RACES OF MAIZE IN COLOMBIA

L. M. Roberts
U. J. Grant
Ricardo Ramirez E.
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in collaboration with
Paul C. Mangelsdorf

NATIONAL ACADEMY OF SCIENCES—
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INTRODUCTION

Early in 1950 the Colombian Ministry of Agriculture, seeking to improve the basic food plants of the country, established, in cooperation with the Rockefeller Foundation, a program of corn improvement. Since plant breeders, like engineers, to proceed effectively, must have an adequate knowledge of the extent and nature of the materials with which they work, it was necessary, as a first step in the improvement program, to assemble and to study and evaluate the native varieties of maize of Colombia.

At about the same time the National Research Council of the United States began to concern itself with the problem of collecting and preserving the indigenous maize varieties in other countries of this hemisphere. Experience in the United States had shown that as new hybrid types and improved varieties of maize are developed and distributed, they tend to replace the open-pollinated varieties formerly grown. In some states, notably Iowa, where more than 99 per cent of the corn acreage is occupied by hybrid corn, the original open-pollinated varieties have virtually disappeared from farmers' fields. If this were to happen generally, the results might well be disastrous. Maize is the basic food plant of the Americas and its diversity, the product of thousands of years of evolution under domestication, is one of

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the important natural resources of this hemisphere. Losing any substantial part of that diversity may not only restrict the opportunities for future improvement, but may also increase the difficulties of coping with future climatic changes or with new diseases or insect pests. To improve the maize of this generation at the expense of losing valuable germplasm needed by future generations would indeed be a short-sighted policy.

With funds obtained from the Technical Cooperation Administration (Point Four), the National Research Council undertook to augment the collecting programs already started at centers in Mexico and Colombia and to broaden their scope to include adjoining countries. A third center was established in Brazil. The Colombian center, at Medellín, maintained cooperatively by the Colombian Ministry of Agriculture, the Rockefeller Foundation and the National Research Council, was assigned the task of collecting maize in Colombia, Venezuela, Ecuador, Peru, Bolivia and Chile. In this it has had the enthusiastic cooperation of agricultural scientists in each of these countries.

This monograph is concerned only with the races of maize of Colombia. However, the distribution of maize ignores national boundaries. Some of the races of maize now grown in Colombia have been introduced from elsewhere while others which have originated in this country have diffused to other regions. Consequently the study of the Colombian races was greatly facilitated by having access to the collections from other countries. Indeed, only by consulting these has it been possible to understand and to describe the diversity of maize in Colombia.

The Colombian collection now comprises 1,999 entries. To assemble these, two full-time collectors travelled the country from end to end. All parts of Colombia except the lowland jungles, where little maize is grown, have been covered at least once. The more important maize-growing regions have been sampled at least twice. In addition, when an especially interesting, but not widely distributed, race has appeared in the collections, special trips were made to enlarge the collections of this race. This has been particularly true of primitive races which are no longer extensively grown. It is believed that the diversity of maize in Colombia has been thoroughly sampled and it is doubtful that many, if any, additional races will be discovered.

Before describing the races of maize in Colombia it seems desirable to discuss the geographic, climatic and cultural conditions under which they were formed and to consider some of the evolutionary factors involved in their formation.

GEOGRAPHY AND CLIMATE OF COLOMBIA

Colombia is a mountainous, tropical country. This combination is largely responsible for the tremendous diversity in ecological conditions, which in turn accounts for the great range in variation in flora and fauna, both wild and domesticated, which characterizes this small country. It has a total area of 439,519 square miles (slightly smaller than the size of the states of California and Texas combined), but the biological diversity found within its boundaries is very impressive. Great diversity is characteristic of all mountainous tropical countries, but the extremely rugged terrain of Colombia together with the fact that it is situated astride the equator (4° South to 13° North), make for conditions that have given rise to a degree of biological variation that is probably not surpassed in any other country of the world.

A general impression of the principal geographic features of the country can be obtained from the schematic map in Figure 1. The principal geographic feature lies in the fact that the Andean mountain chain divides into three ranges near the southern boundary. These three ranges with the two principal river valleys between them, the Magdalena and the Cauca, occupy slightly less than 50 per cent of the total area of the country. More than 98 per cent of the entire population lives in this area that lies to the western part of the country. The vast expanse of level land situated to the east of the easternmost mountain range is very sparsely populated and is divided climatically and ecologically into two distinct zones; more than half of this vast area to the south of the Amazon and Orinoco drainage basins, a part of the upper headwaters (shown on the map in Figure 1 as the darkly shaded area) is in tropical rain forest; the lighter-shaded part of the map to the north of this area is covered by prairie grassland

FIG. 1. Map of Colombia showing schematically the five natural geographic regions and the localities at which the maize collections were grown for study. For detailed description of the regions, see text.

and is named "Los Llanos" (The Plains). The amount of cultivated crops in this entire, immense region is now very limited and this has probably always been so, even in prehistoric times. Another region that is ecologically unsuitable for human population is the narrow coastal plain situated along the Pacific Ocean west of the westernmost mountain range. The watershed is covered by a typical tropical rain forest.

As previously stated, the great majority of the population is concentrated on the slopes of the three mountain ranges and in the almost infinite number of valleys interspread among them, primarily because high elevations are more salubrious than lowlands in a tropical country. Only in recent years has there been an evident tendency for a population migration from the highlands to low elevations, and this has been stimulated by population pressures as well as advances in knowledge of medicine and public health that have permitted the populace better to cope with the hazards of such common diseases as yellow fever and malaria.

Areas in relatively close proximity in the mountainous region are often rather completely isolated from each other because of topographical barriers. For example, it now takes only 55 minutes to go from Medellín to Bogotá by plane, whereas only thirty years ago this trip required approximately a month on muleback over mountain trails.

The mountainous terrain not only has produced a high degree of geographic isolation but also has provided extremely varied climatic conditions, which have also isolated races of maize one from another. For general purposes Colombia is traditionally divided into four climatic zones largely on the basis of temperature, which in tropical countries of considerable relief is almost directly related to altitude. These are (1) "Clima Cálido" (Hot Climatic zone) 0–800 meters, (2) "Clima Medio" (Temperate Climatic zone) 800–1,800 meters, (3) "Clima Frío" (Cold Climatic zone) 1,800–3,000 meters, and (4) "Páramo" (Extremely Cold Climate above timber line) 3,000 meters and above. Agricultural crops are grown almost entirely in the first three of these zones. Clima Cálido is a zone of tropical agriculture. The principal crops are maize, sugar cane, cotton, rice, cassava, and plantains. Clima Medio is especially well adapted to the production of coffee, maize and cacao. The Clima Frío zone is adapted to the production of maize, barley, wheat and potatoes. Except for potatoes and a small amount of rye, there are almost no agricultural crops in the Páramo.

As pointed out by Wellhausen *et al* (1952), races of maize vary in adaptation to altitude. Some are quite restricted in this respect while others are much more flexible. This flexibility permits the geographical overlap of the different races that are best adapted to one or the other of the climatic zones, although each individual race will prosper less when moved outside of the limits of the zone to which it is adapted. Experimental results from the practical corn improvement program have shown that a race adapted to Clima Cálido shows extreme lack of adaptation above 1,800 meters, and usually produces no seed. Similarly, a race adapted to Clima Frío reaches the lower limit at which it will produce seed at about 1,000 meters.

Colombia can be divided into five natural regions: The western coastal plain; the northern coastal plain with the two principal river valleys extending inland; the mountainous region; the Llanos; and the tropical rain forest region in the southeastern part of the country. Rainfall varies greatly both in amount and distribution in these different regions.

The Guajira peninsula of the northern coastal plain is extremely arid, receiving approximately 15 inches of rainfall annually, whereas the western coastal plain, which has more than 400 inches of rainfall a year in certain localities, is one of the highest rainfall regions of the world. The mountainous region is generally well favored with respect to precipitation, receiving on the average approximately 30 to 50 inches of rainfall fairly well distributed throughout the year. Two rainy seasons normally occur, alternating with two dry seasons. The rainy seasons ordinarily extend from about March 15 to July 15 and from approximately September 15 to December 15. The change between the wet and dry seasons is not abrupt and the dry seasons are usually never completely devoid of a certain amount of rainfall. The Llanos receive approximately 100 inches of rain annually, most of which falls during the rainy season from April to September. The alternate season is usually very dry. The tropical rain forest in the southeastern part of the country receives a heavy and more or less continuous rainfall throughout the year. The records from this region are scanty but they indicate that the average annual precipitation is from 150 to 200 inches and that this falls mostly during the months of March to October.

