Spanish ambassadors, disappointed at finding only a small Indian village, returned to Gibara on the night of November 5. They reported to the admiral that they had been received with great dignity by the inhabitants, who believed that they had come from Heaven, that the land was very fertile and well sown with root crops and beans as well as millet, and that they had seen large quantities of harvested cotton.

Several editions of Columbus' Journal have been published which differ in important respects. The original manuscript was sent to the Catholic Sovereigns of Castile at Barcelona, where one or more fair copies were made. The priest Las Casas and Columbus' son Fernando in turn copied or made abstracts of these official copies. The original manuscript and the official copies of Columbus' Journal have unfortunately disappeared. Since both Las Casas and Fernando wrote histories of the voyages of exploration, however, it is possible to check their authenticity by comparing one with the other. Morison (33, Vol. I, p. 205) states that such checks "prove that the Bishop [Las Casas] did his work honestly and well. Las Casas' abstract of the Journal, in his own hand, is still preserved at the National Library at Madrid; and that is the text we have today." According to Morison, the most accurate publication of Las Casas' abstract of the Journal is the monumental *Raccolta di Documenti e Studi pubblicati dalla R. Commissione Colombiana* (Rome, 1892). The Raccolta (*10*) was used in the present study.

Las Casas' account of the embassy to Holguín is, unfortunately, abstracted. The part concerning the discovery of millet is as follows:

La tierra muy fértil y muy labrada de aquellas mames y fexoes y habas muy diversas de las nuestras, eso mismo panizo, y mucha cantidad de algodón cogido. (*Raccolta*, Part I, Vol. I, p. 37).

The word *panizo*, as Weatherwax (*44*) points out, was probably used by Columbus in a generic sense to include millets and grain sorghums. There seems to be little doubt that the

ambassadors, who were not botanists, reported a cultivated plant which looked to them like millet or sorghum, which, of course, are Old World plants not known in the West Indies before the European discovery. The ambiguity is cleared up in Las Casas' *Historia de las Indias*, where the bishop expands the account given in his abstract of Columbus' Journal. He writes of the ambassadors' discoveries (Lib. I, Cap. XLVI): "y del grano que llaman los indios maiz, que ellos llamaban panizo, hallaban mucha cantidad." Since Las Casas lived in Cuba from 1512 to 1514, his identification of "panizo" with "maiz" would not have been made with such assurance if he had not seen maize in Cuba.

Corn seems to have been discovered for the first time about three weeks earlier in the Bahamas. Morison identifies the place as "a village somewhere near the present Burnt Ground" on the island now called Long Island and the date as October 17, 1492. Las Casas quotes Columbus' Journal:

Martes y miercoles. 16 de Octubre. . . . Ella es isla muy verde y llana y fertilíssima, y no pongo duda que todo el ano siembran panizo y cogen, y así todas otras cosas. (*Raccolta*, Part I, Vol. I, pp. 22–23).
(Tuesday and Wednesday, 16 October. . . . It is a very green and flat and extremely fertile island, and I have no doubt that they sow and harvest "millets" all year long, and similarly all other crops.)

Weatherwax (*44*: p. 29) is clearly in error in identifying the place as "Haiti," for Columbus did not arrive at Hispaniola until December 5, 1492.

The best early description of maize is that of Oviedo, who sowed it for twenty-eight years before 1541 for his own house on Hispaniola. He wrote (*Historia*, Lib. VII, Cap. I) that the stalk was as thick as a lance or staff and commonly taller than a man. The leaf was longer, broader, and more flexible than that of the common cane of Castile. Each stalk was said to produce one to three ears containing two to three hundred grains; some large ears produced up to five hundred grains. The ears were wrapped tightly in three to four (*sic*) husks, which were believed to protect the ripening grains from sun and air. This description, unfortunately not sufficiently detailed to permit the identification

of any race of Caribbean maize, is adequate proof of the existence of corn on Hispaniola in the early sixteenth century, and thus tends to confirm Las Casas' version of Columbus' Journal.

We may assume that what Oviedo said of Hispaniola can be applied directly to Cuba, for he wrote (Lib. XVII, Cap. IV) that the natives of Cuba lived just like those of Hispaniola, that their agriculture was of the same type, and that they possessed all the cultivated plants, fruits, and vegetables known on Hispaniola.

Las Casas (*Apologetica Historia*, Cap. XI, XX) briefly described Hispaniolan maize. He stated that each plant commonly produced three ears, each of which contained six hundred to eight hundred grains, and that purple, red, white, and yellow grains sometimes occurred in a single ear.

The first direct post-Columbian reference to maize in Cuba appears to be that of Antonio Vásquez de Espinosa (*43*), a Carmelite friar who returned to Spain from a trip to the New World in 1622. He reported that Santiago de Cuba and Habana were provided with an abundance of meat, maize, manioc, and seafood.

Three nineteenth-century Cuban writers on agricultural subjects, La Sagra (*29*), Bachiller y Morales (*4*), and Reynoso (*36, 37*), described the importance of maize in Cuba's economy and offered opinions about contemporary cultural practices. Reynoso proposed a study of "the different varieties of maize," but apparently never completed this work.

Kuleshov (*26*) wrote that the small collections of Cuban corn he received from Bukasov were very uniform compared with those from other Latin American countries. He stated that they were of the *indurata* type and were similar to the maize of Spain, Italy, and Argentina.

Del Valle (*15, 16*) distinguished two types of Cuban corn, a dent called "Gibara" and a flint he named "Habana." In trying to separate by inbreeding the "different types of corn which enter into the mixture called Maíz Criollo," he obtained a few floury grains, from which he readily developed a true-breeding flour corn. Del Valle later reported the production of a sweet corn adapted to Cuba (*17*), a commercial hybrid (*18*) and, with E.

Hidalgo Gato, a popcorn (*19*). Another Cuban corn-breeder, Manuel Diaz Cuevas, produced by continued selection in the 1940's an improved form of "Maíz Criollo" which he called "Victoria."

Hernández (*24*) briefly described six races of corn in Cuba and stated that five of these were probably related to Mexican varieties.

Brown (*8*) gave detailed descriptions of the five races of maize which he found in Cuba and stated that their relationships were predominantly with South America, although he considered that the Cuban cylindrical dents probably could be traced to Mexico.

METHODS OF COLLECTION AND CLASSIFICATION

CONCEPT OF RACE

In many recent studies of types of maize, concept of race has been based on a definition proposed by Anderson and Cutler (*3*): "a group of related individuals with enough characteristics in common to permit their recognition as a group." In spite of its redundancies, this definition has the merit of emphasizing the necessity of employing several characters. The authors further state that such characters should not be trivial but rather should be those which reflect the interaction of a large number of genes. The definition, being chiefly morphological, corresponds well with conservative taxonomic practice while emphasizing at the same time certain contributions of maize genetics.

An immediate difficulty, perhaps not fully appreciated by Anderson and Cutler, is that it is possible to select from granary piles ears with a large number of characteristics in common which are sufficiently different from most other ears to permit their recognition as a group. Such practices need not be fraudulent; indeed, the collector may find it quite impossible to determine whether he is dealing with relatively pure types of a somewhat rare race or simply a segregating type which has happened to have caught his eye. Hernández, for example, described a yellow popcorn as a race of Cuban maize on the basis of ears selected from four granary piles for likeness to the Mexican Nal-tel race.

Subsequent attempts to find plantings of this race have yielded negative results.

The Anderson-Cutler definition leads to a second, less obvious difficulty – that of distinguishing between a common mongrel or mixed type and a well established race. In an area like eastern Cuba, where two or more well defined, true-breeding races have recently been thrown into contact, mixing of germplasm is common, and in granary piles mongrels are sometimes more abundant than relatively pure types. Such mixtures often have enough features in common to permit their recognition as a group. Indeed, Brown described as a race of Cuban maize a common and persistent type which he stated was intermediate between, and probably a hybrid derivative of, two other well defined races. Yet it would seem to be the feeling of most students of maize that well defined races of some antiquity should be distinguished from mongrel types which, although admittedly potential or incipient races, have existed for only a few generations.

Chance segregates and recent mixtures can be eliminated from consideration by slight modifications of the definition of Anderson and Cutler. Such modifications clarify but do not alter the concept of race. Since a race consists of one or more groups of living organisms, it would appear desirable in the case of maize to demonstrate the existence of interbreeding populations of plants having certain characteristics in common. Such a provision automatically eliminates the possibility of describing a group of chance segregates as a race. Mongrels may be detected best by inbreeding and observation of degree of segregation in the F_1 generation. A useful supplement to such studies is the careful determination of local names for races. In Cuba and probably elsewhere, well established races have names which may vary from region to region but are usually stable within a relatively large area. Mongrel types, on the other hand, are usually not named or are recognized as mixtures or "degenerations." In fact, planters who have idealized concepts of how their variety should appear are not uncommon, and such concepts usually differ little from the investigator's notion of the pure form of the race, obtained from observation of many collections. Such considera-

tions lead to the definition of race of maize as a group of one or more populations of true-breeding individuals with a number of significant characteristics in common. Implicit in the definition and helpful in identifying the races of maize in any country is the fact that such a population is usually recognized as an agricultural variety by the more careful farmers among the people who grow it.

PRELIMINARY CLASSIFICATION

In February 1949, E. Hernández X. and I. D. Clement made an extensive collection of Cuban corn. Seed from this collection was used in a yield test conducted at the Atkins Garden in the summer of 1949. About 400 of the resulting ears, which represented a sample of the major variation in Cuban commercial corn, were stored in metal containers.

In 1953 the present writer found that if these ears were arranged in a line according to the relative amount of soft starch appearing at the apex of the kernel, the variation was continuous. If the ears were simultaneously arranged in order of increasing width of grain, one end of the previous linear arrangement was split, so that the collection now lay in the form of a Y. The three extreme types were (a) flints of intermediate grain width; (b) wide-grained dents; (c) dents with very narrow grains, almost isodiametric in cross section. Surprisingly, other characteristics were correlated. Thus, the narrow-grained dents had long, slender, flexible cobs and soft glumes. The three extreme forms corresponded well with the three races already described by Hernández (*24*) and later also by Brown (*8*) and suggested the hypothesis that most Cuban corn consisted of three main types, together with their hybrids and recombination products. In fact, if this sample fairly represented Cuban corn, it appeared that relatively pure races must be uncommon in Cuba and that the country must swarm with mongrels.

COLLECTIONS IN 1953

This impression was confirmed on a brief field trip to Oriente province in 1953. In commercial granaries and on farms the proportions of pure flint, pure dent, and intermediate semiflint

types were approximately the same as those observed in the yield test obtained from the Hernández-Clement collection. Grain dealers and growers of this major corn-producing region of Cuba repeatedly offered the opinion that "degeneration" of well known varieties was an increasingly serious problem. Relatively pure forms of the commercially important orange flint corn called "Argentino" were said to be scarce, although similar types with a somewhat higher proportion of soft starch in the endosperm were abundant. Many dealers strongly believed that the modern Cuban grower was becoming more and more careless in his farming methods.

A somewhat more easily demonstrable cause for "degeneration" of Cuban varieties of maize would appear to be the recent rapid destruction of physical isolating factors which formerly prevented large-scale hybridization of races. A wide two-lane concrete highway, constructed in the early 1930's, extends from the city of Pinar del Río, in western Cuba, through Habana to Santiago de Cuba, a distance of 1143 kilometers. Hard-surface roads, railroads, and airlines provide ready access to all major cities and towns not on the Central Highway. Converted military vehicles provide regular bus service over rough secondary roads during the dry season. Where jeep roads stop, mule trains carry supplies to coffee farms.

Markets in the principal cities sell food carried by rail or truck from all parts of Cuba. Modern tractor-trailers heavily loaded with cooking bananas from Oriente are a common sight anywhere along the Central Highway. Market vendors buy shelled Oriente corn in 100-pound sacks and sell it by the pound to housewives. Such corn, of course, is frequently tested by local growers. One farmer in Naranjo, a town in the Trinidad Mountains four hours by jeep from Cienfuegos, was found in possession of an ear of the Tusón race, until recently restricted to Oriente province, about 500 kilometers distant. He stated that he had bought his seed corn in the Cienfuegos market, whence it had come by truck from Oriente.

Nevertheless, since it seemed possible that relatively uncontaminated forms of the major races might still be found in some of the more inaccessible parts of Cuba, an intensive search for

types similar to the extreme forms found in the progeny of the Hernández-Clement collection was undertaken in the mountainous regions of Oriente province. The results of this excursion were not entirely negative. Farmers shown specimens of extreme forms of the Tusón, Canilla, Argentino, and pop types often were able to give the names and addresses of people believed to grow those varieties; usually it was possible to locate such individuals and actually to collect suitable specimens. An unexpected result of the trip, however, was the discovery that the people living in relatively remote parts of Cuba were mostly recent immigrants to such areas. Many were "precaristas" (squatters) who had moved from rude huts along government roads on the outskirts of towns to new lands in the mountains opened by lumbering operations which had partially destroyed the virgin native forests. In such cases they often obtained their seed corn in the villages from which they came. It is the writer's experience that intensive searches among these unfortunate people for remnants of pure races of corn are not likely to be fruitful.

Much better success in obtaining relatively pure types was had in the more prosperous corn-growing districts with good access to important centers of commerce. In such places, by inspecting the condition of the house, yard, and fields it was possible to guess with some accuracy the degree of mongrelization of a man's corn. If the field was free of weeds and the house freshly thatched, the owner generally was found to take special pains to maintain the uniformity of his corn and to select his seed carefully for the type he preferred. Such successful farmers tend to increase their holdings by purchasing the property of their less industrious neighbors. Their cornfields increase in size with the years, and the importance of contamination from pollen of corn grown by neighbors decreases. Thus by continued careful selection and growth, the successful Cuban farmer improves the uniformity of his corn. Relatively pure forms of three races were collected on such farms.

CHARACTERS USED IN CLASSIFICATION

Since Cuban corn collected on farms and in commercial granaries is often of mixed parentage, measurements of plant and

tassel characters were made only on collections which bred true (in a relative sense) in experimental plantings. Two crops planted at the Atkins Garden in the summer of 1953 and the winter of 1953–54 were thus devoted to elimination of mixtures and testing of crosses and inbred lines which, it was hoped, might aid the determination of origins of certain races. Several stocks were obtained which bred true to type, although the number of collections represented was much reduced.

In the summer of 1954 vegetative characters were measured in seventy-seven stocks in seven races. Excellent growing conditions, characterized by long hot days with frequent heavy afternoon showers, resulted in a vigorous crop. Eliminated were all data obtained during the growing season from stocks which at harvest were found to have produced ears not characteristic of the race to which they had been assigned.

Despite these precautions, the differences in vegetative characters were slight among the four races of Cuban maize important in commerce. Average plant heights, for example, varied only from 2.58 to 2.64 meters, and internode patterns were scarcely distinguishable. Although with considerable field experience it is possible to recognize certain Cuban races by glossiness, color, or shape of leaf or by degree to which tassel branches droop, such characteristics are difficult to measure or describe and are of doubtful biological importance. Indeed, perhaps the most striking feature of Cuban maize is that plants which are essentially identical in most respects produce ears which are very distinctive. Such observations lead naturally to the hypothesis, discussed in detail below, that the races of Cuban maize have undergone repeated hybridization and selection. Since the latter operates only on the ear (except insofar as certain vegetative characters may be correlated with those of that structure), the features which distinguish the common races of Cuban maize are most apparent in the ear.