The geographical location of Colombia is of interest especially in relation to the bearing this has had on the migration of both pre- and post-Columbian man. Colombia is situated at the northwest tip of South America, adjacent to Panamá. This has made it a natural crossroads between the North and South American continents, and indeed, as Bennett (1948) has stated, "historically Colombian cultures reflect the marginal position (of Colombia) to the Peruvian Andes and to Central America." The influence of migrating Indian tribes, some of which appear to have carried maize during their wanderings, is not difficult to discern in some Colombian maize.

COLOMBIAN INDIAN GROUPS AND THEIR AGRICULTURE

Four major groups of Indian cultures were discovered in Colombia by the early Spanish explorers. The most advanced of these was the famous Chibchan civilization, centered in the eastern cordillera in the present Departments of Cundinamarca and Boyacá. A second group of major importance consisted of many Carib tribes which had extended their conquests inland from the Atlantic coast well up the Cauca and Magdalena river systems. Arawak tribes occupied a small part of the Caribbean coast and had moved up the Orinoco basin to make contact in the foothills of the Andes with the highland Chibchan Indians. Finally, in the south the rapidly expanding Incan empire had extended its borders to include part of the present Colombian department of Nariño.

Although the Chibchan civilization reached its highest development in the region around the present capital city of Bogotá, Chibchan culture was much more widespread. The linguistic affinities of the Indian tribes of Panamá, Costa Rica, and much of Nicaragua were chiefly Chibchan. In southern Colombia the Barbacoa and other tribes belonging to Chibchan linguistic groups extended from the mountains of central Ecuador northward to the Pacific coast and inland along both western and eastern cordilleras. The Quimbaya of the present Departments of Caldas and Antioquia, whose ceramics and gold objects are famous, may have had Chibchan affinities. In the isolated high Sierra Nevada de Santa Marta many tribes still speak Chibchan languages.

The disjunct distributions of the pre-conquest Chibcha suggest an ancient, relatively uniform distribution of Chibchan-speaking tribes scattered throughout highland Colombia and extending to Guatemala in the north and central Ecuador in the south. Trade and other cultural contact between Chibchan groups was interrupted by invasion of Carib tribes, and the high level of political integration achieved in the savannas of the eastern cordillera seems to have affected other Chibchan-speaking cultures very slightly, if at all. Trade in gold, salt and cotton between the Chibchan civilization of the eastern cordillera and neighboring tribes continued to be active, however, and there appears to be strong evidence of commerce in gold objects between the present Department of Antioquia and the region of Panamá (Duque Gómez, personal communication).

The agriculture of the highland Chibcha appears to have been based on maize and a number of Andean crops which have their centers of distribution to the south in Ecuador, Peru and Bolivia (Sauer, 1948). Among the important staples of the Chibcha were potatoes, quinoa *(Chenopodium quinoa)*, cubio *(Tropaeloum tuberosum)*, oca *(Oxalis tuberosa)*, beans, squashes, tomatoes, peppers, coca, and tobacco. The center of origin of some types of corn probably grown by the Chibcha also appears to be south of Colombia. The common flour corn of the savanna of Bogotá, for example, resembles more southern types in some respects. Thus the influence of Central Andean civilizations on Chibchan agriculture appears to have been considerable.

The agriculture of the Carib and Arawak tribes of the Atlantic coast and the Cauca and Magdalena valleys was based on crops adapted to warmer climates, such as cassava *(Manihot utilis-*

sima), beans, sweet potatoes, cotton, peppers *(Capsicum spp.)*, avocadoes, cacao, tobacco and maize (Robledo, 1916). Certain varieties of maize grown by the Colombian Arawak are essentially identical to those grown by the coastal Venezuelan and Antillean Arawak (Brown, 1953; Hatheway, 1957) and may represent pre-Columbian introductions to Colombia. Carib races of maize outside Colombia are little known, except in the Lesser Antilles, but it is possible that they, too, were introduced to Colombia from coastal areas to the east. In both Arawak and Carib cultures cassava was the basic crop, with maize occupying a decidedly secondary role.

Of special interest is the occurrence in Colombia of certain races of maize identical in many respects to Mexican races considered pre-Columbian introductions to that country (Wellhausen *et al*, 1952). These include a sweet corn, a long-eared flint, and at least two types of flour corn. The existence of Chibchan linguistic groups from Ecuador to central Nicaragua makes such discontinuous distributions not altogether surprising and suggests that careful collections in the highlands of Honduras, Nicaragua, Costa Rica and Panamá may eventually fill in present gaps.

THE ANTIQUITY OF MAIZE IN COLOMBIA

Maize is undoubtedly an ancient plant in this hemisphere. The earliest evidence of its existence is found in fossil pollen grains, discovered in drill cores at more than 70 meters below the present site of Mexico City, which have been identified and described by Barghoorn, Wolfe, and Clisby (1954). Since there is no evidence that man had reached this hemisphere at the time represented by the fossil pollen (estimated to be at least 60,000 years ago), the latter is probably that of a wild maize which once grew in the Valley of Mexico. This pollen does not prove that the domestication of maize originated in Mexico but it leaves little doubt that it originated in this hemisphere.

The earliest remains of cultivated maize are much more recent, but still quite ancient. Archaeological specimens of cobs of maize, dated by radiocarbon determinations at more than 5,000 years, have been found in Bat Cave in New Mexico (Mangelsdorf and

Smith, 1949). Similar specimens from La Perra Cave in northeastern Mexico, dated at 4,450 years, have been described by Mangelsdorf, MacNeish, and Galinat (1956). In South America the oldest archaeological maize, so far discovered, comes from the excavations at Huaca Prieta on the coast of Peru (Bird, 1948) and is dated at about 2,900 years.

In both Peru and Mexico there is additional evidence of the antiquity of maize in the representations on prehistoric funerary urns. Many of these are cast from molds of actual ears and these are invaluable in showing the kinds of maize which were grown when the urns were made.

In contrast to Mexico and Peru, evidence of the antiquity of maize in Colombia is conspicuous by its absence. The only known archaeological remains of maize consist of a single cob found in 1946 at the famous site at San Agustín, in the upper Magdalena Valley, by Duque Gómez (personal communication). His notes indicate that the specimen, unfortunately lost, was similar to Pira, a race of popcorn still grown in that region. No objects closely resembling ears or other parts of the maize plant have been found on the prehistoric pottery or on the superb gold ornaments that are so characteristic of the Colombian cultures and on which lizards and other indigenous animals are frequently depicted.

Interest in the antiquity of Colombian corn, however, has been stimulated by Birket-Smith's conclusion (1943) based primarily on linguistic evidence, that the lower Magdalena valley may have been the center of origin of maize domestication. Reichel-Dolmatoff (1948) stated the archaeological studies have demonstrated a former advanced state of agriculture, including terraces and irrigation, among the Tairona Indians of the Sierra Nevada de Santa Marta. He concluded that these facts, coupled with the presence there of certain artifacts widely distributed in the Americas and a generally high level of culture, tend to support Birket-Smith's hypothesis. Mesa (1955, 1956) has carefully reviewed the botanical and historical evidence for a Colombian origin of maize, and has concluded that additional factors supporting Birket-Smith's hypothesis are the existence in Colombia of three primitive races of maize, two of which are precocious;

the discovery of maize in Colombia by the earliest Spanish conquistadores; a favorable climate; and the considerable differentiation of maize in Colombia.

Morphological and cytological studies presented in some detail below indicate that only one of the relatively primitive races found in Colombia could possibly be considered wild corn which has undergone slight modification under domestication. Such evidence, however, is at best only faintly suggestive. Nevertheless, any critical examination of Birket-Smith's hypothesis should await careful archaeological exploration in eastern Boyacá and Cundinamarca, where the race is endemic. It should be noted that these departments are somewhat remote from the lower Magdalena valley, Birket-Smith's postulated center of origin of maize domestication.

The only compelling reasons for believing that maize may be of considerable antiquity in Colombia are those based on cultural and linguistic considerations. Unfortunately, the actual antiquity of the indigenous Colombian cultures is not known. Perhaps they were more recent than those of Mexico and Peru. Perhaps, because of the abundance of root crops, maize was less important as a food plant in Colombia than in other regions. Whatever the reason, it is a fact that there is virtually no evidence available on the antiquity of maize in Colombia or on the races which were grown. The lack of such evidence has made it difficult to determine with any degree of finality the origin and relationships of the majority of Colombian races.

WHERE MAIZE IS GROWN IN COLOMBIA

Except for regions in the lowland jungles, which either are not inhabited or are sparsely peopled by non-agricultural Indians, maize is grown in all parts of the country. It occurs from sea level in the western and northern coastal regions to altitudes of more than 10,000 feet in the high sierras. It is grown under conditions of low rainfall in the Guajira peninsula and at the other extreme in the Department of Chocó which has one of the highest rainfalls in the world.