Characters of the ear were studied in specimens selected from a collection of 991 ears obtained in 1954 and 1955 at seventy-one farms and six commercial granaries. In cases in which material collected in the field was insufficient, as in the pop and white dent races, ears grown at Soledad were studied. Since the high degree

FIG. 1. Map of Cuba. Open circles indicate localities at which collections of maize were made.

of mongrelization of Cuban corn makes selection of "typical" or "average" ears of commercial races difficult, twenty-five ears which best represented the race were chosen for careful description. In general, an ear was used for description of a race only if, in the opinion of the author, a Cuban farmer would select it for sowing. Concepts of farmer preference were based on an extensive series of conversations and careful interviews conducted in all parts of Cuba. It should be pointed out that measurements of such ideal specimens are not necessarily "representative" of a race as it exists in Cuba. Ear length and diameter of Tusón, for example, are probably somewhat greater in the specimens studied than in most ears of that race, for the grower of Tusón prefers large cylindrical ears. The procedure of selecting the "best" available ears of a race for description thus has certain shortcomings.

To facilitate easy comparison of Cuban races of maize with those of Mexico, characters of plant and tassel and most of those of the ear were measured as described by Wellhausen *et al.* (*45*). For kernel denting, the scale suggested by Anderson (*1*) and followed by Brown (*8*) was used. Endosperm color was determined by comparison with a standard color chart (*7*) following removal of the pericarp. Dimensions of the cupule and length of glume, cupule, and pedicel hairs were measured from camera lucida sketches. Thickness of the "schlerenchyma zone" (*30*) of the cob rachis was determined by subtracting pith diameter from rachis diameter and dividing by two. Frequencies of midcob, pericarp, and cob colors were studied in a random collection of nearly 1000 ears made in 1954–55.

EXISTING RACES OF MAIZE IN CUBA

From the standpoint of economic use, Cuban maize may be classified into two broad types: corn grown for sale and corn produced for domestic use only. Since Oriente province is the center of commercial corn production in Cuba, it is perhaps not surprising that the distributions in Cuba of three commercial varieties, Tusón, Argentino, and Canilla, are more or less restricted to that region. Tusón and Canilla, being dent types and

thus highly susceptible to attack by granary weevils, are not popular with the small farmers of western Cuba who store their corn in cribs for several months. Maíz Argentino is a low-yielding flint grown chiefly for industrial conversion to corn meal. A fourth variety, Maíz Criollo, is a general-purpose corn grown on almost all farms in western Cuba for domestic use and in Oriente for sale as well.

In addition to Maíz Criollo, popcorn is grown for domestic use by a few Cuban farmers whose families enjoy popped corn, often eating it with sugar or molasses. A white pop and an occasional red-pericarped variant of it are grown in several widely scattered towns in Pinar del Río, Habana, Las Villas, and Oriente provinces. Two farmers in Las Villas were found in possession of a rice-type orange popcorn used mainly for feeding young chickens. Finally, a white dent variety strikingly similar to a well known Mexican race was encountered at a single farm in a remote, mountainous town in eastern Cuba, where it was considered to produce a good grade of corn meal.

Table 1, based on collections made at seventy-one farms in 1954–55, shows the approximate frequency of occurrence of the races of maize in Cuba. Not included are the discoveries of White Pop and White Dent in Oriente province in 1953. "Eastern provinces" are Oriente and Camagüey; "western provinces" are Pinar del Río, Habana, Matanzas, and Las Villas. Total percentages exceed 100 because some farms reported more than one race.

TABLE 1

FREQUENCY DISTRIBUTION OF FARMS REPORTING INDICATED RACES OF CUBAN MAIZE

Race	Eastern Provinces	Western Provinces	Total
	%	%	%
Criollo	38.5	93.5	64.2
Canilla	58.3	—	31.4
Argentino	19.4	9.7	14.9
Tusón	19.4	—	10.4
White Pop	—	6.5	3.0
Yellow Pop	—	3.2	1.5
Total	135.6	112.4	125.4

Only three of the seven varieties are possibly indigenous, in the sense that they may have been grown in Cuba by the aboriginal inhabitants before the discovery of that island by Columbus. The rest are considered probable post-Columbian introductions, chiefly on the basis of historical evidence. They are included in this report because they are now more or less well established in Cuba and play some part in the daily life of the ordinary farmer. No attempt has been made to include here the many North American hybrids continually being imported by relatively wealthy Cubans who have seen such corn at fairs or in the United States and make special efforts to introduce seed.

MAÍZ CRIOLLO

Plants. Tall, 2.2 to 3.2 m.; summer crop early maturing; no tillers; 0–2 rows of prop roots; 12 to 16 wide, very long leaves; venation index low; 1–2 ears, the uppermost about 0.9 m. below base of tassel; sun-red color common but not intense; purple color often intense but not common. Seedling sun-red leaf colors: tip 100%, margin 28%, blade none, sheath 89%, midrib 31%, auricle none. Pubescence slight; moderately susceptible to rust; chromosome knobs 6 or 7.

Tassels. Long, very highly branched; about 25% of branches secondary; tertiary branches infrequent. Condensation index low.

Ears, external characters. Medium to long, cylindrical with slight taper toward tip; butt often slightly swollen. 12 to 16 rows; shank thick; midcob color in 34% of ears examined. Kernels medium sized, with soft starch extending to apex; no denting in 73% of ears examined. Husk striations prominent; endosperm hard, saffron yellow to tangerine orange; aleurone colorless (with very rare exceptions); pericarp color common (P^{cw} in 13% of ears examined). Glumes colored in 50.2% of ears studied. Average number of husks 15.6, thick, coarse textured, tightly wrapped around ear.

Ears, internal characters. Ear diameter 46–53 mm.; cob diameter 28–41 mm.; rachis diameter 17–24 mm.; kernel length 10–12 mm.; kernel volume 0.26 cc.; estimated rachilla length 3.2 mm.;

cob/rachis index low, 1.67; ear length/rachis index medium, 9.6; glume/kernel index medium, 0.62; rachilla/kernel index high, 0.29; pedicel hairs 0.2 to 0.6 mm. long, absent, sparse, or very dense; cupule 5.2 mm. wide, 0.8 mm. high, 1.0 mm. deep; cupule

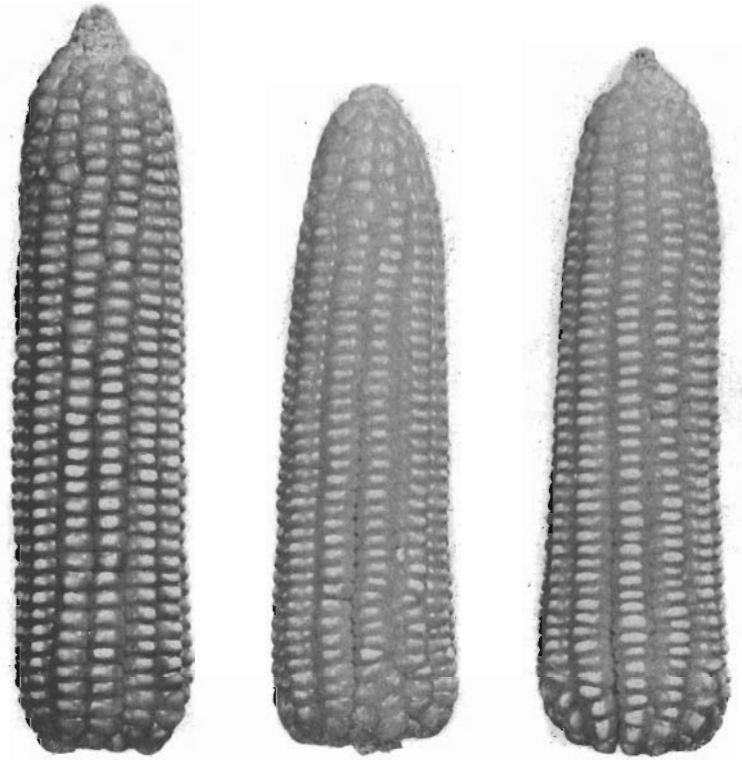

FIG. 2. Criollo. Hard yellow grains in which the soft-starch column extends to the apex of the kernel, producing a white cap, are the outstanding feature of this race, which is common in the West Indies and in coastal regions of South America from Brazil to Panama. In eastern Cuba introgression from Argentino, Canilla, and Tusón tends to produce relatively long, slightly conical ears. Ears collected west of Camagüey are generally somewhat stubbier than those figured here. Scale 1 cm. = 2.2 cm.

hairs 0.2 to 0.5 mm. long, sparse to dense; rachis flap mostly 2.2 mm. wide, prominent; lower glumes horny to bony, the margins mostly angulate, surface hairs mostly 0.2 mm. long, dense, few, or none, mostly lateral; marginal hairs 0.3 to 0.6 mm. long,

sparse to dense; upper glumes papery to fleshy, venation mostly moderately weak, the margins straight or slightly indented, basal hairs few, mostly 0.2 mm. long; tunicate allele tu^w; rachis tissue hard.

Distribution and importance in Cuba. Maíz Criollo, the chief general-purpose corn of Cuba, is grown on nearly every farm of the provinces west of Oriente: Pinar del Río, Habana, Matanzas, Las Villas, and Camagüey. It is also common in Oriente province, although dents and flints are grown on a somewhat larger scale for sale in national and foreign markets. In a sample of 369 ears

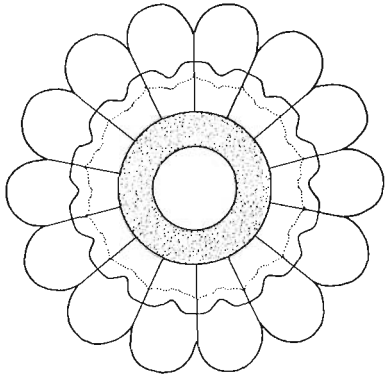

FIG. 3. Ear cross-section diagrams of the races of Cuban maize are natural size and were drawn according to measurements listed in Table 18. Stippled area indicates schlerenchyma zone of rachis. Dotted line indicates base of kernel; solid line immediately exterior to it encloses zone of glume tissue.

collected at random in three commercial granaries in Oriente, 28 per cent were later classified as Criollo.

Probably the chief reason for the importance of Maíz Criollo in the western provinces is that many farmers know of no other variety. When asked what type of corn they grow, they frequently answered, "Maíz cubano" (Cuban corn) or "Maíz corriente" (ordinary corn), or finally, if pressed "Maíz Criollo." Others who have grown "Maíz Gibara," the Cuban dent corn widely distributed recently by the Cuban Ministry of Agriculture, have for the most part returned to the Criollo, stating that they "don't like" the former. One suspects that, when confronted with a

choice of the two varieties, many farmers would continue to grow the Criollo simply because they tend to resist change.

An important reason for the popularity of Maíz Criollo among farmers producing corn for home use only is their strong belief in its ability to resist granary weevils. About half the farmers in western Cuba who stated that they had tried "Maíz Gibara" but later returned to "Maíz Criollo" gave poor weevil resistance as their reason for abandoning the former variety. Weevil resistance is certainly an important consideration to the small Cuban farmer. He must wait about four months between the harvest of the "winter" crop in January and the sowing of the spring crop, usually in late April or early May. Frequently the winter crop fails because of insufficient rainfall. Facilities for storage are mostly primitive: a thatched shelter for swine and poultry with a compartment under the roof in which the unshucked dry ears are piled is probably the most common arrangement. Under such conditions, a combination of tightly fitting, tough husks and hard grains with a low percentage of soft starch is commonly believed to minimize weevil damage. Maíz Criollo, according to the Florida State Department of Agriculture (Komarek, 25), possesses these characteristics and is, in fact, very resistant to weevils.

Origin and relationships. Brown (*8*) found Maíz Criollo throughout the West Indies and identified it with the "Coastal Tropical Flint" which Cutler (*14*) had found common in coastal eastern South America. There is no reason to question this identification. Ears from Colombia, Venezuela, and Brazil in the maize collection of Professor P. C. Mangelsdorf also match much material obtained in Cuba. This is almost certain proof that Maíz Criollo had its origin outside Cuba, probably in South America. Its wide distribution in Cuba suggests the hypothesis that it was introduced there by the Sub-Taino Arawak between 1200 and 1400 A.D. (cf. Rouse, *40*). Other aboriginal varieties now more or less restricted to eastern Cuba may have been introduced following the later invasion of eastern Oriente by the Taino Arawak, about 1440 A.D.

Other morphological evidence, however, suggests that some forms of Maíz Criollo may be of recent origin in Cuba. Its ears are characterized by orange-yellow grains with a soft-starch cap

but no denting, thick cobs with a slight taper toward the tip, slightly swollen butts, and relatively hard, stiff glumes. In these respects and in many quantitative characters as well, Maíz Criollo is intermediate between two other Cuban races, Maíz Argentino and Tusón. In Oriente province, ears virtually indistinguishable from Maíz Criollo of western Cuba were collected at farms whose owners were attempting to grow Maíz Argentino. Usually it was not difficult to find the putative dent parent of the mongrel at the same or an adjacent farm.

These considerations suggest that Maíz Criollo may have had its origin in Oriente province, since in Cuba the putative parents occur together only there. If this were the case, however, Maíz Criollo must have acquired its vast range throughout the Caribbean and coastal eastern South America since 1200 A.D., when the Arawak first arrived in Cuba. This seems so unlikely that polyphyletic origins are suggested for the race as it occurs in Cuba: one prehistoric, in northeastern South America, with the Brazilian Cateto and Venezuelan cylindrical dent as possible parents; the other recent, in eastern Cuba, the product of introgression of Cuban dent germplasm into Maíz Argentino. Since the Cuban dents are apparently identical with those of Venezuela, and Maíz Argentino is the direct descendent of a Cateto flint recently introduced to Cuba, the putative parents are essentially the same in both cases.

Importance outside Cuba. Maíz Criollo is known widely outside Cuba as "Caribbean Flint," "Creole Flint," and "Cuban Yellow Flint" (Brown, 8; Komarek, 25). Improved selections of this type of corn made by C. G. Del Valle, formerly of the Estación Experimental Agronómica, Santiago de las Vegas, have enjoyed outstanding success elsewhere in Latin America. Thus, Shideler (*41*) reported good results in Bolivia with a corn developed by Del Valle in 1938–42. Since Del Valle (*16*) reported distributing a cross developed about that time between improved lines of "Habana" (Argentino) and "Gibara" (dent), Shideler's corn was probably a Criollo type. In winter tests conducted by the Florida State Everglades Experiment Station in 1952–53, two hybrids developed by Del Valle outproduced seventeen other types developed in the United States and elsewhere in the

Western Hemisphere. Indeed, in this trial Del Valle's Cuban corns occupied five of the first six places. The outstanding success of these hybrids may be attributed in part to hybrid vigor resulting from crossing two distinct and unrelated races: Cuban dents and a South American orange flint. The result seems comparable to that obtained in the United States cornbelt by crossing dents from the southeastern United States (possibly related to the Cuban dents) with northern flints (Anderson and Brown, 2).

Derivation of name. Criollo in Spanish means creole, that is, born in Cuba; hence Maíz Criollo or native corn.

References. Cutler, *14* (as "Coastal Tropical Flint"); Kuleshov, *26;* Brown, *8* (as "Coastal Tropical Flint"); Komarek, *25* (as "Cuban Yellow Flint").

TUSÓN

Plants. Tall, 2.5 to 2.7 m.; summer crop early maturing; no tillers; 0–2 rows of prop roots; 14 to 16 wide, very long leaves, venation index low; 2 ears per plant, the uppermost about 0.9 m. below base of tassel; sun-red color in all plants, not intense; purple color frequent, especially in husks. Seedling sun-red leaf colors: tip 94%, margin 10%, blade none, sheath 94%, midrib 31%, auricle none. Pubescence slight to intermediate; moderately susceptible to rust; chromosome knobs 5 to 7.

Tassels. Long, extremely highly branched; 33% of branches secondary; tertiary branches frequent. Condensation index low.

Ears, external characters. Medium to long, cylindrical, often with slight taper toward tip; 14 to 18 rows; shank thick; midcob color in 36% of ears examined. Kernels large, dented, pericarp wrinkled in 12% of ears examined; husk striations prominent; endosperm medium hard, indian yellow to cadmium orange; aleurone almost always colorless; pericarp color common (P^{cw} in 28% of ears examined). Glumes colored in 41.5% of ears examined. Average number of husks 14.7, coarse, tightly wrapped around ear.

Ears, internal characters. Ear diameter 48–56 mm.; cob diameter 30–39 mm.; rachis diameter 18–24 mm.; kernel length 11–13 mm.; kernel volume 0.30 cc.; estimated rachilla length 3.4 mm.;

cob/rachis index low, 1.62; ear length/rachis index low, 8.8; glume/kernel index medium, 0.52; rachilla/kernel index high, 0.28; pedicel hairs 0.3 to 0.6 mm. long, dense or none; cupule 5.7 mm. wide, 0.8 mm. high, 0.9 mm. deep; cupule hairs 0.3 to 0.6 mm. long, mostly dense; rachis flap 1.8 mm. wide, not prominent; lower glumes horny, the margins mostly angulate to cordate, surface hairs 0.2 to 0.4 mm. long, sparse to dense, mostly lateral; marginal hairs 0.4 to 0.9 mm. long, moderately dense; upper glumes papery or papery-fleshy, venation prominent or none, the margins straight or slightly indented, basal hairs dense, few, or absent, 0.1 to 0.3 mm. long, tunicate allele tu^w; rachis tissue mostly moderately hard.

Distribution and importance in Cuba. Tusón, a thick-cobbed cylindrical dent, until recent years was practically restricted in Cuba to the province of Oriente. Because of the common Cuban misconception that shelling percentage is equivalent to yield, many farmers prefer the slender-cobbed Canilla types to cylindrical dents. Thus, in early 1953 Tusón was something of a rarity; typical cylindrical dent ears could be selected from granary piles, but the author was unable to find a farmer who was growing Tusón and selecting it as a desirable type. Cylindrical dents in Cuba seemed therefore to be merely chance segregates, perhaps representing the occasional reappearance of an ancestral stock. In 1954 the situation was different. Of 991 ears collected on farms and granaries, 306 could be classified as cylindrical dents. In a large granary in the town of Palma Soriano, Oriente, 127 ears were classified as Tusón of a total of 205 collected at random. I was told by at least one farmer that relatively low shelling percentage was offset by larger grains and higher row number. This suggests that fashions change even in corn growing, but the data for 1953 are inadequate for conclusive proof.

Dent corn known to maize growers in western Cuba as "Gibara" (the name of a town on the north coast of Oriente province) enjoyed a brief popularity outside of Oriente province when, about the start of the Second World War, the Ministry of Agriculture distributed about 300 tons of corn purchased in Oriente to farmers throughout Cuba (informant: Ing. Pablo Diaz Cuevas, University of Santa Clara). Although its influence is clearly

visible in many Criollo semiflints collected in 1954, "Maíz Gibara" is not popular with the small farmer who grows corn for home consumption. Of thirty-one farmers interviewed in the provinces of Pinar del Río, Habana, Matanzas, and Las Villas, fifteen stated that they had formerly grown Maíz Gibara. Several gave weevil

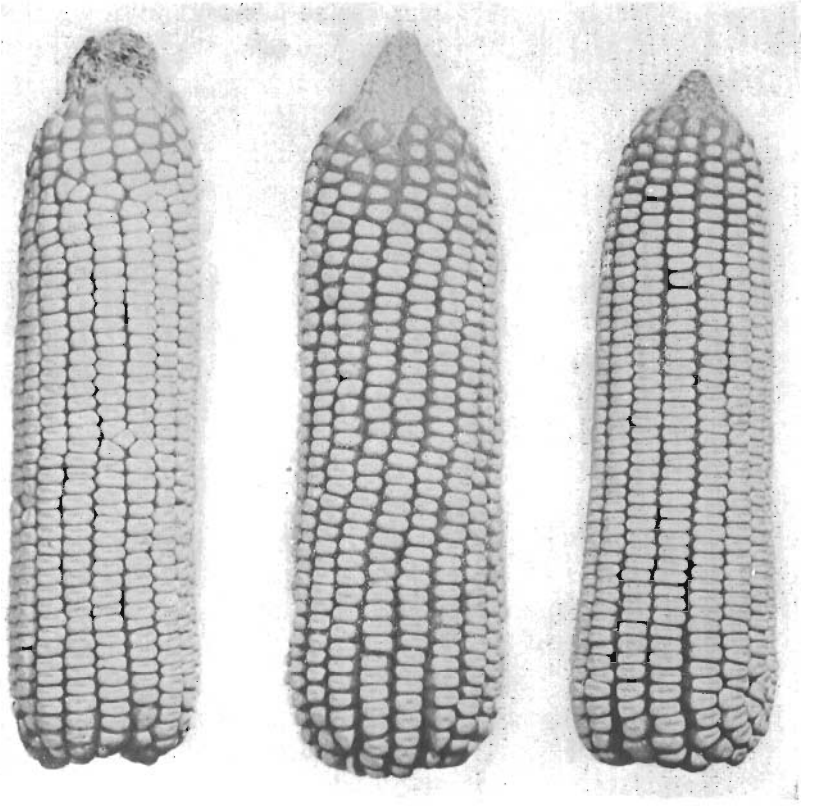

FIG. 4. Tusón. The thick cylindrical ears of this race, although similar to those of the Mexican Tuxpeño, resemble even more closely material collected in Haiti, Trinidad, and parts of Venezuela adjacent to Trinidad. In Cuba Tusón is common only in Oriente Province. This and all other photographs are reduced to the same scale: slightly less than one-half natural size; 1 cm. = 2.2 cms.

damage as their reason for abandoning the dent, although eight said that the dents gave better yields. Weevil damage, of course, is a more important consideration to the farmer who stores his corn for several months than it is to the grower who sells his

crop to a granary immediately after the harvest, as is common in Oriente. Eden (*20*) has shown that weevil infestation in corn is negatively correlated with hardness of grain.

Distribution elsewhere in Caribbean. Brown (*8*) collected cylindrical dent maize in Cuba, Haiti, and Trinidad. He wrote that "it is never found growing as a variety yet it constantly occurs as a segregate in certain areas." The highest concentration occurred in Trinidad, although it was "not uncommon as a segregate in Cuba."

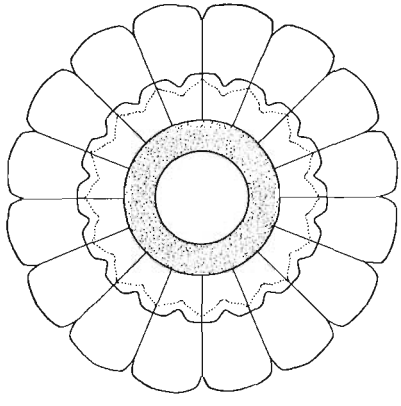

FIG. 5.

Ears which match Cuban Tusón have been discovered recently in the vicinity of Monagas in northeastern Venezuela by collectors of the National Research Council's Committee on Preservation of Indigenous Strains of Maize. They are stored at Medellín, Colombia.

Since the distribution of Tusón thus coincides almost perfectly with the pre-Columbian distribution of the Caribbean Arawak, there seems little reason to doubt that they introduced it from South America through the Lesser Antilles to Puerto Rico, Hispaniola, and eastern Cuba before 1440 A.D. Brown, however, who considered that all denting in maize probably originated in Mexico, suggested that country as the place of origin of Cuban and Haitian cylindrical dents. Subsequently, Trinidad may have

received its cylindrical dent from the Greater Antilles. Nevertheless, dent corns are of frequent occurrence in collections from coastal regions of northern South America. Since there is no other convincing evidence of migration of items of material culture from Mexico to northeastern South America via the Antilles, the hypothesis of Arawak introduction of dent corn into the West Indies from eastern Venezuela and possibly the Guianas seems more attractive to the present author.

Derivation of name. *Tusa* is the word for cob in Cuba; hence Tusón, meaning "large cob," the name used in most of eastern Oriente province. In western Oriente province, especially around the city of Bayamo, the name Maizón, meaning "big corn," is more common. "Diente caballo," meaning "horse's tooth," is also encountered frequently throughout Oriente province; the name refers to the shape of the grain. In western Cuba, Tusón is usually called Maíz Gibara after the town on the north coast of Oriente province.

References. Hernández, *24* (as "Race 6"); Brown, *8* (as "Cylindrical Dent").

ARGENTINO

Plants. Tall, 2.4 to 2.9 m.; summer crop early maturing; no tillers; 0–1 row of prop roots; 12 to 16 broad, long leaves; venation index medium; 1–2 ears per plant, the uppermost about 0.8 m. below base of tassel; sun-red color in all plants, not intense; purple color common, especially in husks and leaf sheaths. Seedling sun-red leaf colors: tip 94%, margin 10%, blade none, sheath 94%, midrib 31%, auricle none. Pubescence slight; moderately susceptible to rust; chromosome knobs 6 to 9.

Tassels. Long, highly branched; about 26% of branches secondary; 0 to 3% of branches tertiary; condensation index low.

Ears, external characters. Medium short, cylindrical to slightly conical or cigar-shaped. 12 to 14 or occasionally 16 rows; shank diameter medium; midcob color in 28% of ears examined. Kernels medium size, short, rounded, smooth; corneous starch very hard, cadmium orange to marigold orange; aleurone colorless or rarely purple; pericarp color common (P^{cw} in 13% of ears ex-

amined). Glume color in 19% of ears examined. Husk striations in all ears examined, in some extending to tip of ear. Average number of husks 13.9, coarse, tightly wrapped around ear.

Ears, internal characters. Ear diameter 37 to 45 mm.; cob diameter 26 to 30 mm.; rachis diameter 14 to 19 mm.; kernel length 8 to 11 mm.; kernel volume 0.20 cc.; estimated rachilla length 2.41 mm.; cob/rachis index low, 1.70; ear length/rachis index medium, 10.2; glume/kernel index medium to high, 0.60; rachilla/kernel index medium, 0.25; pedicel hairs 0.3 to 0.7 mm. long, frequently dense; cupule 5.6 mm. wide, 0.8 mm. high, 1.0 mm. deep; cupule hairs 0.3 to 0.6 mm. long, dense; rachis flap 1.8 mm., intermediate; lower glumes horny to bony, the margins mostly angulate, surface hairs 0.2 to 0.4 mm. long, many, few, or lacking, mostly lateral; marginal hairs 0.3 to 0.7 mm. long, sparse to dense; upper glumes papery or fleshy, venation weak or none, the margins straight or somewhat wrinkled; basal hairs 0.1 to 0.3 mm. long, few or none; tunicate allele tu^w; rachis tissue mostly hard to very hard.

Distribution and importance in Cuba. Maíz Argentino, an orange flint variety with relatively small ears, is grown chiefly in the province of Oriente, most of it being sold by farmers to *almacenes* (storage depots) in the larger towns, where it is shelled and subsequently shipped to Habana. In Habana the grain is converted to corn meal (*harina*) which is an important article of commerce in all of Cuba, as well as a basic constituent of noodles and similar products. Because of its deep orange-yellow color and relatively low soft-starch content, Maíz Argentino is the preferred variety for making corn meal. Oriente grain dealers pay about 25 per cent more for shelled grain of Maíz Argentino than for semi-dents and dents.

This higher price and the widespread notion that Maíz Argentino is a recent introduction and hence probably superior to unimproved local varieties have induced many relatively wealthy Cuban farmers to grow the variety, and poorer farmers have followed their example. In recent years, however, the popularity of Maíz Argentino has apparently declined. Twenty-one per cent of Cuban farmers interviewed in 1954 had grown or were

growing Maíz Argentino, but low yields and other undesirable qualities had induced more than half of these to abandon the variety and take up others.

History in Cuba. According to statistics published by the Cuban Ministerio de Hacienda (*12*), between 1914 and 1930 more than 171,000 tons of corn were imported into Cuba from Argentina. Parodi (*35*) has stated that the main type of maize

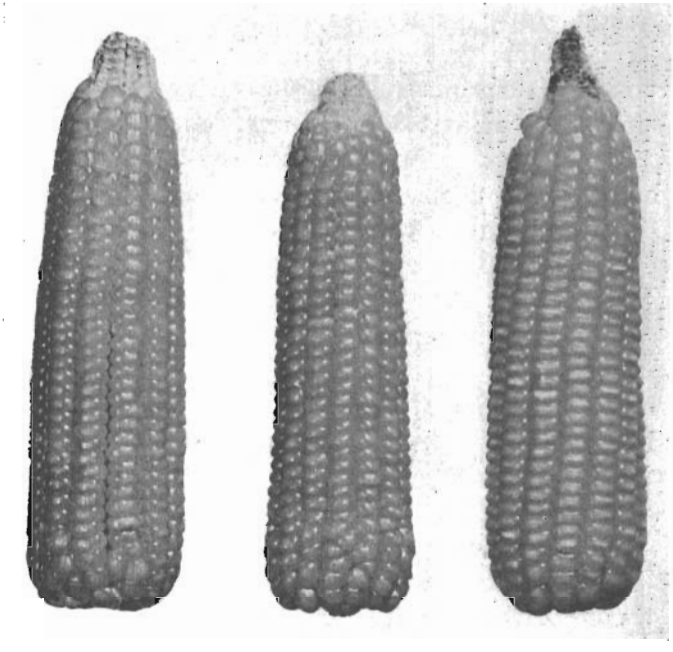

FIG. 6. Argentino. This race was introduced into Cuba from Argentina after the First World War and was modified subsequently by introgression from indigenous races. Although yields are low, the orange flint grains of Maíz Argentino command a relatively high price in Cuban markets. Scale 1 cm. = 2.2 cm.

exported from Argentina is the orange-yellow Cateto flint, ears of which are very similar to Cuban Maíz Argentino. Santiago importers interviewed in 1954 stated that they purchased large quantities of orange flint maize from Argentina between 1917 and 1928, ships having made delivery from that country to the Santiago docks. Until about 1928 this business was highly profitable, for the grain was purchased duty-free at $2.25 to $2.50 a

hundred-weight, and a good market existed for corn meal produced from Argentine corn. In order to encourage local producers, in the late 1920's a duty was placed on imported maize; imports from Argentina fell from nearly 34,000 tons in 1920 to 1,246 in 1930.