The bulk of the corn is grown in the mountainous regions and in the two principal river valleys between them where the human population is concentrated (Fig. 1). The rugged terrain of this region has been an important factor in the differentiation of the many races of maize found in Colombia.

In 1950, approximately 75 per cent of the maize production was in the Departments of Cundinamarca, Antioquia, Boyacá, Bolivar, Nariño, Valle and Magdalena. Of this, the major part was grown in small fields on mountainous terrain. Maize occupies about the same total land area as coffee and it is second in importance in value, representing about 9.5 per cent of the total value of the agricultural crops of the country (Palacio del Valle, 1952).

The traditional pattern of concentrating corn production in the highlands is now rapidly changing. Recently, the trend has been to grow more and more corn at the lower elevations. This has been especially true in the Cauca valley and throughout the northern coastal plain. Vast grassland regions of the Sinu River valley of the northern coastal plain are now being planted to cotton and corn. Large areas in the upper Magdalena valley which were once grazing lands are now being used. Forested areas in the Department of Magdalena are being cleared and utilized. Simultaneously, with the increase of the demand for land at the higher elevations and the improvement of health conditions in the lowlands the agricultural population is shifting to the lower altitudes for its intensified corn production.

With the movement toward the lowlands the mode of cultivation is changing rapidly. For example, it is not now uncommon to see extensions of thousands of acres of corn planted in the Cauca valley where only small fields of a few acres in size were seen only five years ago. With this change to the lower flat areas mechanization is increasing rapidly, and the complete economy of maize production is being greatly affected. Not only can maize be produced more cheaply with machinery than with human labor in Colombia, but also it can be produced in a much shorter period of time. A crop of corn can be produced at sea level in approximately four months, while a crop may take up to sixteen months to develop at elevations near the Páramo. Two crops per year can be produced at elevations of about 1,500 meters. Above these elevations the time from planting to maturity is too great for more than one crop.

This changing pattern of maize production in Colombia has already had a marked effect on the distribution of the races of maize.

The distribution maps seen later in this monograph are incomplete to the extent that only the "pure" collections are shown and the places where introgression occurs are not evident. It can be stated, however, that in almost every instance where the "pure" collections overlap at least some mixture has occurred.

FACTORS INVOLVED IN THE EVOLUTION OF MAIZE IN COLOMBIA

Birket-Smith (1943), as mentioned above, has suggested that the cultivation of maize may have originated in Colombia. His argument is based largely on evidence from linguistics. In Colombia are found names associated with maize, its culture and uses, some of which are "primitive" and which have affinities with those of Central America, Ecuador, Peru, Venezuela and the South American lowlands. But this situation might also have occurred if this region had been, not a center of origin, but a crossroads, in which the cultures of Central America, the Andean highlands and the South American lowlands converged. The evidence from races of maize in Colombia tends to support the latter interpretation.

Of the twenty-three races of maize recognized in Colombia, only two, Pollo and Pira, are primitive. Pollo has a limited distribution on the eastern slopes of the eastern cordillera in Boyacá and Cundinamarca. It may be an ancient indigenous race, endemic to Colombia. However, since Pollo resembles rather closely a race in Peru, Confite Morocho, it may be no more than an early introduction into Colombia of a race which has never spread widely nor played any substantial part in the evolution of other Colombian races. Pira (or types resembling it) is found in Venezuela and Bolivia. There is no evidence that this race had its center of origin in Colombia, or that it has played a large part in the formation of other races in Colombia.

Of the remaining races, several others, especially Sabanero, Cabuya, Andaquí, Clavo and Imbricado or types resembling them are also widely distributed and appear to have had their origins not in Colombia but to the south.

Nevertheless a number of new races have originated in Colombia, largely through the hybridization of races introduced from the south, the west and the east. In addition, there appears to have occurred in Colombia hybridization with teosinte-contaminated maize from Mexico and Central America. Finally, there is an indication that in Colombia there has been hybridization of maize with its wild relative, Tripsacum. These three types of hybridization have produced new races in Colombia, some of which have diffused to other regions where they have become the parents of additional new races. A discussion of these three types of hybridization follows.

HYBRIDIZATION BETWEEN RACES

Wellhausen *et al* (1952) have shown that one of the most important factors in the evolution of maize in Mexico has been hybridization between races. Of the twenty-five clearly recognized races of Mexico, thirteen were regarded as pre-Columbian hybrids and four as incipient races, the product of more recent hybridization.

The same process has obviously been occurring in Colombia and indeed has preceded and been responsible for part of the evolution of maize in Mexico. For example, the Colombian race, Montaña, is apparently a hybrid of Sabanero and Pira Naranja, both of which may have come originally from Peru. Montaña has diffused to Guatemala and Mexico where it is known as Olotón. There it has hybridized with the Guatemalan-Mexican race, Tehua, to produce a large-eared race, Comiteco, of southern Mexico. Comiteco in turn is one of the parents of Jala, the gigantic corn of the Jala valley of Mexico. Thus the world's largest corn owes much of its size to the hybridization of two races in Colombia, one of which, Pira Naranja, contributed genes for long ears, the other, Sabanero, genes for large diameter of cob.

Other examples of interracial hybridization are discussed as part of the descriptions of the individual races and are illustrated in the diagrams of postulated genealogies. There is no doubt that in Colombia, as in Mexico, interracial hybridization has been a major factor in race formation. An important difference between Colombia and Mexico is that in Mexico, because archaeological remains are available, it is possible to determine broadly when the hybridization occurred. In Colombia this is more difficult, often impossible.

HYBRIDIZATION WITH TEOSINTE-CONTAMINATED MAIZE

A second important factor in the evolution of maize in Guatemala and Mexico has been the introgression of teosinte. This close relative of maize is widely distributed in western Mexico and in parts of Guatemala where it grows in profusion in non-cultivated sites and also quite commonly as a weed in and around the maize fields. Hybridization of maize and teosinte is constantly occurring and has been observed by all students of maize who have given attention to the problem. There is a repeated introgression of teosinte into maize and, reciprocally, of maize into teosinte.

Wellhausen *et al* concluded that many of the races of maize of Mexico are the product of teosinte introgression and that some of the more productive races are the result of combining independent lines of descent each of which has separately undergone introgression from teosinte. For example, Tuxpeño which enters into the ancestry of several modern Mexican races, as well as the Corn-Belt Dent of the United States, is the progeny of Olotillo and Tepecintle, both of which appear to have been the product of teosinte introgression.

There is now substantial archaeological evidence in support of the conclusions of Wellhausen *et al.* Collections of ancient corn from caves in Mexico (Mangelsdorf, MacNeish, and Galinat, 1956; Mangelsdorf and Lister, 1956), from Bat Cave in New Mexico (Mangelsdorf and Smith, 1949) and from several caves in Arizona (Galinat, Mangelsdorf, and Pierson, 1956) all include numerous specimens which resemble closely the cobs of segregates from modern maize-teosinte hybrids. The evidence from archaeological maize and modern maize is in agreement in showing that teosinte introgression has been an important factor in the evolution of maize.

The evidence from chromosome knobs indicates that the majority of present-day Colombian varieties have undergone introgression from teosinte or Tripsacum or from both. Since teosinte is unknown in Colombia, any such introgression which cannot be attributed directly to Tripsacum must derive from teosinte-contaminated races introduced from Central America and Mexico. There is evidence that the Mexican race Tuxpeño has been grown in northeastern Colombia and northern Venezuela and that it has hybridized with the Colombian race, Clavo, to produce Puya and Puya Grande. Tuxpeño may also be the source of teosinte introgression in other Colombian races having high chromosome-knob numbers which cannot be attributed to introgression directly from Tripsacum.

POSSIBLE HYBRIDIZATION WITH TRIPSACUM

Mangelsdorf and Reeves (1939) postulated that teosinte is itself a hybrid of maize and Tripsacum. If this is true then the introgression of teosinte into maize actually represents an introduction into maize of germplasm from Tripsacum. This hypothesis has, however, never been proven. And since the natural hybridization of maize and Tripsacum is, at best, rare, while that of maize and teosinte is common, it seems preferable in most instances to speak of introgression from teosinte or from teosinte-contaminated maize rather than of introgression from Tripsacum.

Regardless of the origin of teosinte there now appears to be a distinct possibility that hybridization of maize and Tripsacum has occurred in Colombia and that it has played a part in the origin and evolution of Colombian races of maize. The evidence for this conclusion comes from the race Chococeño, the principal maize of the Chocó region of Western Colombia. Plants of this race, to be described later, are tripsacoid in a number of characteristics. Some of the plants resemble segregates from maize-teosinte hybrids, but, since teosinte does not occur in the Chocó, their characteristics must have come from another source. Tripsacum is common in the Chocó and plants of maize and Tripsacum often grow together in the same field and flower at the same time. Señor Patiño, one of the Colombian collectors, reports that it is difficult before flowering to distinguish maize and Tripsacum plants growing in the same field. The circumstantial evidence points to the hybridization of maize and Tripsacum as the source of the unusual characteristics of Chococeño.

Whether there has been hybridization of maize and Tripsacum in parts of Colombia other than the Chocó is a question which cannot be answered with the evidence now at hand. Tripsacum is not uncommon in Colombia and it has been collected from a number of localities ranging in altitude from sea level to 1020 meters. The collections have not yet been identified taxonomically, but since their chromosomes have knobs they probably are not *Tripsacum australe* which is reported by Graner and Addison (1944) to have knobless chromosomes.

In a preliminary experiment some of the varieties of Tripsacum collected in Colombia have been crossed with a number of different races of maize. Hybrid seeds were produced in all crosses and many of them yielded, without embryo culture, seedlings with two well-developed leaves and with seminal roots. No attempt was made in this experiment to grow the hybrid seedlings to maturity.

It is also possible that the hybridization of maize and Tripsacum has occurred in other parts of South America and that such hybridization has influenced certain Colombian races. The Colombian race Costeño is probably related to the Brazilian race Cateto whose chromosome knobs are still to be explained. And Ing. Urbano F. Rosbaco working in the state of Entre Ríos in Argentina has sent to Mangelsdorf a collection of the peculiar "Maíz Amargo" the ears of which are highly tripsacoid and scarcely distinguishable from segregates of experimental maize-Tripsacum hybrids. From this maize, as well as from slightly less tripsacoid varieties from Colombia, Venezuela, Brazil, Paraguay, Peru and Bolivia, Mangelsdorf (unpublished) has succeeded in transferring to a uniform North American inbred, Minnesota No. A158, single chromosomes carrying genes for prominent horny glumes and highly lignified rachises. A preliminary study of the chromosome so transferred shows that in some hybrids with ordinary maize there is a lack of homology in the chromosome 1 pair.

There seems to be little doubt that there are throughout the countries of South America, races and varieties of maize with tripsacoid characteristics which are probably the product of introgression with either teosinte or Tripsacum. Since teosinte is unknown in the countries of South America and Tripsacum is fairly common—much more so than earlier studies had indicated —there is at least a distinct possibility that these Tripsacum characteristics have been derived from the natural hybridization of maize and Tripsacum.

COLLECTING PROCEDURES

The great majority of collections were made directly from farmers' fields during the harvest seasons, which in many parts of Colombia are two each year. An effort was made to obtain a minimum of fifteen ears from each field and to include among this number as much as possible of the variation in plant and ear type which occurred. The localities from which collections were made are shown in Figure 2.

Samples received at the center at Medellín were catalogued, dried and photographed, and data on the ear and kernel characters were recorded. A museum sample of three or four ears was selected and the remaining ears were shelled and the seed mixed. Four-ounce samples of each collection were put into cold storage at Medellín and these are being renewed periodically by growing and sib pollinating. As a precaution against the loss of the collections through fire, earthquake or other disaster, duplicate samples were sent to the seed storage center maintained at Glen Dale, Maryland, by the Division of Foreign Plant Introduction of the United States Department of Agriculture.

IDENTIFYING THE RACES

Races of cultivated plants, especially of those which, like maize, are naturally cross-pollinated, are usually not clear-cut and well-defined taxonomic entities as are genera and species.

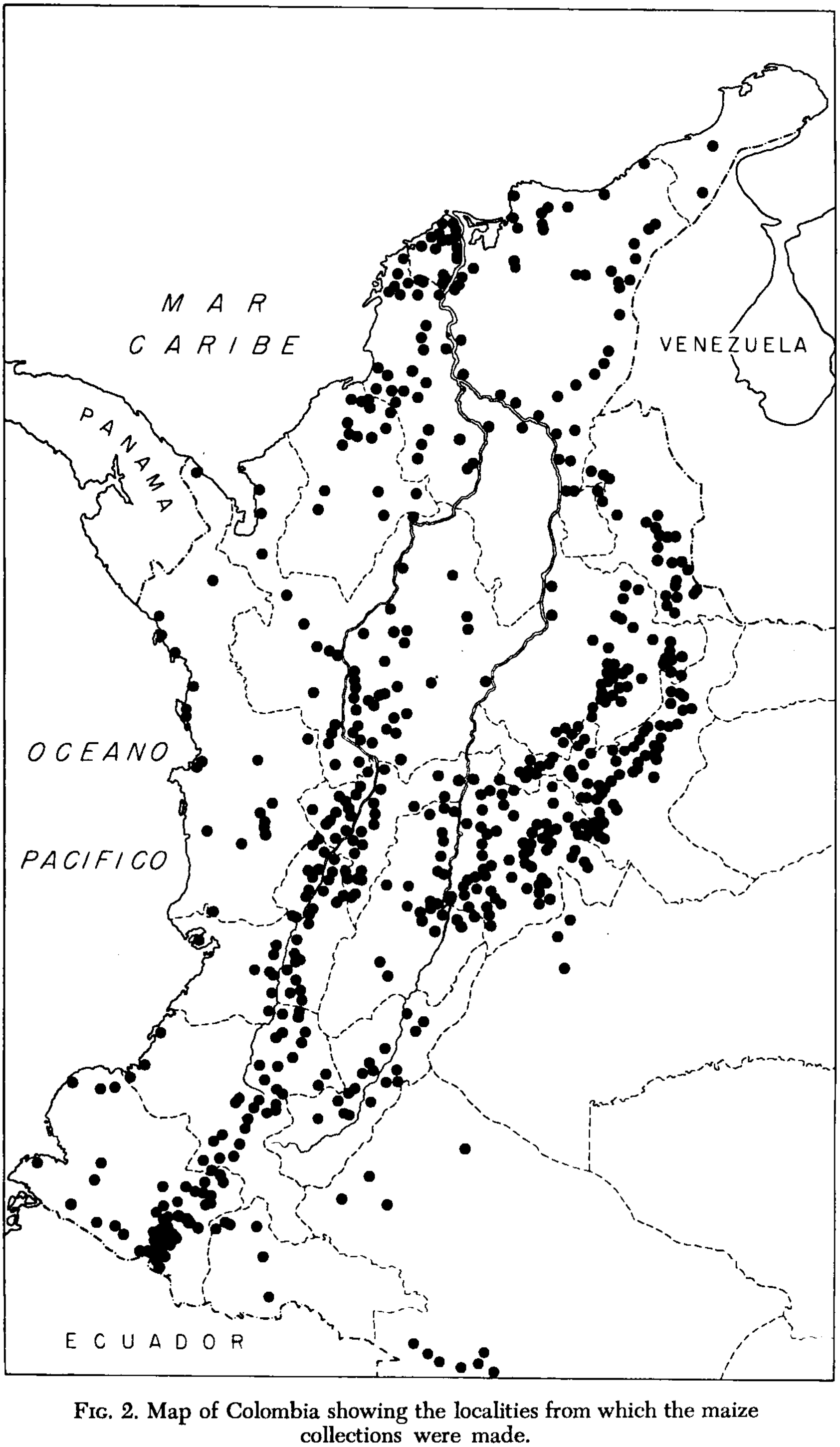

FIG. 2. Map of Colombia showing the localities from which the maize collections were made.

The average field of cultivated maize comprises a population of genotypes, no two of which are completely identical. Yet in countries such as Colombia, with its diversity of physical features and a corresponding diversity of environmental conditions, involving altitude, temperature, rainfall, soil and other characteristics, genetic populations which are distinguishable from other genetic populations have developed. It is these recognizable populations which can be distinguished from other populations, which are here called races.

In prehistoric times the races of maize were probably more distinct than they are now. Improved transportation facilities and the establishment of commerce have greatly increased the opportunities for the mixing of races. Today many of the collections of maize in Colombia represent mixtures of races. Nevertheless the "pure" races are in most cases still recognizable, but only by studying the entire complex of characteristics, morphological, physiological and cytogenetic.

The initial step in identifying the races of maize of Colombia was based upon study of the ears. All collections which appeared to belong to a single race were then grown in adjoining plots in the field. Those which proved to be similar in their plant characteristics were considered to belong to the race in question. Those which deviated strongly were classified as mixtures. The distinction between the two, although based on numerous measurements, is still somewhat subjective. Actually there are no pure races of maize and there can be no hard and fast distinction between races and racial mixtures. The taxonomy of maize, like that of other organisms, is in large part a matter of judgment.