Although most Argentine maize was converted to corn meal, some was sold to farmers in the Santiago area without prior fumigation. Yields at first were probably discouraging, for Cateto corn is not well adapted to Cuban conditions. Brazilian Cateto corn tested at the Atkins Garden has produced only spindling plants which set very few seeds. The Cuban corn breeder Pablo Diaz Cuevas stated (personal communication) that he had

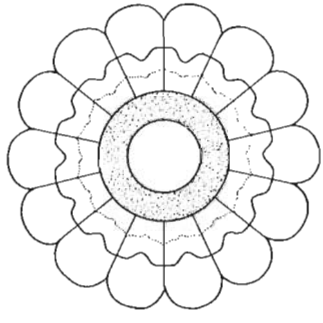

FIG. 7.

obtained similar results with material obtained from Argentina, but that hybrids of the Argentine corn and a Cuban variety yielded well. It is possible that the present Maíz Argentino of Cuba had a similar origin. Farmers in the Santiago region probably made repeated attempts to grow the valuable Argentine flint. Because of the common Cuban practice of planting two varieties in the same field, even if no sound Cateto-type ears were obtained at first, some Cateto pollen must have fallen on the indigenous Criollo (semi-flint) silks. Continued introgression and selection for orange flint grains might well have resulted in the present race, which in its vegetative aspects is like other Cuban field corn but the ears of which are strikingly similar to the Cateto of South America.

Distribution outside Cuba. Brown (*8*) found that Maíz Argentino occurs in the West Indies only in Cuba. Ears of Cateto flints of Brazil and Argentina are essentially identical to relatively pure types of Cuban Maíz Argentino. If the Cuban race is indeed the same as the orange-yellow flints of eastern South America, its strikingly discontinuous distribution is further evidence of recent introduction to Cuba, since no races which could have given rise to it are known in the West Indies.

Derivation of name. Argentino is the common local name for this race in Oriente province. Other names are "Especial" and, in western Cuba "Habana" and "Provincia."

References. Hernández, *24* (as "Race 5"); Brown, *8* (as "Cuban flint"); Parodi, *35* (as "Cateto").

CANILLA

Plants. Tall, 2.4 to 2.7 m.; summer crop early maturing; no tillers; 0–2 rows of prop roots; 14 to 16 wide, long leaves, venation index low; 2 ears per plant, the uppermost about 0.9 m. below base of tassel; sun-red color in all plants, not intense; intense purple color frequent, especially in husks and leaf sheaths. Seedling sun-red leaf colors: tip 96%, margin 44%, blade 6%, sheath 100%, midrib 52%, auricle none. Pubescence slight, moderately susceptible to rust; chromosome knobs 7 to 9.

Tassels. Long, many branches; about 26% of branches secondary; 0 to 5% of branches tertiary; condensation index low.

Ears, external characters. Long, very thin cylindrical to candle-shaped, frequently extremely flexible; 10 to 16 rows; shank medium to small; midcob color in 32% of ears examined. Kernels of two types: one narrow, wedge-shaped, nearly orbicular in transverse section, conspicuously dented, with pericarp frequently wrinkled; the other rounded, more or less rectangular in transverse section, with soft starch extending to apex but no denting; corneous starch medium hard to hard, indian yellow to saffron yellow; aleurone colorless or rarely red or purple; pericarp color common (P^{cw} in 28% of ears examined). Glume color in 51% of ears examined. Average number of husks 15.5, tightly wrapped but frequently shorter than ear, the cob then protruding beyond husk covering. Staminate spikelets common at tip of ear.

Ears, internal characters. Ear diameter 36 to 41 mm.; cob diameter 20 to 28 mm.; rachis diameter 9 to 14 mm.; kernel length 9 to 12.5 mm.; kernel volume 0.22 cc.; estimated rachilla length 2.26 mm.; cob/rachis index high, 2.08; ear length/rachis index very high, 18.7; glume/kernel index medium, 0.54; rachilla/kernel index medium, 0.21; pedicel hairs when present 0.3 to 0.7 mm. long, lacking in 64% of ears examined; cupule 4.0 mm. wide, 1.7 mm. high, 1.0 mm. deep; cupule hairs 0.3 to 0.4 mm. long, sparse to dense; rachis flap 0.5 to 1.5 mm. wide, not prominent; lower glumes papery to fleshy, the margins mostly undulate to angulate, surface hairs 0.2 to 0.4 mm. long, dense, sparse, or lacking, chiefly lateral; marginal hairs 0.3 to 0.8 mm. long, dense; upper glumes thin papery to papery, venation mostly very strong, the margins straight or slightly indented, basal hairs few (lacking in 80% of ears examined), 0.1 to 0.2 mm. long; tunicate allele tu^w; rachis tissue mostly soft or medium.

Distribution and importance in Cuba. Canilla, a race characterized by long, slender, often flexible ears, is abundant in Oriente and eastern Camagüey provinces, where it is one of the chief commercial types. The reason most commonly given for its popularity is its high shelling percentage, which is frequently confused with yield. To many a Cuban farmer Maíz Canilla is almost "all corn" and "no cob." I suspect that the fundamental notion here is that the function of the corn plant is to produce grain, and that consequently the cob represents wasted energy. However this may be, commercial granaries discount only 15 per cent of the weight for the cob when buying Canilla in the ear and this is considered advantageous by many growers. The discount rate for other races is usually 20 per cent. Canilla is also preferred by many farmers because of the ease with which it can be shelled by hand.

Outside of Oriente and Camagüey, Canilla is known as "Argentino." Its introduction into the western provinces seems to have been recent. About 30 per cent of the farmers interviewed in western Cuba had tried this variety, but only one was still growing it in 1955. Many seemed unaware of the existence of the variety, although seed is frequently available in the markets of all the larger cities.

Maíz Canilla exists in two forms described by Hernández (*24*) as distinct races. The more common variety is characterized by long, thin, wedge-shaped, dented grains, soft lower glumes, and a flexible cob. The grains of the second type are round, relatively

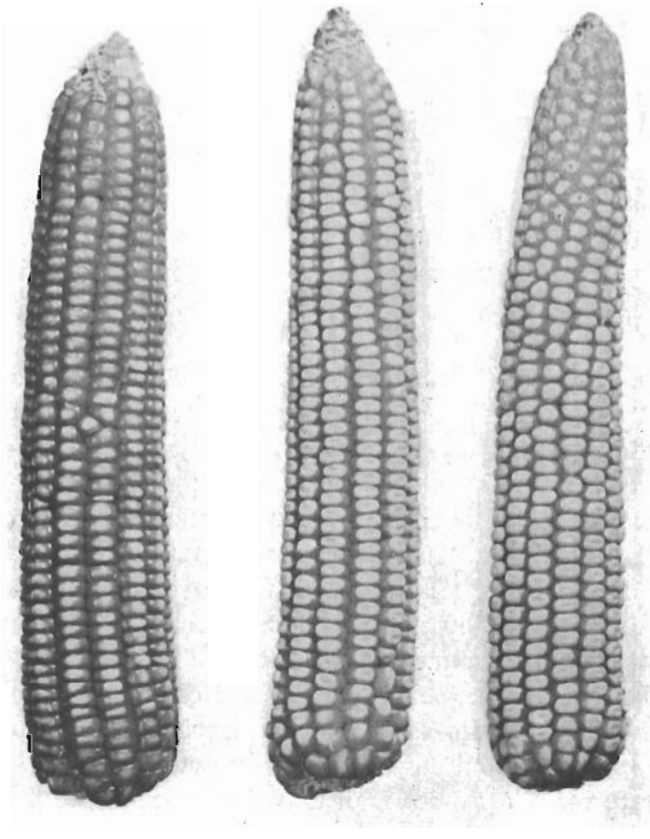

FIG. 8. Canilla. Long, slender, often flexible ears characterize this race, which has been collected in eastern Cuba, Haiti, Trinidad, Venezuela, and Colombia. Scale 1 cm. = 2.2 cm.

short, and hard, although the soft-starch column reaches the tip of the grain. Intense pericarp color is frequent. The lower glumes are moderately hard and short. The cob is only slightly flexible. Brown considered the two varieties as forms of the same race, as do the Cuban farmers interviewed by the present

author. A multiplicity of local names exists for the various forms, however.

Distribution outside Cuba. Brown (8) found "Maïs Chandelle" in Cuba, Haiti, the Dominican Republic, and Trinidad. The semi-flint type was restricted to Cuba and Haiti. A Colombian variety known as "Puya amarilla" seems identical with the semi-flint type (Mangelsdorf's accession No. 1813), and the dent variety can be matched with specimens collected in Venezuela (Mangelsdorf's accession No. 1554).

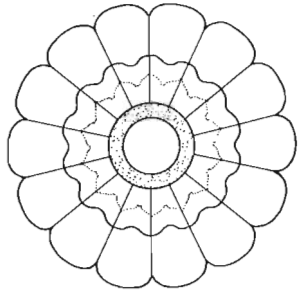

FIG. 9.

Origin and relationships. The range of Canilla in the West Indies coincides with that of Tusón and corresponds well with the known pre-Columbian distribution of the Taino Arawak. No races of corn are known in Cuba which could have given rise through hybridization or selection to Canilla. It therefore seems obvious to search for the origin of this race on the mainland of South America, where very similar ears have indeed been collected. The Dzit-bacal race of Yucatan is also similar. Since the ancestry of Dzit-bacal is not well understood (Wellhausen *et al.*, 45), it is at least possible that both Canilla and Dzit-bacal had a common origin along the north coast of South America.

Although Maíz Canilla is probably indigenous in the West Indies, it is possible that in Cuba this variety and the cylindrical dent race, Tusón, are post-Columbian introductions from Hispaniola. The Taino tradition was centered on that island and Puerto Rico before the Spanish conquest, whereas most of Cuba

was occupied by the less advanced Sub-Taino culture. A perusal of Columbus' Journal gives the impression that the admiral considered the agriculture of Hispaniola much more highly developed than that of Cuba. It seems possible, therefore, that the Taino Arawak possessed more varieties of corn than the more primitive Sub-Taino of Cuba.

Following the cession of Santo Domingo by Spain to France in 1697, considerable immigration from Haiti to Oriente province took place. The revolution of negro slaves in Haiti in 1803–04 caused more people to flee to eastern Cuba. It is not impossible that Maíz Canilla was introduced during either of those periods. French influence in Oriente province is apparent in the local names for some cultivated plants. For example, the word *carrota* is occasionally used for the carrot near Santiago de Cuba, although *zanahoria* is universal outside of Oriente province.

Derivation of name. Canilla in Spanish means "armbone" or "shinbone," an obvious reference to the long, slender ears of this race. Cuña, which means "wedge" and probably refers to the shape of the grain, is used in eastern Oriente. From Bayamo west to Camagüey the common name is Tayuyo, a local term for the tamal. Pineo, an archaic word meaning "pygmy," is used in some parts of Oriente province. In western Cuba Maíz Canilla is commonly called "Argentino."

References. Hernández, *24* (as "Races 3 and 4"); Brown, *8* (as "Maïs Chandelle").

WHITE POP

Plants. Short to medium height, 1.5 to 2.5 m.; summer crop early maturing; no tillers; 1 row of prop roots occasional, mostly lacking; 11 to 14 leaves of intermediate length and width; venation index medium high; 1 to 2 ears, the uppermost about 0.7 m. below base of tassel; sun-red color present in all plants, very weak; purple plant color occasional, if present, strong in leaf sheaths and husks. Seedling sun-red leaf colors: tip 100%, margin 25%, blade none, sheath 100%, midrib 75%, auricle none. Pubescence slight, moderately resistant to rust; chromosome knobs 6.

Tassels. Short, many branches; about 17% of branches secondary; tertiary branches rare; condensation index low.

Ears, external characters. Short, small, tapering toward apex and sometimes also toward base; 12 to 16 rows; shank small; midcob color in 32% of ears examined. Kernels small, rounded at tip, "pearl pop" type; endosperm horny, dirty white; aleurone colorless; pericarp colorless or infrequently dark red. Average number of husks 15.6, somewhat loosely wrapped around ear.

Ears, internal characters. Ear diameter 33 to 43 mm.; cob diameter 27 to 31 mm.; rachis diameter 13 to 16 mm.; kernel length 7 to 10 mm.; kernel volume 0.15 cc.; estimated rachilla length 2.57 mm.; cob/rachis index medium, 1.89; ear length/rachis index low, 8.0; glume/kernel index high, 0.72; rachilla/kernel index high, 0.30; pedicel hairs mostly 0.2 to 0.4 mm. long, dense; cupule 4.8 mm. wide, 0.6 mm. high, 1.1 mm. deep; cupule hairs 0.1 to 0.4 mm. long, sparse to dense; rachis flap 1.3 mm. long, intermediate; lower glumes horny, the margins angulate to cordate; surface hairs 0.2 to 0.4 mm. long, lateral or apical, dense, sparse, or lacking; marginal hairs 0.2 to 0.6 mm. long, dense; upper glumes papery to fleshy, venation weak, the margins straight; basal hairs 0.1 to 0.3 mm. long, sparse or more frequently lacking; marginal hairs 0.1 to 0.3 mm. long, sparse or lacking; tunicate allele tu^f; rachis tissue hard to very hard.

Distribution and history. In 1949, Hernández and Clement discovered in the district of Filipinas, near Guantánamo, a white pearl popcorn with relatively thick, slightly conical ears unlike any types then known in the United States or Mexico. Subsequently, however, somewhat similar popcorns were encountered in Yucatan, Guatemala, and Colombia. Despite such similarities, a study of the recent history of the Cuban white popcorn leads to the conclusion that it is an indigenous product, the hybrid of a white rice pop imported from the United States and the common Criollo semi-flint.

By interviewing growers in the Filipinas district in 1953, the author was able to trace the white popcorn to the town of Zaza del Medio, in central Cuba, whence it had been brought to Filipinas by a single family. In Zaza del Medio the white popcorn was found in abundance. According to an apparently re-

liable informant in that town, the white popcorn had been imported from the United States in small cardboard packages shortly after the First World War.

In the western province of Pinar del Río several farmers claimed formerly to have grown a white popcorn, seeds of which they had purchased in stores in the provincial capital. With the aid of local merchants the salesman who had distributed the seed

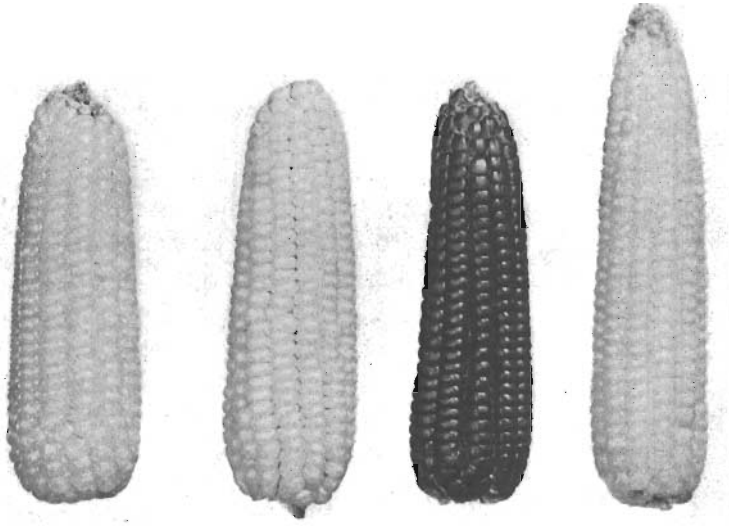

FIG. 10. White Pop. A United States improved variety modified by introgression from Maíz Criollo, White Pop is grown sporadically in Cuba. A red-pericarped variant is not uncommon around the town of Zaza del Medio, Las Villas Province. Scale 1 cm. = 2.2 cm.

was located, and from him the popcorn was traced to "Viuda de López," a well known importing house in Habana. An officer of "Viuda de López" confirmed the salesman's account and produced invoices showing that it had purchased popcorn from the Albert Dickinson Company of Chicago.