CHARACTERS USED IN CLASSIFICATION

The races of maize to be described later in detail were identified and classified on the basis of a large number of data which have been compiled over the past five years. The same four principal categories of characters which were used in classifying the races of maize in Mexico (Wellhausen *et al,* 1952) have been employed here. These are: (1) vegetative characters of the plant; (2) characters of the tassel; (3) characters of the ear, both external and internal; and (4) physiological, genetic and cytological characters. Also the same general procedures were followed in obtaining the measurements and in making the observations on the different characters in these four principal groups.

For example, the data which are presented in Tables 8–12 (Appendix) to characterize a race were taken from a selected group of collections which were chosen after much study as being the most typical of that particular race. The number of collections that were selected as "type specimens" for any given race varied. The number and identity of the collections used as being the most representative of each race is given in Table 13 (Appendix). The measurements and observations of characters under the general categories (1), (2) and (4) given above were made on the collections grown under the same uniform environmental conditions. Studies on characters of the ears are based on the original collections. The reasons for using both of these procedures are given in "Races of Maize in Mexico" (Wellhausen *et al,* 1952).

That publication also gives a complete description of the characters employed in the classification and the techniques used to study them. For the convenience of the reader and since certain minor modifications were made in the study presented here, a brief summary of the characters used in the present classification and the methods by which they were studied is given below.

VEGETATIVE CHARACTERS OF THE PLANT

Range of Adaptation to Altitude. As is true in any mountainous tropical country, the dominant factor influencing the distribution of the Colombian races of maize is altitude. Temperature in a country such as this is almost directly related to elevation, and it is largely for this reason that any given race can only be moved up and down within a certain range of elevation and still remain relatively well adapted to the environment. As was found in Mexico, Colombian races vary widely in the degree of sensitivity to changes in altitude. Some are quite restricted in the range of altitude to which they are adapted while others have considerable flexibility in this respect. It has also been observed that in general there is a corresponding decrease in the degree of flexibility of the different races with an increase in mean elevation to which each is best adapted. Altitudes for most of the collections were accurately measured with an aneroid altimeter. Where this was not possible for a small percentage of the collections, the altitudes were taken from the best maps available.

Height of Plant. The mean height of plant for each race was determined by averaging the mean heights of plants of the varying number of collections selected as typical of the race. In turn, the mean height of plant for each collection is the average of the measurements of the first ten normal plants in the field plot. The measurements were uniformly made on the main stalk from the ground level to the base of the tassel. The plant height measurements were made at two different locations. All the collections from above 1,800 meters were measured when grown at the experiment station "Tibaytatá" near Bogotá, which has an elevation of 2,650 meters. The collections from below 1,800 meters were measured for plant height when grown at the experiment station "Tulio Ospina" at Medellín, with an elevation of 1,500 meters.

Height to Ear. The means shown in Table 8 for this character were derived in the same manner as for height of plant. The measurements were uniformly taken from the ground to the base of the principal ear on the main stalk.

Stem Diameter; Maximum and Minimum. The means by races for this character are averages of measurements made at the mid-point of the first internode above the ground on the main stalk. Also to obtain a picture of the relative shapes of the main stalk at the mid-point of the first internode, two measurements were taken at this point. One was taken of the maximum diameter and the other of the minimum. The relationship between the averages of the two serves to give a fairly good idea of the cross-sectional shape of the main stem slightly above ground level. Some races have slightly elliptically shaped stems; others have stems which are almost round; the majority have stems that fall somewhere between these two extremes in shape.

Total Number of Leaves per Plant. The mean for each typical collection is based on actual counts of all leaf-bearing nodes on ten to fifteen plants. The means of the representative collections were averaged to derive the racial means for this character.

Number of Leaves Above Ear. The number of leaf-bearing nodes above the primary ear was counted on the same plants used to determine the total number of leaves per plant.

Length of Leaf. The mean for each typical collection is based on the measurement of a leaf from the first ten normal plants in a plot. The measurements were made from the ligule to the tip on the leaf arising from the upper ear-bearing node. The means of the representative collections were averaged to derive the racial means for this character.

Width of Leaf. The same procedure was followed as for length of leaf, the measurements being made at the mid-point in the length of each leaf.

Venation Index. The procedure described in the study of the races of Mexico (Wellhausen *et al*, 1952) was used to derive this index. It consists of the quotient of the average number of veins counted at mid-point in the length of the leaf from the upper ear-bearing node and the average width at the same point. The counts and measurements were made on ten mature plants in each collection.

Number of Tillers. Actual counts were made on the first ten normal plants in the plots for each collection. The means of the typical collections were averaged to derive the racial means.

Internode Patterns. According to Anderson (1949) each kind of corn has its own characteristic pattern of internode elongation. We have found internode patterns (Figs. 84–89) to be a useful tool in showing relationship between races. Within a given collection the number of internodes per plant varies rather widely; in Cacao, for example, three plants measured had only nine internodes and two had as many as seventeen. After the modal number of internodes for each race had been chosen as characteristic, the pattern was determined by measuring the length of successive internodes on all plants having that number of internodes. The results were then averaged and expressed in a diagram showing the pattern of relative internode lengths which also indicates the position of the uppermost ear of the plant. Numbers on the vertical scale in the diagrams represent lengths of each internode in centimeters. Numbers at the base of the diagram represent the number of internodes from the base upwards. Tassels are represented by circles and ears by triangles. The consistency of internode patterns is well illustrated in Figure 87 in which the patterns of two varieties of Costeño, white and yellow, are compared.

CHARACTERS OF THE TASSEL

Tassel Length. The length was measured in centimeters from point of origin of the lowermost branch to the tip of the central spike. The average for each collection is based on measurement of ten tassels.

Length of Peduncle. The distance was measured in centimeters from the upper node of the stalk to the lowermost branch in the tassel. The average for each collection is based on ten plants.

Length of Branching Space of Tassel. The length along the central axis of the tassel on which branches occurred was measured in centimeters on ten plants in each collection.

Per cent Branching Space. This is the percentage figure derived by dividing the average length of that part of the central axis on which branches occurred by the total average length of the tassel.

Total Number of Tassel Branches. All branches, primary, secondary, and tertiary, were counted in the tassels on the main stalk of ten plants from each collection.

Percentage of Secondary Branches in Tassel. The total number of secondary branches in the tassel on the main stalk of ten plants of each collection was divided by the total number of branches in the same tassels.

Percentage of Tertiary Branches in Tassel. Determined in the same manner as for percentage of secondary branches.

Condensation Index. The average condensation index of ten tassels from each collection was determined according to the procedure described by Anderson (1944). The index is computed by dividing the number of pairs of spikelets by the number of apparent nodes counted along the central portion of the lowermost primary branch in the tassel.

A high condensation index is characteristic of most of the races common in the high central plateau of Mexico (Wellhausen *et al*, 1952) and consequently was useful in helping to indicate relationships between races. This was not found to be the case in Colombia, however, and the means for this character in Table 9 serve only to show that condensation in the races of Colombia is uniformly low and almost non-existent.

CHARACTERS OF THE EAR

For the reasons presented by Wellhausen *et al* (1952), special attention has been devoted to studying both the external and internal ear characteristics in classifying the Colombian races. Studies of the characters in this principal category that will be described below were all made on the original ears of each collection. These are, in fact, the only characters that were studied in plants grown in their native habitats. The measurements and observations were made on ten to fifteen ears of each of the original collections, which now total 1,999. As in the case of the characters studied in the other three principal categories, the racial means for the ear characters in Table 10 are averages of only the most typical collections of each race.

EXTERNAL CHARACTERS

Ear Length. The measurements were made on all normally developed ears in the collections.

Mid-ear Diameter. The diameters of the same ears used to determine ear length were measured with calipers at the mid-point of their length.

Row Number. Actual counts were made of the number of rows of grain on the same ears used for length and diameter determinations.

Angle of Taper. Diameters at the tip and base of the ear were measured with calipers. The angle of taper is the angle formed by the intersection of projections of lines drawn from opposite sides of the base of the ear to opposite sides of the tip of the ear; it is computed by simple trigonometry.

Diameter of Peduncle. The diameter of the shank or peduncle was measured in millimeters at a point as near to the base of the ear as possible.

Length of Peduncle. The length of the peduncle of the ear or shank was measured from the point of its attachment to the stalk to the base of the ear.

Number of Husks. The husks (modified leaf sheaths) surrounding the ear were counted on the upper ears of each of ten plants. The data are expressed as an average number per plant.

Kernel Width. The width of ten kernels taken from near the middle of the ear and laid side by side was measured in millimeters.

Kernel Thickness. The thickness of ten consecutive kernels in a row near the mid-point of an ear was measured in millimeters with metal calipers. The measurements were made while the kernels were on the ear.

Kernel Length. The same ten kernels were measured when laid end to end.

Kernel Denting. This is a visual estimate recorded on an arbitrary scale: from 0 = maximum to 5 = none. Observations were individually recorded for twelve to fifteen ears of each collection, the scores being averaged.