In answer to a letter of inquiry a representative of the Albert Dickinson Company wrote than an "open pollinated white rice popcorn . . . out of production in [the United States] was formerly sold in Cuba under the YANKEE BRAND. . . . Some

twenty years ago a yellow popcorn was substituted, because it does a better job of popping." Hybrids have been developed from this "so-called Argentine Popcorn." It is now being packaged in sealed tins, since "we found over the years that you could not use a paper carton and retain the popping quality of the corn in the container." Unfortunately, "any records on the old white rice popcorn would be so old that they have long since been destroyed. . . . we can assure you that the old type of white rice popcorn which was first put out under the YANKEE BRAND after the First World War has been out of production for a great many years in this country."

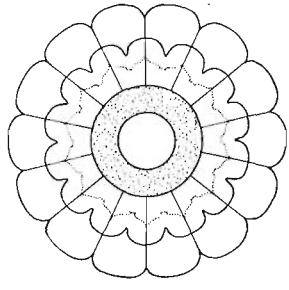

FIG. 11.

Thus it is clear that a white rice popcorn packaged in paper cartons was sold in Cuba for about fifteen years after the First World War by a Chicago seed house. In addition, the reliability of the Cuban informants is established, in this case at least, so that there is no reason to doubt their statements that the United States popcorn was actually grown by some farmers.

One important discrepancy remains. The United States variety was a "rice type" or pointed pop, whereas the Cuban form is a "pearl type" with rounded grains. This difference, together with the poor popping quality of the Cuban pop, is most simply explained by assuming hybridization of the American white rice variety with the indigenous Cuban "Criollo" semi-flint corn. In 1954 at Zaza del Medio the two varieties were planted in the same or adjacent fields by farmers who did not understand the biological function of pollen, and it was not difficult to collect intermediate forms.

Del Valle and Hidalgo Gato (*19*) stated that the white popcorn which they collected in the province of Las Villas and at Güines (Habana province) is probably a "selection from a white popcorn which came originally from the United States and which is not yet completely acclimated." In an earlier paper Del Valle (*17*) remarked that foreign varieties when grown in Cuba often displayed a more vigorous vegetative stage than indigenous races, but that, shortly after the appearance of the tassels and ears, the plants frequently died without producing well developed ears or grains. He noted this behavior in some of the progeny of white popcorn collected in Cuba.

Some efforts have been made by Ing. Pablo Diaz Cuevas, of the University of Santa Clara, to discourage Cuban farmers from sowing the white popcorn, since the practice of growing it in the same field with the Criollo semi-flint should theoretically result in the contamination of the latter with genes of the low-yielding pop. Such campaigns may have temporary local success, but the desire of the small Cuban farmer to have a small amount of popcorn in the house probably will ensure the survival of this variety in Cuba for many years. Del Valle has recently announced the production of a new yellow popcorn obtained from selection and hybridization of mutants of orange Cuban flints. In view of the almost invariable habit of the small Cuban farmer who has two varieties of corn to sow both in the same field, it is unlikely that the new popcorn will find widespread use in Cuba, for once in the hands of the small farmer immediate swamping out by yellow field corns would seem inevitable. White grain color has undoubtedly been the most important factor in the survival of the Cuban white popcorn. Its wide distribution — from Pinar del Río to Guantánamo — is the result of modern merchandising practices on the part of the Albert Dickinson Company and Viuda de López y Cia., and the increasing mobility of the Cuban people, whose propensity to nomadism resembles somewhat that found to a greater degree in the United States.

Local name. In Cuba all popcorns are called "maíz de pollo" — meaning literally "corn for chickens" — or "maíz de rositas." The word "rosita" alludes to the form of the popped grain, which is considered to resemble a little rose. The White Pop is some-

times called "maíz de pollo blanco"; the red-pericarped variant is called "maíz de pollo morado," or "purple popcorn."

Reference. Hernández, 24 (as "Race 1").

YELLOW POP

Plants. Short to medium height, 1.7 to 2.1 m.; summer crop very early maturing; no tillers; 0 to 1 row of prop roots; 11 to 15 fairly wide, short leaves; venation index very low; 1 to 3 ears, the uppermost about 0.6 m. below base of tassel; sun-red and purple plant colors common. Seedling sun-red leaf colors: tip 93%, margin 11%, blade 2%, sheath 96%, midrib 18%, auricle none. Pubescence moderately strong; moderately susceptible to rust; chromosome knobs 9 to 11.

Tassels. Very short, very high number of branches arising from 40% of the length of the main axis; about 30% of branches secondary, 2% tertiary; condensation index low.

Ears, external characters. Short, mostly slender, cigar-shaped, tapering chiefly toward tip; 12 to 16 rows; shank mostly slender; midcob color in 33% of ears examined. Kernels very small, long, frequently wedge-shaped, rounded at tips; striations pronounced; endosperm horny, pop type, with very little soft starch, orange-yellow; aleurone colorless; pericarp colorless; ears frequently slightly flexible. Average number of husks 16.2, tightly wrapped around ear.

Ears, internal characters. Ear diameter 20 to 40 mm.; cob diameter 15 to 25 mm.; rachis diameter 7 to 16 mm.; kernel length 7 to 10 mm.; kernel volume 0.14 cc.; estimated rachilla length 1.6 mm.; cob/rachis index high, 2.04; ear length/rachis index high, 11.4; glume/kernel index medium, 0.61; rachilla/kernel index low, 0.19; pedicel hairs 0.2 to 0.6 mm. long, mostly dense; cupule 3.2 mm. wide, 0.8 mm. high, 0.8 mm. deep; cupule hairs 0.1 to 0.4 mm. long, sparse to dense; rachis flap mostly 0.8 mm. wide, weak; lower glumes mostly papery to fleshy, the margins angulate to cordate; surface hairs 0.1 to 0.3 mm. long, mostly lateral, dense, sparse, or none; marginal hairs 0.2 to 0.3 mm. long, mostly dense; upper glumes papery, venation weak to prominent, the margins straight or slightly indented;

basal hairs if present very short, lacking in 83% of ears examined; marginal hairs 0.1 to 0.2 mm., scattered or lacking; tunicate allele tu^w; rachis tissue soft.

History and distribution. Yellow Pop is readily distinguished from all other races of Cuban maize by its small cylindrical to slightly conical ears with 12 to 16 rows of slender, wedge-shaped grains, its relatively short plants with hairy leaf sheaths, and its

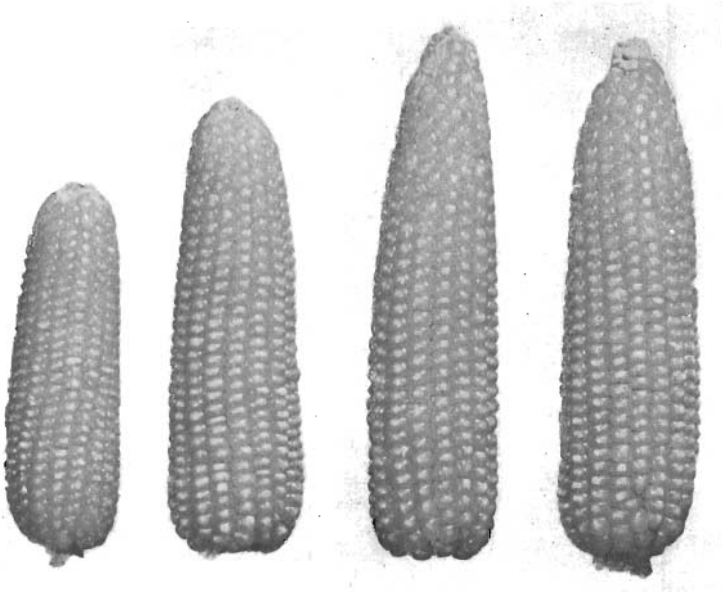

FIG. 12. Yellow Pop. This race was collected at two farms in Las Villas Province. It is probably a selection from the United States variety "Queen Golden." Scale 1 cm. = 2.2 cm.

earliness. It was found in a single town in the central province of Las Villas only after a persistent search for growers of a type reported by Hernández (*24*) to be similar to the Nal-tel race of Mexico. Hernández' variety, which was based on specimens selected from commercial granary piles in Oriente province, appears to have been a group of chance segregates or second ears of Maíz Argentino and thus does not constitute a race as that term is defined in this paper.

Farmers in Las Villas stated that they had known the Yellow

Pop only since about 1945. It is said to be grown for popping and to feed young chicks, which are unable to swallow the larger grains of field corn. Because of its limited distribution and short history of use, the Yellow Pop race is here considered a recent introduction to Cuba. It may be a selection from the open pollinated United States variety Queen Golden (Sturtevant, *42*),

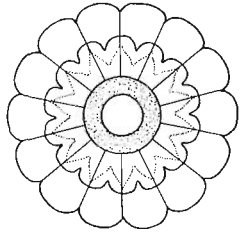

FIG. 13.

which it resembles in certain respects. Since there is a persistent demand among small Cuban farmers for a variety of popcorn adapted to their growing conditions, it may increase in importance.

Local name. None well established, but one grower suggested "Maíz de pollo enano," or "Dwarf popcorn," referring to the small stature of the plant.

WHITE DENT

Plants. Short, 1.4 to 1.8 m.; summer crop early maturing; no tillers; 0 to 1 row of prop roots; 13 to 14 short, medium narrow leaves; venation index high; 2 ears, the uppermost about 0.6 m. below base of tassel; sun-red color slight; purple color infrequent. Seedling sun-red leaf colors: tip 100%, margin 54%, blade 8%, sheath 100%, midrib 85%, auricle none. Pubescence very slight; moderately susceptible to rust; chromosome knobs 6 to 8.

Tassels. Very short, poorly exserted from uppermost leaf sheaths; number of branches intermediate, arising from more than one third length of tassel; about 15% of branches secondary; tertiary branches lacking; condensation index very low.

Ears, external characters. Extremely short, cylindrical or

slightly tapering, usually with a pronounced sterile tip. 10 to 12 rows; shank diameter medium; no midcob color. Kernels short, medium wide, medium narrow, well dented, highly susceptible to attack by weevils; husk striations present; endosperm medium hard, dirty white; aleurone and pericarp colorless. Average number of husks 12, long, tightly wrapped around ear.

Ears, internal characters. Ear diameter 34 to 39 mm.; cob

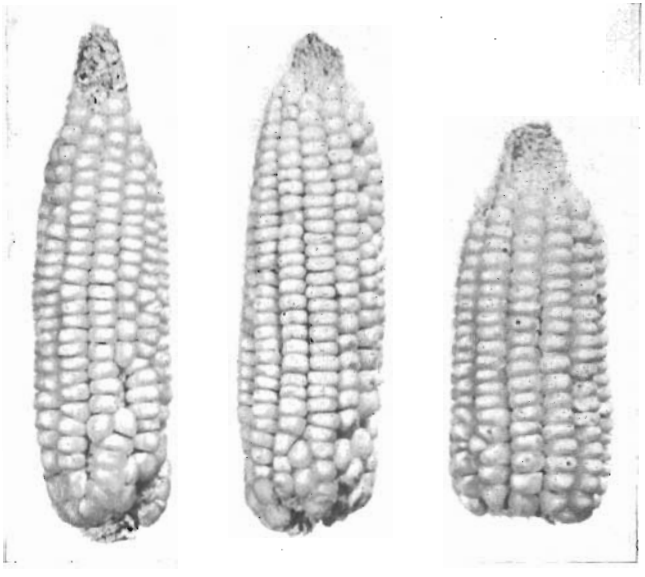

FIG. 14. White Dent. Apparently identical to the Mexican race "Zapalote Chico," White Dent was collected at a single farm in a remote village in Oriente Province. Scale 1 cm. = 2.2 cm.

diameter 20 to 24 mm.; rachis diameter 11 to 14 mm.; kernel length 9 to 11 mm.; kernel volume 0.15 cc.; estimated rachilla length 2.38 mm.; cob/rachis index medium, 1.78; ear length/rachis index low, 8.8; glume/kernel index low, 0.50; rachilla/kernel index medium, 0.24; pedicel hairs lacking; cupule 5.6 mm. wide, 0.3 mm. high, 1.4 mm. deep; cupule hairs 0.2 to 0.3 mm. long, sparse to dense; rachis flap about 1.4 mm. wide, moderately weak; lower glumes fleshy to horny, the margins angulate to cordate, surface hairs 0.1 to 0.2 mm. long, mostly scattered near apex; marginal hairs 0.6 to 0.7 mm. long, scattered; upper glumes

fleshy, the margins straight or somewhat wrinkled, venation very weak or none, glabrous. Tunicate allele tu or tu^w; rachis tissue moderately hard.

Distribution. The rarest of Cuban races of maize is a small white dent corn collected at a single farm in the mountainous district of Caujerí, in eastern Oriente province. Its small stature, narrow leaves, tendency to put forth silks before the emergence of the anthers, and its relatively soft white grains set it far apart from other races of Cuban maize. According to the wife of the grower, although commercial granaries refuse to buy this

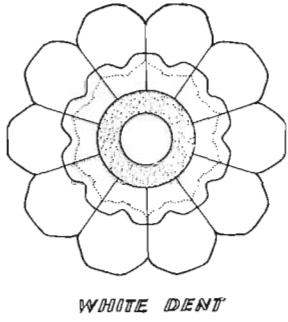

FIG. 15.

white corn, it is maintained on her husband's farm because it produces a superior corn meal. It is not used for popping.

In 1954 Professor P. C. Mangelsdorf suggested that the Caujerí corn was practically identical with "Zapalote Chico," which has been collected at low elevations near the western coast of southern Mexico. Table 2 shows that the two types are indeed similar. If the identification is correct, it would seem probable that an introduction from Mexico to Cuba was relatively recent. Any careful investigation of the presence of this race on a single farm in a remote hamlet in the mountains of eastern Cuba, of course, should begin at Caujerí. Unfortunately, at the time of the author's visit, the grower, who might have known something of the history of his white dent corn, was not at home.

Local name. "Argentino Blanco" or "White Argentine corn."