Kernel Hardness. Visual estimates were made on the total sample of ears of each collection and these were recorded on an arbitrary scale from 1 (hard) to 5 (soft).

INTERNAL CHARACTERS

The techniques used for studying the internal characters are fully described by Wellhausen *et al,* (1952). These characters are often extremely valuable, as proved to be the case in Mexico, in defining races and their inter-relationships, for they are rather constant in their expression and are affected only slightly by environmental conditions. However the amount of variation found for these characters in the different Colombian races was much less than that found in the Mexican races. Consequently their value in helping to distinguish the races of Colombia was greatly reduced in comparison to Mexico. The measurements and observations on these characters which will be described below are presented in Table 11 and the cross-sectional diagrams of the ears of each race based on these measurements and observations are included with the descriptions. They at least serve to demonstrate that variation between Colombian races for a number of these characters is slight.

Cob Diameter. This was measured from the center of the upper surface of the upper glume on one side of the cob to the corresponding point on the upper surface of a glume directly opposite.

Rachis Diameter. This was measured with calipers on the lower half of the broken ear. The measurement was made from the base of an upper glume on one side of the cob to the base of an upper glume directly opposite. Since the base of the glume is usually somewhat below the rim of the cupule, this measurement does not represent the maximum diameter of the rachis but rather its diameter to the points at which the upper glume arises.

Rachilla Length. Accurate measurements of rachilla length can be made only in histological sections, but a very good estimate of rachilla length can be obtained from the data already available. The diameter of the rachis is substracted from the diameter of the ear and divided by two. From the figure so obtained is subtracted the average length of kernel. The difference represents the average length of the rachilla from the base of the glume to the base of the kernel.

Cob/rachis Index. This is computed by dividing the diameter of the cob by the diameter of the rachis. Other factors remaining constant, a high cob/rachis index indicates long glumes resulting from one of the intermediate alleles at the *Tu–tu* locus. (Mangelsdorf and Smith 1949.)

Glume/kernel Index. This index gives a measure of the length of the glume in relation to the length of the kernel. It is computed by subtracting the diameter of the rachis from the diameter of the cob and dividing the figure obtained by twice the average length of kernel. Other factors remaining constant, this index provides an excellent indication of the alleles which are involved at the *Tu–tu* locus.

Rachilla/kernel Index. This figure expressed the relation of the length of the rachilla to the length of the kernel.

Cupule Hairs. The cupule, a term used by Sturtevant (1899) to designate the depression in the rachis from which the spikelets arise, is almost invariably hairy. The hairs vary both in number and length from a few short prickles to many long, sometimes appressed hairs. The variation is so extensive that the characteristic alone is of little value. It may, however, be useful when considered with other characteristics and employed as part of the total description. Hairiness is scored by numbers, from 0 = none to 3 = profuse.

Lower Glume: Texture. The texture of the lower glumes is estimated by probing or puncturing with a dissecting needle. In some races the glumes are chartaceous or chaffy, often with considerable areas toward the margins of thin transparent material resembling tissue paper. In other races the glumes are fleshy and thickened, but soft, and yield easily to the needle point. In still other races the glumes are distinctly indurated and are difficult to puncture. Induration is scored by numbers, from 0 = none to 4 = strong.

Lower Glume: Hairiness. The hairs of the lower glumes vary in number, length and position. Hairs are found almost universally on the upper margins of the glume. These vary from a few short hairs to many long, soft hairs. The surface of the glume proper may be completely glabrous. More commonly a few hairs are found at the base or toward the lateral margins of the glumes. In general, the hairiness of the lower glume is not in itself a satisfactory diagnostic character, since there is often considerable variation within a race. Considered with other characteristics, however, it has some usefulness. There is some indication that the influence of Tripsacum or teosinte-contaminated maize tends to reduce hairiness of the glumes. Hairiness of the glumes is scored by numbers, from 0 = none to 3 = profuse.

Lower Glume: Shape of the Glume Margin. The upper margin of the glume varies in shape from race to race. The margin is rarely truncate and is usually more or less indented. The indentation may be luniform (crescent-shaped), more or less broadly angulate (wedge-shaped), sinuate (undulate or wavy), or cordate (heart-shaped). The shape of the margins is fairly uniform among different ears of the same race.

Upper Glume: Texture. The upper glume, like the lower, may be chaffy or fleshy. It is seldom strongly indurated. Texture of the upper glume, like that of the lower, is scored by numbers.

Upper Glume: Hairiness. Hairs on the upper glume, like those on the lower, vary in number, length and position and are scored in the same way.

Rachis Induration. The surface of the rachis tissue varies in the degree of induration. This is probably a matter of degree to which the tissue is schlerenchymatized. Lenz (1948) has found conspicuous differences in varieties of maize with respect to the development of a schlerenchyma zone. An estimate of the induration of the rachis, like that of the lower glume, can be made by probing the rachis tissues with a dissecting needle. The induration has been arbitrarily scored as follows: 1 = no induration, 2 = slight, 3 = intermediate, 4 = strong.

PHYSIOLOGICAL, GENETIC AND CYTOLOGICAL CHARACTERS

The characters included in this category (Table 12) are as follows:

Maturity. The number of days from planting to silking was used as a measure of maturity. The date of silking for each collection was recorded when one-half of the plants in a plot containing 50 to 60 plants had put forth silks.

Corn Rust. Three species of rust, *Puccinia sorghi, P. polysora* and *Angiospora zeae,* have been identified on maize grown in Medellín. Since *P. sorghi* is of major importance and the other two species are relatively unimportant, only one rust note was taken with respect to the degree of resistance or susceptibility on the scale of 1 to 5, 1 being highly resistant and 5 highly susceptible. The various races of maize, when grown at Medellín, exhibited considerable differences in reaction to *P. sorghi.*

Helminthosporium. This disease, like rust, is very common and damaging at Medellín. At this altitude (1,500 meters) the climate is temperate (21° C. mean average), and this factor in conjunction with other environmental factors of probably lesser influence makes this location a good one at which to determine the resistance of the collection to the different species and races of this pathogen. To date these have not been identified with any degree of certainty, although it is now fairly clear that *H. turcicum* largely predominates with *H. carbonum* being present, but to a minor degree. All of the collections have been scored for resistance or susceptibility to this disease, taking into account the combined frequency and intensity of the lesions in a plot of approximately 60 plants. Scorings of this nature have been made during several growing seasons at Medellín and Bogotá. The scale used for recording the visual estimates was from 1 = resistant to 5 = susceptible.

Pilosity. Some of the maize varieties have strongly pubescent or pilose leaf sheaths. Paxson (1953) has found that the inheritance of pubescence is relatively simple and is dependent upon two principal genes, one of which is located on chromosome 9 and the other on chromosome 3. Pilosity of the leaf sheath is most common in the maize of high altitudes in Mexico, Guatemala and Colombia. Pubescence in Table 12 is arbitrarily scored from 0 to 5 for both frequency and intensity, the higher number indicating the stronger pubescence.

Plant Color. Many high-altitude races of Mexico, Guatemala and Colombia have strongly colored leaf sheaths. This color is sometimes due to the *B* factor on chromosome 2, sometimes to one of the *R* alleles on chromosome 10, and sometimes results from both. The empirical scores in Table 12, ranging from 0–5, do not distinguish between these two genes for color. Color, like pubescence, reaches its maximum in the high-altitude corns. A visual estimate was made in a plot or from 50 to 60 plants of each collection for both frequency and intensity of the plant color to arrive at an arbitrary score.

Lemma Color. The color of red-cobbed corn is in the lemma, but there are other colors in the lemma as well. Coloration of the lemma of one sort or another was found to be common in some of the Colombian races (Cariaco, Imbricado, and Puya) and non-existent in others (Clavo and Montaña). No attempt was made to distinguish between colors due to the different genes involved, and only the presence or absence of color was noted on 10 to 15 ears of each original collection. This is expressed (Table 12) as percentage of ears with lemma color among the ears which were scored for this character.

Glume Color. Lacking anthocyanin, the glumes are white, buff or brownish. Anthocyanin coloration may be red, cherry or purple. The frequency of glume color is recorded as a percentage of the ears studied.

Midcob Color. First described by Demerec (1927), midcob color affects the tissues between the pith and epidermis of the rachis. It is seen only when the cob is broken and for this reason its widespread distribution in Latin American races has been largely overlooked. Studies by Mangelsdorf (1947) indicate that midcob color is the result of the action of an allele of *R* on chromosome 10. The data recorded represent an average percentage of the ears that had midcob color. Approximately fifteen ears of each collection were read for this character.

Pith Color. Expressed in percentage of the ears of the original collections that showed color in the pith, regardless of its nature. The genetic nature of pith color is not known.