TABLE 2

COMPARISON OF ZAPALOTE CHICO WITH THE WHITE DENT CORN FOUND IN CAUJERÍ, ORIENTE

	Zapalote Chico (Data from *Races of Maize in Mexico*)	*Caujerí Dent* (Grown at Soledad, summer, 1954)
Plant Characters		
Height (m.)	1.20	1.97[a]
Number of leaves	10.00	12.70
Width of leaves (cm.)	7.90	7.88
Length of leaves (cm.)	64.20	83.30
Venation index	3.30	3.27
Tassel Characters		
Length	34.00	33.40
Branching space	10.70	11.30
Per cent branching space	34.00	35.80
Number of branches	18.90	20.10
Per cent of secondary branches	16.00	15.40
Condensation index	1.72	1.06
External Characters of Ear		
Length (cm.)	9.90	11.00
Diameter (cm.)	4.20	3.68
Row number	10.70	10.30
Shank diameter (mm.)	13.70	11.60
Width of kernel (mm.)	9.80	9.30
Thickness of kernel (mm.)	3.60	4.40
Length of kernel (mm.)	10.10	9.70
Internal Characters of Ear		
Diameter of cob (mm.)	23.30	22.40
Diameter of rachis (mm.)	14.00	12.70
Length of rachilla (mm.)	3.70	2.38
Cob/rachis index	1.66	1.78
Glume/kernel index	0.46	0.50
Pedicel hairs	0–1	0
Rachis flap	1	2
Chromosome Knobs, range	10–14	6–8

[a] 1.17 m. at Soledad, summer, 1953

HOW CORN IS GROWN IN CUBA

METHOD OF INTERVIEWING: 1954–55

Field studies in 1953 suggested that much Cuban corn was undergoing a process of "mongrelization." The construction of a modern highway system had tended to destroy regional isolation, and introduction of foreign varieties for which grain dealers in cities paid high prices had induced many farmers to abandon lines inherited from parents. In order to estimate the importance of these disturbing factors, seventy-one farmers were interviewed by questionnaire in 1954 and 1955. Emphasis was placed on varietal names, source of seed, and characteristics considered desirable in selection of ears for sowing, but also included were economic and social factors which might affect indirectly the genetic composition of cornfields.

The Cuban farmers, whose courtesy, hospitality, and generosity are well known to all who have lived among them, offered complete cooperation in almost every case. Many expressed a lively interest in agricultural practices in the United States. Most growers seemed to have little difficulty in understanding the questions put to them. Only four interviews were later rejected because of the informants' doubtful reliability – one of the four, for example, was apparently demented.

As a check on the data obtained by personal interviews, certain statistics published by the Cuban Ministry of Agriculture in the 1946 Agricultural Census (*11*) are included below. In general, the farms visited by the author appear to approach the national average fairly closely in size of farm and type of tenancy.

For a geographical study of the factors affecting the production of corn and hence the evolutionary changes which maize may be undergoing, it is convenient to divide Cuba into two sections. The eastern division, consisting of the provinces of Oriente and Camagüey, produces nearly all the maize sold in the national markets as grain. It contains about 55 per cent of the land area of Cuba and produced about 58.5 per cent of the country's corn in 1946. Dent corn is common only in Oriente and Camagüey. Both provinces are noted for very large estates on which sugar cane, rice, and cattle are produced.

The western division, containing the provinces of Pinar del Río, Habana, Matanzas, and Las Villas, sells very little corn in the national markets as grain. The chief cash crops are sugar cane and tobacco, although cattle and coffee are important in Las Villas and rice increasingly so in Pinar del Río. In all, the sale of fresh vegetables, including green corn, in the city markets is an important source of income for the small farmer.

The distribution of farms at which interviews were obtained was as follows:

Eastern Division		
Oriente	33	
Camagüey	3	
		36
Western Division		
Las Villas	14	
Matanzas	1	
Habana	5	
Pinar del Río	11	
		31
Total		67

SIZE AND VALUE OF PRODUCTION OF FARMS (Source: 1946 Agricultural Census)

Although the average farm size in Cuba was 56.7 hectares in 1945, the median area was between 10 and 25 hectares. About 20 per cent of all farms covered less than 5 hectares. The national median value of farm products in 1945 was between $500 and $1,000 per farm; 54.6 per cent of Oriente farms, however, produced less than $500.

Cane and corn offer interesting economic contrasts, as shown in Table 3.

TABLE 3

VALUE OF SUGAR CANE AND CORN PRODUCED IN CUBA IN 1945

	Eastern Cuba		*Western Cuba*	
	Cane	*Corn*	*Cane*	*Corn*
Crop value ($1,000)	71,670	7,068	64,294	8,206
Percentage of farms	12.9	57.1	36.9	58.5
Crop value per farm ($)	8,670	191	2,030	163

These data illustrate the great importance of latifundios in eastern Cuba, where in 1945 more than 49 per cent of the total value of agricultural production was produced on only 12.9 per cent of the farms. In general, in those provinces cane is a rich man's crop. Corn is grown by almost all poor farmers and by a few larger landholders who have felt diversification desirable. For the poor farmer, corn is relatively more important in eastern Cuba than in the western provinces, where cane, sold to sugar mills, and tobacco are important sources of revenue to many small farmers. For example, 71.7 per cent of all farms in Matanzas province produced some sugar cane in 1945. Tobacco is very important in Pinar del Río and Las Villas. It accounted for 39.1 per cent of the total value of agricultural production in those two provinces in 1945 and was grown on 48.1 per cent of all farms.

TYPE OF TENANCY

Cuban farmers interviewed did not hesitate to state whether they owned, rented, or simply occupied the farms they worked. Similar data obtained in the 1946 Agricultural Census provided a convenient check on the accuracy of the author's sample. Subrenters have been included under the heading "renter."

TABLE 4

FREQUENCY DISTRIBUTION OF TYPES OF TENANCY

Type of Tenancy	*1946 Census*	*1954–55 Sample*
	%	%
Proprietor	31	43.5
Administrator	6	3.0
Renter	33	28.5
Sharecropper	21	18.0
Squatter	9	7.5

Although proprietor-class tenancy is somewhat overrepresented, the sample appears to be a fair one.

In the western provinces, 69.3 per cent of all farms were rented or sharecropped in 1945. The corresponding percentage in the eastern provinces was only 33.2. Squatters, on the other hand, occupied less than 2 per cent of the farms in western Cuba but 17.7 per cent of those in Oriente and Camagüey.

NUMBER OF YEARS ON FARM

The 1946 Agricultural Census provides data which indicate the tendency toward mobility of persons who operate Cuban farms. The data presented in Table 5 have been calculated from Table 14 of the Census.

TABLE 5

FREQUENCY DISTRIBUTION OF TENANTS (OWNERS, ADMINISTRATORS, RENTERS, SHARECROPPERS, OR SQUATTERS) WHO HAVE OPERATED FARMS THE INDICATED NUMBER OF YEARS.

Years	*Eastern Cuba*	*Western Cuba*
	%	%
less than 5	29.3	19.4
5 to 9	19.4	17.8
10 to 14	14.5	18.2
15 to 25	16.2	16.9
over 25	19.1	22.8

Obviously, land tenure is somewhat less stable in eastern than in western Cuba. Since farmers who move to new areas sometimes carry seed corn or buy it at stores or markets, tenant mobility is a factor tending to introduce new germplasm and thus to modify existing types of corn.

USE OF FERTILIZER, IRRIGATION, AND MACHINERY

Only seven farmers interviewed used chemical fertilizer on their corn. Of these, six were tobacco growers and one an Habana dairyman. One other farmer stated that he occasionally burned limestone in a kiln for use on his poor serpentine soils, and another put cane ashes and "mud" (*cachaza*) on his cornfields. The data obtained in the present survey are compared with those of the 1946 Agricultural Census in Table 6.

TABLE 6

PERCENTAGE OF FARMS USING FERTILIZER AND IRRIGATION

	1946 Census	*1954–55 Sample*
Fertilizer	12.0	10.5
Irrigation	4.0	6.0

Ten farmers stated that they used machinery, chiefly tractors, in their work. Still by far the most common method of plowing in Cuba is the use of a team of oxen hitched to a metal-tipped plow.

SIZE OF CORNFIELD

The sizes of cornfields reported by farmers interviewed varied from 0.25 to 350 hectares; the median size was 2 hectares (4.95 acres). The frequency distribution of areas of cornfields is shown in Table 7. The average size of cornfields reported in the 1946 Agricultural Census was 2.9 hectares.

TABLE 7

FREQUENCY DISTRIBUTION OF CORNFIELDS BY SIZE

Area of field	%
0 to 0.9 hectares	15.0
1 to 1.9	19.5
2 to 2.9	16.5
3 to 3.9	12.0
4 to 4.9	6.0
5 to 10	13.5
11 to 100	7.5
over 100	1.5

YIELDS

Forty-nine farmers reported estimated yields. Average reported yield was 27.8 quintales per hectare, the approximate equivalent of 20.5 bushels per acre. Reported yields ranged from 3.3 to 73.5 bushels per acre, but 90 per cent fell between 7.4 and 35.2 bushels per acre. The 73.5 bushel/acre yield is not impossible, since the farmer reporting this figure used chemical fertilizers and machinery.

According to the Agricultural Census of 1946, the average national per hectare yields were 917 kilograms in the summer and 924 in the winter crop. These are the approximate equivalents of 14.9 and 15.0 bushels per acre.

NUMBER OF VARIETIES GROWN BY A SINGLE FARMER

Table 8 illustrates the strong tendency for Cuban farmers to grow at least two varieties of corn in regions where more than one race is available. In addition, 54 per cent of all farmers reported that they had formerly grown at least one other variety. Twelve of the fifteen farmers who grew more than one variety stated that they sowed all varieties in the same field, usually in separate rows. Only two farmers specified that they kept varieties well separated in order to prevent crossing.

Of all farmers, 19.4 per cent reported that nearby neighbors sowed varieties different from their own.

TABLE 8

FREQUENCY DISTRIBUTION OF CUBAN FARMERS GROWING ONE, TWO, OR THREE RACES OF CORN

	Number of Varieties Grown			
	1	*2*	*3*	*2 or 3*
	%	%	%	%
Eastern Provinces	66.7	22.2	11.1	33.3
Western Provinces	90.4	6.5	3.2	9.7
Total	77.7	14.9	7.5	22.4

Only 14.9 per cent of all farmers interviewed understood the sexual function of pollen. Some ideas expressed were surprising; for example, one grower stated that pollen's only role in the life of the maize plant was to kill the weeds and other competing vegetation on which it fell. Others, who recognized that some of their lines had "degenerated," believed the change due to a vague kind of influence which had moved into the plant from the soil. The writer was frequently assured that in order to counteract this supposed process it was necessary to obtain new seed every few years from relatively distant places.

SOURCE OF SEED AND NUMBER OF YEARS HELD

Tables 9 and 10 suggest that the process of seed changing is a fairly important one in Cuba. Thus 48.4 per cent of all farmers indicated that they had obtained their seed no more than ten years before the time of the interview.

TABLE 9

FREQUENCY DISTRIBUTION OF FARMERS REPORTING SEED HELD FOR INDICATED NUMBER OF YEARS

Years Held	*%*
1	12.1
2	15.5
3	10.3
4	3.5
5	1.7
6 to 10	5.2
10 to 30	13.8
"always"	37.9

Such practices make it easy to understand Brown's statement (*8*) that Caribbean corn at first sight appears to be a "hopeless mess." Hybridization and migration are evidently occurring constantly and on a relatively large scale. Nevertheless, the opposite tendency toward fixation of racial types through careful selection also takes place in Cuba. A large majority – 94 per cent – of all farmers interviewed stated that they selected seed ears carefully and were generally able to demonstrate the characteristics they preferred.

TABLE 10

FREQUENCY DISTRIBUTION OF FARMERS REPORTING INDICATED SOURCES OF SEED

Source of Seed	*%*
Immediate family	36.0
Neighbor	42.3
Purchased in nearby store	12.4
Obtained from source more than 50 km. distant	9.4

SELECTION OF EARS FOR SOWING

Grain type was almost always carefully selected. Farmers in western Cuba tended to reject all ears with light colored, defective looking grains; dented grains were regarded with suspicion. A common superstition states that grains from the tips or butts of ears will produce barren plants; consequently

these are always shelled off before planting. Table 11 indicates types of grain preferred by the Cuban farmers sampled.

TABLE 11

FREQUENCY DISTRIBUTION OF FARMERS STATING PREFERENCE FOR INDICATED TYPE OF GRAIN

Type of Grain	*%*
Large, well filled, strong color	34.9
Orange flint	20.9
"Healthy looking" or "well formed"	10.4
Yellow flint	9.0
Dent	9.0
Long, slender grain	6.0
No preference stated	9.0

Reasons for selection were indicated in twenty-six cases; these are summarized in Table 12.

TABLE 12

FREQUENCY DISTRIBUTION OF FARMERS STATING INDICATED REASON FOR PREFERRING GRAIN TYPE

Reason for Preference	*%*
Better flour (chiefly orange flint)	30.8
Better price (chiefly orange flint)	19.2
Better yield or stronger plant	19.2
Resists granary weevil	15.4
Characteristic preferred of general type of corn	3.9
Germinates better	3.9
Healthier to eat	3.9
Better for chickens	3.9

While grain type is perhaps the chief basis of selection of seed of the farmer in western Cuba, growers in Oriente tend to select more for certain ear shapes and cob sizes. Farmers growing Maíz Argentino, however, based their choice mainly on color of grain. Table 13 indicates types of cob preference stated by farmers in all of Cuba. A strong preference for straight rows of grain was volunteered by five growers.

TABLE 13

FREQUENCY DISTRIBUTION OF FARMERS STATING PREFERENCE FOR INDICATED TYPE OF COB

Cob Type	*%*
Thin cob	45.3
Thick cob	22.4
Medium cob	4.5
No preference	29.9

Reasons given for selection of Cob type are listed in Table 14.

TABLE 14

FREQUENCY DISTRIBUTION OF FARMERS STATING INDICATED REASON FOR PREFERRING COB TYPE

Reason for Preference	*%*
Higher yield	69.7
Characteristic of general type of corn preferred	15.1
Easier to shell	6.1
Resists weevil	3.0
Produces better grain	3.0
Prettier	3.0

High yield was usually given as the reason for preferring the thin-cobbed Canilla race. In this connection it should be understood that the Cuban farmer's conception of yield is somewhat confused. Generally, growers were able to state approximately how many ears they harvested, and hence should have the basis for comprehending the idea of yield per unit area of land. The Cuban farmer's concept, however, seems to be that total yield depends ultimately on yield per ear, other things being equal. Consequently, many believe that Maíz Canilla is the highest yielder since its ears consist almost entirely of grain; the energy of the plant is not wasted in producing a large, useless cob. An apparently increasing number of farmers in Oriente province, however, are beginning to reason that the ear which produces the largest number of rows of grain produces the highest yield; such farmers are changing to the Tusón type.

Surprisingly, 35.8 per cent of all growers interviewed expressed a strong preference for colored husks, which they believed were resistant to attack by weevils and borers. One farmer exhibited

a crib in which more than 90 per cent of the ears were enclosed in red or purple husks, the result of several years of careful selection. Since glume color seems to be correlated with husk color, the high frequency of the former in Cuban corn is probably due in part to selection pressure.

White husks, on the other hand, were selected by 26.9 per cent of all growers interviewed. Three farmers stated that white husks resisted insect attack more than others; six disliked husk colors because food prepared in husks (e.g., tamales) became stained; seven stated frankly that they simply disliked colored husks.

Cob color of all kinds was avoided by 9 per cent of farmers interviewed. They considered foods unattractive if stained by the soluble anthocyanins. Broken ears of corn are an important constituent of "ajiaco," a popular Cuban stew.