Aleurone Color. Expressed in percentage of the ears of the original collections that had aleurone color, irrespective of its nature.

Pericarp Color. Scored on all the ears of the original collections and expressed in percentage.

Chromosome Knobs. The importance of chromosome knobs as a racial characteristic has been discussed by Wellhausen *et al* (1952). The average knob numbers for the races shown in Table 12 is based on counts made from 1 to 35 typical collections of each race.

DESCRIPTION OF COLOMBIAN RACES

Twenty-three more or less distinct races are now recognized in Colombia. For the majority of these the data on various categories of characteristics are complete. Two of the races, Güirua and Maíz Harinoso Dentado, have been identified only recently and few data concerning them are available.

Because evidence both archaeological and historical on maize in Colombia is lacking, it has not been possible, as it was in Mexico, to classify the races with respect to their antiquity. The most that can be done is to group them into three principal categories, which to some extent reflect their origins and relationships. These categories are: Primitive Races, Races Probably Introduced, and Colombian Hybrid Races.

The names under which the Colombian races of maize are described are, in the majority of instances, those which are commonly applied by the people who grow it. However, when a local name, for example "Criollo" (native), is not particularly descriptive, another name, usually one referring to the locality where the maize is commonly grown, has been chosen. For example, the maize commonly grown in the northern coastal region is called "Costeño", and the principal race of the Chocó is called "Chococeño".

A brief description of each race, a discussion of its origin and relationships, and a statement on the derivation of its name is presented in the following pages. Detailed data on the characteristics of each race are set forth in Tables 8 to 12 (Appendix). The descriptions and data are based upon only those collections regarded as typical. The collections which were used for this purpose are listed in Table 13 (Appendix).

PRIMITIVE RACES

Except for Sturtevant (1894), who postulated that primitive corn is both a pop and a pod corn, most botanists have been reluctant to speak of any kind of maize or even of any particular botanical characteristic as being primitive. Recent studies of archaeological maize, previously cited, have shown that the most ancient maize was small-eared and small-seeded and that it had relatively long, soft glumes. Living races of maize which have these two characteristics are usually popcorns, and popcorns, as a class, are undoubtedly more primitive than the general run of maize varieties.

Popcorns are often shorter in stature, earlier in maturity and more prone to tillering and branching than commercial field corns of the same region. Some races of popcorn, of which Chapalote of Mexico is an example, owe their long glumes to an allele of the tunicate gene (Mangelsdorf, 1953b). Some races carry a genetic factor which inhibits the monstrous development of the tunicate character (Mangelsdorf, unpublished). Many varieties of popcorn carry a gene for cross sterility (Nelson, 1951) and this is probably a "wild" gene which served as a barrier to crossing during the evolutionary divergence of maize from its relatives. Many races of popcorn have low chromosome-knob numbers.

Most of the countries of Latin America have races which exhibit part or all of this combination of primitive characters. In Mexico there are four such races (Wellhausen *et al,* 1952), and in Peru at least three (Grobman *et al,* 1956). Similar races have been collected from Ecuador, Bolivia and Chile. In Colombia two races of popcorn, Pollo and Pira, regarded as primitive, have been collected. The description of these races follows.

POLLO

Plants. Very short, early; no tillers; very few short, relatively broad leaves; venation index low; plant color and pubescence slight; highly susceptible to races of corn rust and slightly resistant to races of Helminthosporium in the savanna of Bogotá; number of knobs low, average 4.0, probably lower in some recent collections showing less admixture. Adapted to intermediate and high elevations, 1,600 to 2,100 meters.

Tassels. Short, medium number of branches arising in one-half the length of the central axis; secondaries and tertiaries numerous; condensation slight or absent.

Ears, External Characters. (Fig. 3) Very short and small; mostly highly conical, but some collections with slight taper at both base and tip; irregular rows common, especially at base of ear; average number of husks medium, 11.3. Midcob color present in 77 per cent of ears examined; pith color common; glumes colored in 41 per cent and lemmas in 4 per cent of ears studied. Kernels short, of medium thickness and width, rounded, without denting. Endosperm flinty, pop type, rarely floury. Aleurone colors, especially those at brown-bronze locus, common probably because of introgression from Sabanero; pericarp colors frequent.

Ears, Internal Characters. (Fig. 4) Average ear diameter 29 mm.; average cob diameter 14 mm.; average rachis diameter 8 mm.; estimated rachilla length 1.4 mm.; cob/rachis index medium, 1.77; glume/kernel index low, 0.36; rachilla/kernel index medium, 0.16; cupule moderately hairy. Lower glumes fleshy, weakly pubescent, margin shape broadly angulate or luniform; upper glumes chaffy, weakly hairy, venation strong. Tunicate allele *tu* and tu^{w}; rachis tissue spongy to horny.

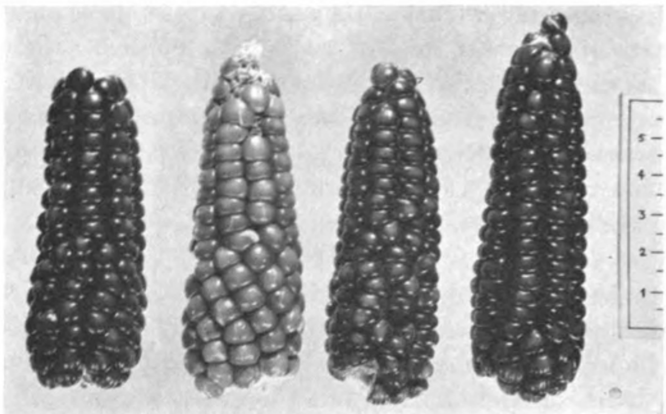

FIG. 3. Pollo, a primitive race of popcorn found in a restricted region in Boyacá and Cundinamarca. One-half natural size.* Most ears of Pollo have staminate tips which break off in handling and do not show in the photograph. Red and other pericarp colors are common in this race. Compare with the Mexican race, Nal-Tel, Fig. 16. Wellhausen *et al,* (1952) and with small ears of the Guatemalan race, Serrano., Fig. 21, Wellhausen *et al,* (1957).

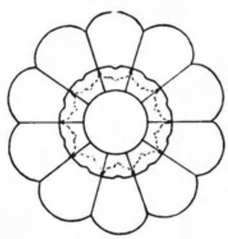

FIG. 4. Ear cross-section diagram of Pollo. Natural size.*

Distribution. Pollo is found only on the eastern slope of the eastern cordillera in the Departments of Cundinamarca and Boyacá at elevations of 1,600 to 2,160 meters. Types very similar

* All of the photographs of ears of maize in this monograph are reproduced one-half natural size.
* All of the cross-section diagrams in this monograph are natural size.

to Pollo are often found in Sabanero as mixtures and therefore Pollo in mixtures extends considerably beyond the limits shown on the map (Fig. 5).

Origin and Relationships. Pollo is probably the most primitive race of maize in Colombia. It has the smallest plants and shortest ears and one of the most limited distributions of any of the Colombian races. It has all of the aspects of a relict race.

Pollo may be a derivative of the high-altitude primitive popcorn, Confite Morocho of Peru, since it resembles this race in its general characteristics. If so, it probably represents the earliest introduction of maize from Peru into Colombia. There are formerly inhabited caves in the mountains near Boyacá where Pollo now has its center and it is possible that Pollo was the maize of early cave-dwelling cultures which preceded the Chibchan Civilization.

It is also possible that Pollo is the domesticated form of a wild maize which once grew in Colombia. It is becoming increasingly probable that cultivated maize had not one center of origin but several. Once agriculture was invented, maize might have been domesticated wherever it was found.

There is one piece of evidence which suggests that Pollo may not be far removed from wild maize. Collections of Pollo grown at Medellín, at an altitude considerably lower than their normal habitat, segregate for plants which in their general aspects are almost identical to the more maize-like varieties of teosinte in Mexico. The plants have several tillers, each bearing a number of ears. The lateral branches of the main stalk are elongated and have secondary branches, each bearing an ear (Fig. 6). A single plant may bear as many as fifteen tiny ears. When such a plant is at the silking stage, it can easily be mistaken for teosinte.

Even the ears of these unusual plants show some resemblance to teosinte. Like teosinte spikes they have staminate tips, and some of them, like teosinte spikes, are distichous. They differ from teosinte in having paired rather than single spikelets and soft rather than indurated glumes.