DISCUSSION

The results of the interviews and the Agricultural Census of 1946 show that most Cuban farmers who produce corn are poor. Because they are unaware of the advantages of fertilizer, proper cultivation, and denser stands, their yields per unit area are about 30 per cent of what they could easily be. They are generally ignorant of sexual processes in plants and hence do not understand the biological basis for the change in their varieties, although they are well aware of the results. Most Cuban cornfields are less than eight acres in size and contain populations of roughly 35,000 plants. When more than one race is available, as in Oriente province, about one farmer in three grows at least two varieties in the same small field. Most Cuban farmers have been on the land they work less than fifteen years and have held their lines of corn less than ten. When seed is lost because of bad weather or carelessness, usually a member of the family or a neighbor will replace it, but occasionally new seed is bought in city markets. Ignorance and economic and social circumstances thus combine to break down old indigenous races and to produce new "mongrel" types, which may, nevertheless, be superior to the old ones in certain respects.

Most Cuban farmers, however, select seed ears very carefully,

and the characteristics sought are precisely those most useful in distinguishing relatively pure races of Cuban corn. Cuban farmers growing Maíz Argentino, for example, almost invariably state that they select for planting ears with the deepest orange flint grains. Those growing Maíz Canilla and Maíz Tusón in the same field generally sell or consume intermediate forms and choose extremely thin and extremely thick ears for seed.

The results of repeated hybridization and selection are twofold. Since cob and grain types resembling the pure races are constantly selected, these forms tend to persist more or less unchanged in Cuban corn. Since no selection is made for vegetative or tassel characteristics except indirectly in so far as these may be correlated with ear and grain types, repeated hybridization tends to produce plants which are intermediate between the old pure races in those respects. Thus vegetative and tassel characters of commercial races of Cuban corn tend to converge more and more toward each other. The result is that plants which are otherwise nearly indistinguishable may bear strikingly different ears.

Finally, the conservative effect of successful farmers should not be overlooked. Such men often take pride in keeping their houses clean, their fields free from weeds, and their varieties of crop plants uniform. As their reputations for successful farming grow, their less industrious neighbors may approach them for advice and for seed. These men therefore constitute, in many cases, a sort of genetic bank to which students of the races of maize of any rapidly developing country should make special efforts to address themselves.

CONCLUSIONS

The races of Cuban maize show clearly the results of interplay of three dominant evolutionary forces: introduction and migration of germplasm; hybridization; and selection. Introductions to Cuba have come from nearly all directions. Three aboriginal races were probably carried to Cuba from northern South America by way of the Lesser Antilles. In recent years varieties from Argentina, the United States, and apparently Mexico have

reached Cuba. Migration and hybridization within Cuba have resulted in a new race and in the partial obliteration of differences in vegetative characters of the four most abundant types. Selection, however, has preserved the essential features of the ear of the aboriginal races, so that it is still possible easily to match them with specimens collected in Venezuela, Colombia, and the other Antillean Islands.

Two races of popcorn grown in Cuba probably have been introduced from the United States since the First World War. One of these, a white pearl type of poor popping quality, seems to be descended from a white rice popcorn marketed in Cuba by a Chicago seed house. In Cuba this variety was unintentionally crossed with the common field corn of the country, giving rise to a yellow corn with occasional white grains which is still considered a distinct variety by some farmers. Probably the present race of White Popcorn arose from sowing this hybrid and selecting the occasional segregating white grains for subsequent planting. The Cuban rice-type orange-yellow popcorn, characterized by earliness, short stature, and heavy pubescence, appears to be a recent selection from the North American "Queen Golden" variety.

A White Dent variety collected at a single farm near the eastern tip of Cuba differs greatly from other races of Cuban maize in characters of both ear and tassel. It may be a recent introduction from Mexico, for it resembles the Zapalote Chico race of Oaxaca and Chiapas in most respects.

Much more important in Cuba's economy is a fourth recent introduction, Maíz Argentino. This race is almost certainly descended from a Cateto-type orange flint imported into Cuba from Argentina during and after the First World War for conversion to corn meal. The Argentino flint of today, however, probably differs from its South American parent in important respects. In characters of the plant and tassel it is similar to other races of Cuban field corn, but its ears are very distinctive. Obviously, the processes of hybridization and continued selection for an idealized type of ear with orange, flinty grains have been operative in the evolution of this race. Although a premium is paid at commercial granaries for good quality grain of this race, Maíz

Argentino seems to be losing popularity in Cuba, probably because of its relatively low yields and the increasing difficulty the small farmer encounters in obtaining unmixed seed. As one of the probable ancestors of the well known commercial variety "Cuban Yellow Flint," Maíz Argentino has become indirectly a source of superior germplasm for many Central American breeding programs.

From Columbus' Journal as interpreted by Las Casas and the admiral's son Fernando, as well as from the writings of Oviedo, it is known that maize was grown by the Indians of Cuba. It is impossible to determine which race of Cuban maize was reported by Columbus' ambassadors, for three indigenous types, Tusón, Canilla, and Maíz Criollo, exist today in the region visited by the exploring party. All three are widely distributed outside Cuba.

The centers of distribution of Tusón and Canilla are apparently in the lowlands of eastern Venezuela. To the north, both occur in Trinidad and Hispaniola, as well as in eastern Cuba. From Venezuela Canilla extends westward to the Caribbean coast of Colombia and up the valley of the Magdalena, where it is known as "Puya." Tusón reaches Colombia, where it is called "Puya Grande," near the headwaters of the Orinoco River system. Archeological evidence indicates that these areas, like the Greater Antilles and part of Trinidad, were occupied by Arawak tribes before the Spanish conquest. Dent types, however, are common in both races, and since according to some students Mexico may be the center of origin of denting, it would appear logical on morphological grounds to seek their origin there. Indeed, similar types do exist in Yucatan. The cylindrical dent race Tusón has an apparent counterpart in the Mexican Tuxpeño, and the slender, flexible ears of Canilla strongly resemble those of Dzit-bacal. The Mexican races possibly may have played a part in the origin of the South American "Puya" types, but the anthropological, botanical, and geographical evidence strongly indicates that Tusón and Canilla were carried by Arawak tribes from coastal eastern Venezuela into the West Indies some time after 900 A.D.

The ultimate place of origin of Maíz Criollo is more obscure. Unlike Tusón and Canilla, it is common throughout Cuba, and in coastal South America extends from Brazil to Panama. Brown

found this race throughout the West Indies. Since mixtures of the Cuban dents and Maíz Argentino, an introduced Cateto flint, have given rise in Oriente province to a type virtually indistinguishable from the Maíz Criollo of western Cuba, it is possible that the "Coastal Tropical Flint" had a similar origin in South America, where both putative parents still exist. The widespread distribution of Maíz Criollo in Cuba suggests that it was introduced to that island by the Sub-Taino Arawak shortly after 1200 A.D.

Corn was probably of secondary importance in Arawak agriculture. Cassava (manioc) seems to have been the principal crop, from which bread and other staple foods were prepared. Maize seems to have been eaten green, as an accessory vegetable in season to add variety to the meal, although it may have been parched as well. Cuba's relative poverty in indigenous races of maize as compared with Mexico, with its twenty-five or more distinct races, is therefore not hard to understand. To the Indians of Mexico maize was the staff of life; to the Arawak it was a delicacy.

The history of Cuban corn to 1955 has involved repeated introductions and hybridization. There is no reason to believe these processes will not continue. Only a few years away is the acceptance by large growers of recently developed synthetic varieties and double-cross hybrids. The Atkins Garden and Research Laboratory has embarked on a program of testing types developed in Mexico and Colombia by the Rockefeller Foundation, and one of these has already come into the hands of a small grower in Esperanza, Las Villas.

These tendencies can only be regarded with apprehension by the student of maize and the corn breeder. The former is interested primarily in working out a natural classification of a variable plant, and hopes to be able to compare the distributions and genealogies of his races with the migration of the people of the Western Hemisphere and perhaps ultimately with the origin of maize itself. The latter, confronted with a bewildering number of local variants from which to select material for breeding work, relies on the economic botanist to provide a rational inventory of his collections. It is obvious that widespread migration and

hybridization, the results of twentieth-century technology, which tend to destroy the stability of morphological types and their geographical distributions, complicate the classification of races of maize.

Cuba's situation is by no means unique. One may expect also to find the masking effects of recent introduction and hybridization present in Venezuela and other rapidly developing countries of Latin America. Brown (*8*) considered Puerto Rico's maize too complicated by the introduction of North American varieties to be susceptible to the type of analysis he applied on other West Indian islands. Fifty or more years ago the maize of Puerto Rico might have been the subject of an interesting study, for the Taino culture was apparently most highly developed on that island.

It should be reemphasized that the problem is not merely an academic one. Workers of the Rockefeller Foundation discovered that an orderly natural classification of the races of maize in Mexico was a necessary prerequisite to an intelligent breeding program in that country. When similar programs are initiated in some other countries of Latin America, studies of the taxonomy of corn may no longer be practicable.

SUMMARY

1. Widespread intervarietal hybridization, which introduced unforeseen complications in the study of Cuban maize, has led to modifications in the concept of race. In order to eliminate chance segregates and recent mixtures from consideration, a race of maize is defined as a group of one or more populations of true-breeding individuals with a number of significant characteristics in common. In addition, its recognition as an agricultural variety by the people who grow it should be taken into consideration.

2. True-breeding stocks of material collected in central and eastern Cuba in 1953 were studied with respect to vegetative, tassel, cytological, and physiological characters. Studies of these and later collections and interviews with more than seventy-one Cuban farmers have made it possible to describe seven races of Cuban maize.

3. Three commercial races, Maíz Criollo, Canilla, and Tusón, were probably carried to Cuba by the West Indian Arawak between 1200 and 1440 A.D. Historical evidence indicates that a fourth commercial race, Maíz Argentino, an orange-yellow flint, is a recent introduction from Argentina.

4. Two popcorns, which are grown on a limited scale for domestic consumption only, are undoubtedly recent introductions from the United States. A white dent corn found in one town in Oriente province seems identical with the Mexican Zapalote Chico and may be a recent introduction.

5. Interviews conducted by questionnaire with sixty-seven Cuban farmers indicate that hybridization and selection for the racial types described in this paper are dominant in the contemporary evolution of Cuban maize. These processes tend to produce plants which are very similar in vegetative, tassel, cytological, and physiological characters but which differ strikingly in the ears which they produce.

LITERATURE CITED

1. Anderson, E. Field studies of Guatemalan maize. Ann. Mo. Bot. Gard. 34: 433–467. 1947.
2. —— and W. L. Brown. The history of the common maize varieties of the United States corn belt. Agr. Hist. 26: 2–8. 1952.
3. —— and H. C. Cutler. Races of *Zea Mays*: I. Their recognition and classification. Ann. Mo. Bot. Gard. 29: 69–88. 1942.
4. Bachiller y Morales, A. Prontuario de agricultura general, para el uso de los labradores i hacendados de la isla de Cuba. Barcina, La Habana. 1856.
5. Bennett, H. H., and R. V. Allison. The soils of Cuba. Trop. Plant Res. Found. Washington, D. C. 1928.
6. Birket-Smith, K. The origin of maize cultivation. Kgl. Danske Videnskabernes Selskab, Hist-Filol. Meddel. 29[3]: 1–49. 1943.
7. British Colour Council, in collaboration with the Royal Horticultural Society. Horticultural Colour Chart. Henry Stone & Son, Ltd. Banbury, Great Britain. 1939, 1942.
8. Brown, W. L. Maize of the West Indies. Trop. Agric. 30: 141–170. 1953.
9. Chamberlain, T. W. Rainfall maps of Cuba. Monthly Weather Rev. 68: 4–10. 1940.
10. Colombo, Cristoforo. Giornale di bordo, 1492–93, secondo il riassunto autografo del Las Casas. *In* De Lollis, C., ed. Scritti di Cristoforo Colombo. Raccolta di Documenti e Studi pubblicati dalla R. Commissione Colombiana. Pt. 1, Vol. 1: 1–119. 1892.
11. Cuba. Ministerio de Agricultura. Memoria del censo agrícola nacional, 1946. Fernández, La Habana. 1951.
12. ——. Secretaría de Hacienda. Sección de Estadística. Comercio Exterior (Importaciones de maíz en grano). 1916–30.
13. Culin, S. The Indians of Cuba. Bull. Free Mus. Sci. and Art (Univ. Penna.) 3: 185–226. 1902.
14. Cutler, H. C. Races of maize in South America. Leafl. Bot. Mus. Harv. Univ. 12: 257–292. 1946.
15. Del Valle, C. G. Tipos cubanos de maíz. Revista de Agricultura (Minist. de Agr. de la Rep. de Cuba). Agosto-Sept.: 109–119. 1936.
16. ——. Estudios genéticos sobre el maíz. Estac. Exp. Agron. Santiago de las Vegas (Cuba). Bol. No. 61. 1944.
17. ——. Tipos cubanos de maíz. II. El maíz dulce. Estac. Exp. Agron. Santiago de las Vegas (Cuba). Bol. No. 62. 1945.
18. ——. La obtención de un híbrido de maíz comercial en Cuba.

Estac. Exp. Agron. Santiago de las Vegas (Cuba). Bol. No. 69. 1952.

19. ——— y E. Hidalgo Gato. El maíz de rosita. Estac. Exp. Agron. Santiago de las Vegas (Cuba). Bol. No. 71. 1954.
20. Eden, W. G. Effects of kernel characteristics and components of husk cover on rice weevil damage to corn. Jour. Econ. Ent. 45: 1084–1085. 1952.
21. Farabee, W. C. The central Arawaks. Univ. Penna., Univ. Mus., Anthrop. Publ., Vol. 9. 1918.
22. Grey, R. M. Report of the Harvard Botanical Gardens, Soledad Estate, Cienfuegos, Cuba (Atkins Foundation). 1900–1926. Harvard Univ. Press, Cambridge, Mass. 1927.
23. Gumilla, J. Historia natural, civil, y geográfica de las naciones situadas en las riberas del río Orinoco. C. Gilbert y Tuto, Barcelona. 2 Vols. 1791. First published, Madrid, 1741.
24. Hernández X., E. Report to Dr. J. G. Harrar, Director of the Rockefeller Foundation Agricultural Program in Mexico. April 1, 1949.
25. Komarek, E. V., ed. Florida Corn. (Chapters 7–16 of Original). State of Florida. Department of Agriculture. 1951.
26. Kuleshov, N. N. The maize of Mexico, Guatemala, Cuba, Panama and Colombia. *In* Bukasov, S. M. The cultivated plants of Mexico, Guatemala and Colombia. Bull. Appl. Bot. Gen., and Pl. Breeding, Supplement No. 47: 492–501. 1930.
27. Las Casas, Bartolomé de. Apologética historia de las Indias. M. Serrano y Saenz, ed. *In* Nueva Biblioteca de Autores Españoles, Vol. 13. Bailly, Bailliere e hijos, Madrid. 1909. Manuscript begun about 1527.
28. ———. Historia de las Indias. A. Millares Carlo, ed. 3 Vols. Fondo de Cultura Económica, Mexico, D. F. 1951. First published, Madrid, 1875–76. Manuscript begun about 1527.
29. La Sagra, R. de. Historia económico-política y estadística de la isla de Cuba. Viudas de Arazoza y Soler, Habana. 1831.
30. Lenz, L. W. Comparative histology of the female inflorescence of *Zea Mays* L. Ann. Mo. Bot. Gard. 35: 353–376. 1948.
31. Lovén, S. Origins of the Tainan culture, West Indies. Elanders boktryckeri aktiebolag, Goteborg. 1935.
32. Marrero, L. Geografía de Cuba. Alfa, La Habana. 1950.
33. Morison, S. E. Admiral of the ocean sea; a life of Christopher Columbus. Little, Brown & Co. Boston. 2 Vols. 1942.
34. Oviedo y Valdés, G. F. de. Historia general y natural de las Indias, islas y tierra-firme. José Amador de los Ríos, ed. Real Academia de la Historia, Madrid. 1851–55. First published, Sevilla, 1535.

35. Parodi, L. R. Los maíces indígenas de la República Argentina. Anales de la Acad. Nac. de C. E. F. y N. de Buenos Aires 12: 9–14. 1948.
36. Reynoso, A. Consideraciones respecto de los abonos dirigidas a los agricultores cubanos. M. Rivadeneyra, Madrid. 1867.
37. ——. Apuntes acerca de varios cultivos cubanos. Madrid. 1867.
38. ——. Notas acerca del cultivo en camellones; agricultura de los Indígenas de Cuba y Haití. E. Leroux, Paris. 1881.
39. Rouse, I. The Arawak. *In* Julian H. Steward, ed. Handbook of South American Indians. Vol. 4, The Circum-Caribbean Tribes: 507–539; 542–546. Smithsonian Inst. Bur. Amer. Ethnol. Bull. 143. Washington, D. C. 1948.
40. ——. The southeast and the West Indies. *In* Griffin, John W., ed. The Florida Indian and His Neighbors: 117–137. Rollins College, Winter Park, Florida. 1949.
41. Shideler, F. J. El maíz amarillo cubano. Revista de Agricultura (Minist. de Agr. de la Rep. de Cuba) Marzo-Agosto: 60–64. 1954.
42. Sturtevant, E. L. Varieties of corn. U. S. Dept. Agr. Off. Exp. Sta. Bull. 57: 1–108. 1889.
43. Vásquez de Espinosa, A. Compendium and description of the West Indies. trans. by Charles Upson Clark. Smithsonian Inst. Washington, Misc. Coll., Vol. 102. 1942. Manuscript written before 1630.
44. Weatherwax, P. Indian corn in old America. The Macmillan Co. New York. 1954.
45. Wellhausen, E. J., L. M. Roberts, and E. Hernández X. in collaboration with P. C. Mangelsdorf. Races of maize in Mexico. Their origin, characteristics and distribution. Bussey Institution of Harvard University, Cambridge, Mass. 1952.

APPENDIX

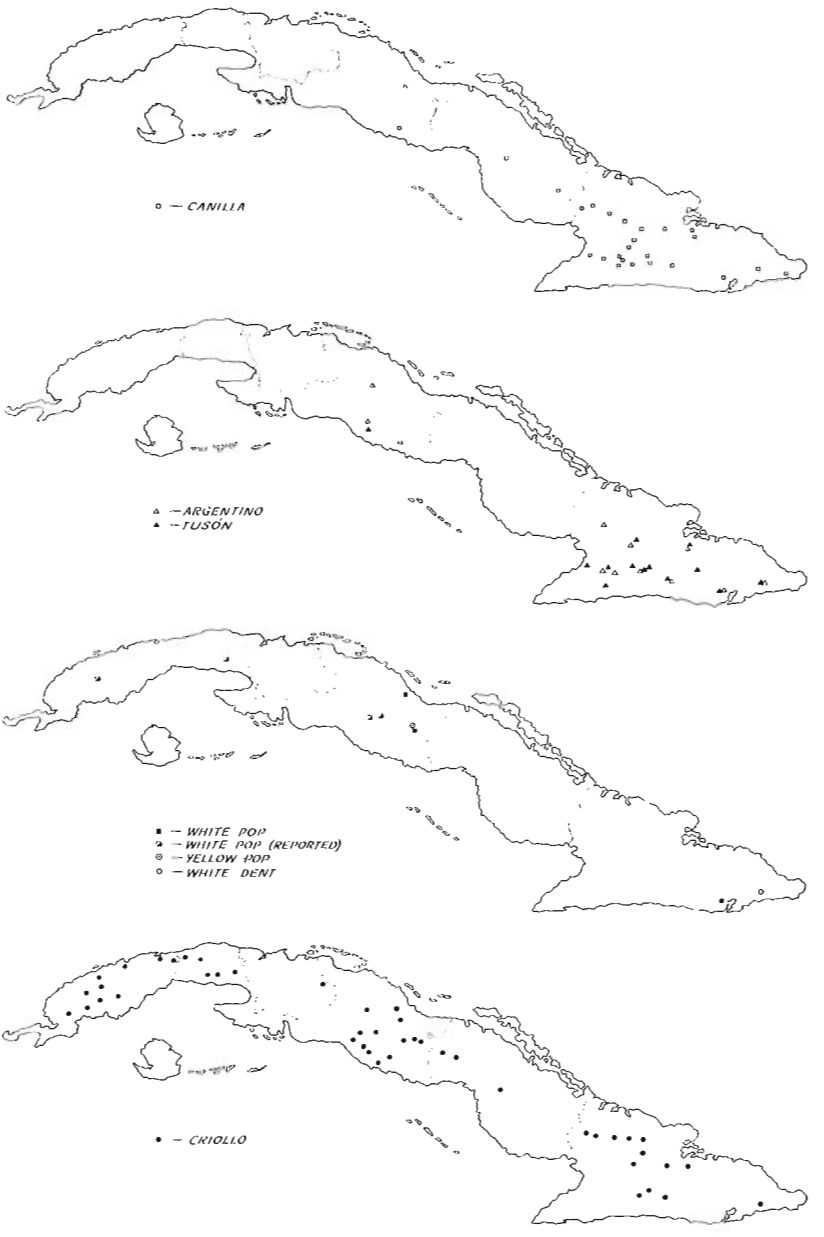

FIG. 16. Distributions of races of Cuban maize.

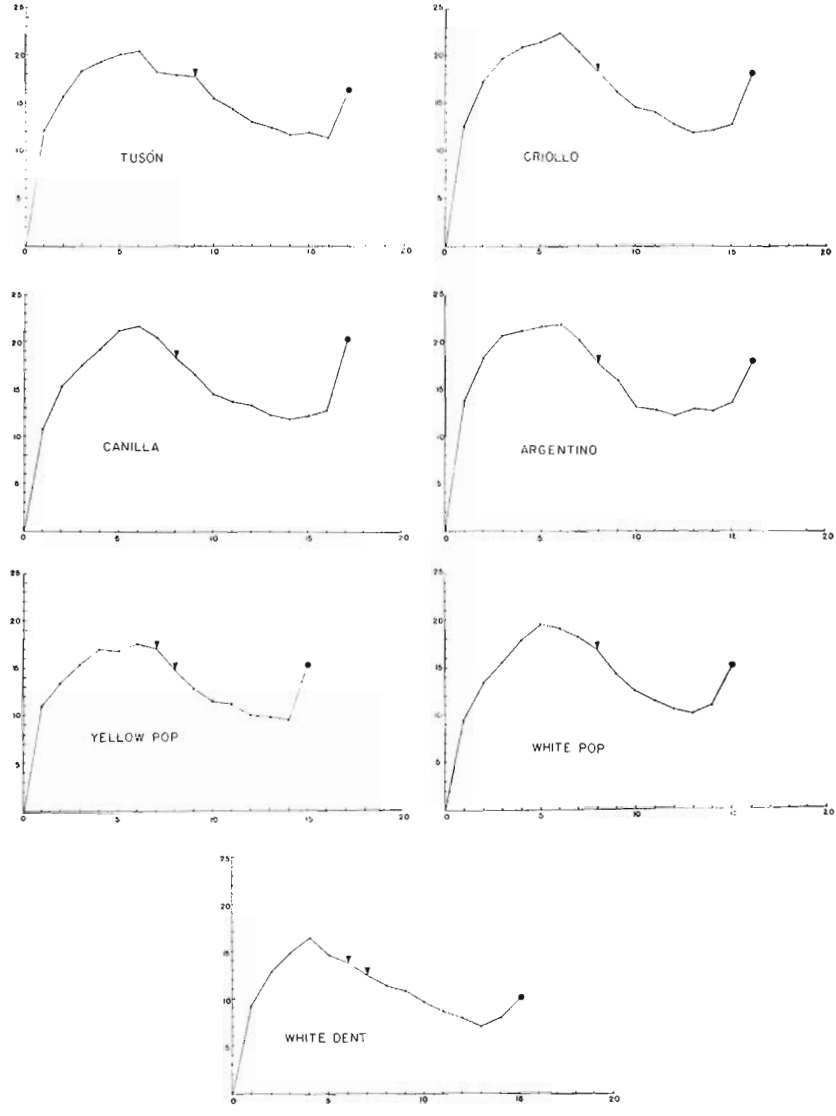

FIG. 17. Internode patterns. Vertical axis represents length of internodes in centimeters. Horizontal axis represents number of nodes. Positions of ears are indicated by triangles, tassels by circles.

TABLE 15. CHARACTERS OF THE PLANTS

	White Pop	*Yellow Pop*	*White Dent*	*Canilla*	*Tusón*	*Criollo*	*Argentino*
Number of stocks studied	10	9	4	8	3	18	14
Sample size	99	44	22	41	25	65	36
Height (m.)	1.97	1.90	1.58	2.58	2.60	2.62	2.64
Total number of leaves	12.70	13.10	13.50	14.50	15.20	14.10	13.80
Number of leaves above ear	5.88	5.97	6.82	6.80	6.60	6.50	6.24
Sample size	122	47	22	49	24	79	41
Width leaves (cm.)	8.58	9.83	7.88	9.98	11.10	10.96	10.22
Length leaves (cm.)	84.20	80.10	83.30	96.90	103.00	98.50	95.00
Length/width index	9.83	8.20	10.60	9.77	9.29	9.05	9.50
Venation index	3.12	2.55	3.27	2.88	2.77	2.68	2.99

TABLE 16. CHARACTERS OF THE TASSELS

	White Pop	*Yellow Pop*	*White Dent*	*Canilla*	*Tusón*	*Criollo*	*Argentino*
Number of stocks studied	10	9	4	9	3	18	14
Sample size	118	46	17	45	24	73	41
Length (cm.)							
Tassel	34.20	33.90	33.40	41.70	45.50	42.60	39.40
Peduncle	14.80	15.00	10.00	20.00	16.00	17.80	17.60
Branching space							
Length (cm.)	13.80	13.30	11.30	17.60	21.30	17.60	17.50
Per cent	40.00	39.20	35.80	42.70	46.80	41.20	44.50
Branches							
Number	26.20	35.00	20.10	28.00	41.30	31.20	34.60
Secondary (%)	17.50	32.40	15.40	28.00	33.30	27.60	25.80
Tertiary (%)	0.04	1.56	0.00	1.46	3.57	0.67	0.96
Condensation index	1.07	1.18	1.06	1.13	1.11	1.17	1.23

TABLE 17. EXTERNAL CHARACTERS OF THE EARS

	White Pop	*Yellow Pop*	*White Dent*	*Canilla*	*Tusón*	*Criollo*	*Argentino*
Number of stocks studied	10	9	4	9	3	18	14
Sample size	51	33	13	38	18	55	28
Number of husks	15.64	16.20	12.04	15.60	14.70	15.60	13.90
Length 6th husk (cm.)	20.50	21.20	20.30	26.90	27.00	25.90	23.50
Length shank (cm.)	7.02	6.78	8.55	12.80	10.40	10.40	8.80
Sample size	25	30	6	25	25	25	25
Length ear (cm.)	11.40	11.10	11.00	20.60	18.13	19.01	17.17
Diam. ear (mm.)	36.90	30.20	36.80	38.00	52.30	49.46	41.22
Number of rows	13.70	14.10	10.20	13.40	15.36	14.87	13.04
Kernel characters							
Length (mm.)	8.77	8.41	9.70	11.10	12.40	10.99	9.75
Width (mm.)	7.50	6.10	9.30	7.84	9.29	9.12	8.66
Thickness (mm.)	3.54	3.69	4.45	4.18	3.79	4.13	3.99
Denting	0.00	0.00	1 70	2.50	3.10	1.20	0.00
Striations, rows	10.40	3.80	2.30	2.00	2.20	2.60	7.00

TABLE 18. INTERNAL CHARACTERS OF THE EARS

	White Pop	*Yellow Pop*	*White Dent*	*Canilla*	*Tusón*	*Criollo*	*Argentino*
Number of stocks studied	10	9	4	9	3	18	14
Sample size	25	30	6	25	25	25	25
Diam. ear (mm.)	36.90	30.20	36.80	38.00	52.30	49.46	41.22
Diam. cob (mm.)	26.90	20.50	22.40	23.20	32.58	33.55	28.75
Diam. rachis (mm.)	14.40	10.30	12.70	11.32	20.75	20.14	17.01
Diam. pith (mm.)	7.40	5.60	6.80	7.33	12.02	11.10	9.50
Thickness of schlerenchyma zone (mm.)	3.36	2.30	2.93	1.95	4.37	4.53	3.75
Diam. shank (mm.)	10.60	9.60	11.60	11.41	15.23	15.76	13.40
Kernel length (mm.)	8.80	8.40	9.70	11.07	12.36	10.99	9.75
Rachilla length (mm.)	2.57	1.58	2.38	2.62	3.43	3.17	2.41
Glume length (mm.)	6.25	5.08	4.86	5.92	6.43	6.72	5.87
Cupule width (mm.)	4.78	3.16	5.58	3.99	5.69	5.24	5.61
Cupule height (mm.)	0.58	0.81	0.30	1.71	0.77	0.81	0.82
Cupule depth (mm.)	1.12	0.84	1.38	1.03	0.91	1.04	0.99
Rachis flap length (mm.)	1.31	0.83	1.35	0.94	1.79	2.17	1.77
Indices							
Ear length/rachis	8.05	11.40	8.81	18.65	8.82	9.55	10.22
Cob/rachis	1.89	2.04	1.78	2.08	1.62	1.67	1.70
Glume/kernel	0.72	0.61	0.50	0.54	0.52	0.62	0.60
Rachilla/kernel	0.30	0.19	0.24	0.21	0.28	0.29	0.25
Rachilla/glume	0.41	0.31	0.49	0.38	0.53	0.47	0.41
Cupule width/height	8.25	3.90	18.60	2.33	7.37	6.44	6.85

TABLE 19. PHYSIOLOGICAL, CYTOLOGICAL, AND GENETIC CHARACTERS

	White Pop	*Yellow Pop*	*White Dent*	*Canilla*	*Tusón*	*Criollo*	*Argentino*
Number of stocks studied	10	9	5	8	3	18	14
Sample size	142	50	26	46	32	82	46
Color	1.86	2.54	1.68	1.56	2.36	2.04	1.75
Pilosity	1.62	4.39	1.73	1.85	2.52	2.06	1.95
Rust	1.80	2.61	2.15	2.38	2.28	2.64	2.57
Maturity	58	56	61	61	61	61	59
Knobs							
Plants studied	2	3	2	5	4	5	7
Range	—	8–11	6–8	5–9	5–7	6–7	6–9
Average number	6.0	9.7	7.0	7.0	6.0	6.8	7.0
Midcob color (%)		not studied		32.2	35.6	34.4	28.6
Pericarp color (P^{cw}) (%)		not studied		27.6	27.8	18.2	13.3
Glume color (%)		not studied		51.3	41.5	50.3	19.0
Lemma color (%)		not studied		3.3	1.0	3.0	1.0
Sample size		not studied		152	306	428	105

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