The exact nature and significance of these peculiar plants remains to be determined but they are probably the result of a virus similar to that in Mexico which causes the "stunt" disease,

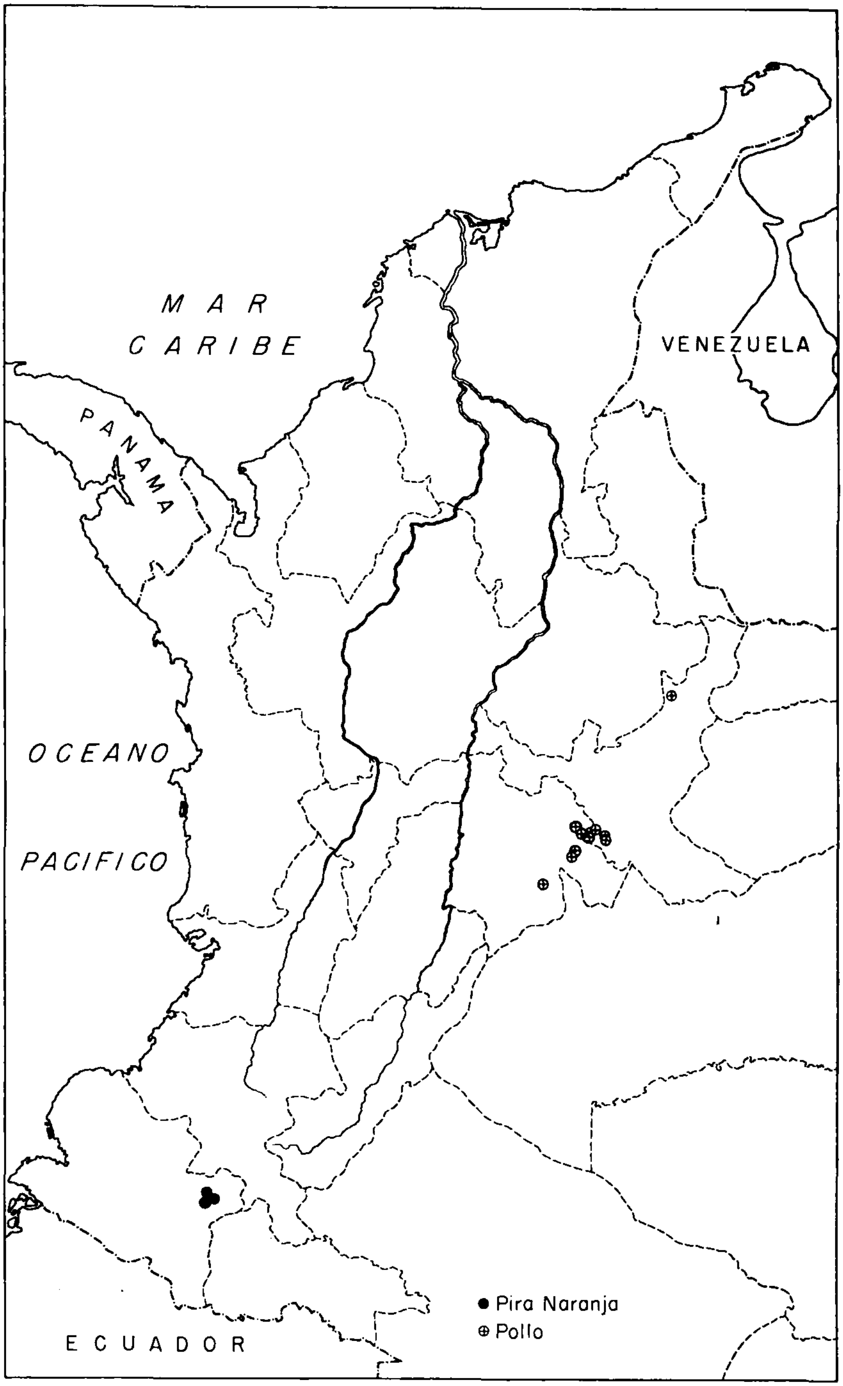

FIG. 5. The distribution of Pollo and Pira Naranja.

Fig. 6. Freely-branching plants of Pollo which, in general appearance, resemble maize-teosinte hybrids. These may be the result of environmental conditions, perhaps infection by a virus, which have accentuated a tendency which is inherent in Pollo.

which in some varieties causes profuse branching. The fact that Pollo exhibits certain primitive characteristics when infected with the virus, while other races, although susceptible to infection, do not exhibit these characteristics to the same degree, may in itself suggest that Pollo is a primitive race.

Additional studies are being made to determine which of these possible explanations best fits the facts. In the meantime, quite apart from the unusual, freely-branching plants which have appeared in it, we regard Pollo as a primitive race.

Pollo appears to have had little influence upon other races in Colombia except Sabanero with which it has introgressed reciprocally. Many populations of Sabanero contain short, early-maturing plants which are not far removed in their characteristics from Pollo. The pericarp color which occurs in Sabanero is believed to have been derived from Pollo, and the blue and bronze aleurone colors sometimes found in Pollo are thought to have come from Sabanero.

Derivation of Name. Many cock-fighting enthusiasts believe that this small-eared, small-grained corn has some special value as food for game cocks. This may be true so far as size of grain and ability of the birds to consume the grains intact is concerned. In any case, the name now commonly applied in the area where the race is found is "Pollo" or "Gallo" which mean "chicken" and "cock".

PIRA

Plants. Of medium height, early to medium maturity; no tillers; intermediate number of leaves of medium length and width; venation index high. Plant color and pubescence intermediate; highly susceptible to races of corn rust and Helminthosporium in central Antioquia; number of knobs high, average 8.4. Adapted to intermediate elevations, 400 to 2,000 meters.

Tassels. Of medium length, medium to high number of branches arising in about one-half the length of the central axis; secondaries and tertiaries numerous. Condensation lacking or slight.

Ears, External Characters. (Fig. 7) Short, very slender, with very slight taper from base to tip or somewhat cigar-shaped;

average number of rows 11.0. Shank of intermediate length, slender; number of husks medium to high. Midcob color present in 36 per cent of ears studied; glumes colored in 9 per cent and lemmas colored in 1 per cent of ears examined. Kernels small, rounded, long in relation to width and thickness. Endosperm

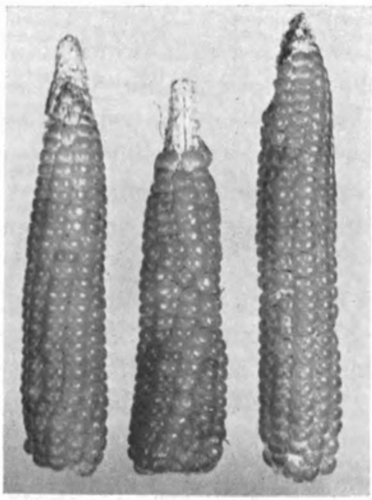

FIG. 7. Pira, a primitive race of popcorn with slender, flexible cobs, long, soft glumes, and a high frequency of the gene for cross-sterility.

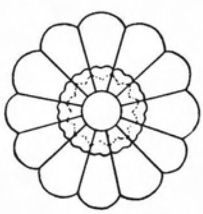

FIG. 8. Ear cross-section diagram of Pira.

flinty, pop type, white. Aleurone colors rare; pericarp colorless.

Ears, Internal Characters. (Fig. 8) Average ear diameter 26 mm.; average cob diameter 11 mm.; average rachis diameter 6 mm.; estimated rachilla length 0.5 mm.; bob/rachis index high, 2.04; glume/kernel index very low, 0.31; rachilla/kernel index low, 0.06; cupule weakly pubescent. Lower glumes chaffy to fleshy, weakly pubescent, the margins broadly cordate. Upper glumes chaffy, glabrous, venation strong. Tunicate allele *tu* and tu^{w}; rachis tissue spongy to horny.

Distribution. Pira is grown mainly in the Department of Cundinamarca but a few farmers are still producing it in Tolima and Huila (Fig. 9). Some Pira is grown in Nariño and Valle. It is found from 400 to 2,000 meters with an average of 1,100 meters.

Origin and Relationships. Pira is primitive in its slender, flexible rachis, relatively long glumes and small seeds, the smallest of any Colombian race. It may be related to the popcorns of Peru, Confite Morocho and Confite Puntiagudo, but it differs from these in its cylindrical or cigar-shaped ear, the regular arrangement of its dorsally-flattened kernels and its clear, white color.

Although seldom found in pure form today, it must have at one time been widely distributed since it has been collected from widely separated localities in Colombia as well as from Venezuela and Bolivia. The only archaelogical specimen of maize discovered in Colombia is described by Duque Gómez as having characteristics which would, in our judgment, place it in the race Pira.

Despite the fact that Pira is usually mixed with other races, it has had little discernible influence upon any race in Colombia. Certainly there are no existing races of which Pira is the direct progenitor.

Derivation of Name. Pira is the name commonly used for small-grained popcorns in Colombia, and so far as we have determined, the word has no relationship to a "funeral pyre" which is the dictionary meaning of Pira in Spanish. It may be an Indian word.

RACES PROBABLY INTRODUCED

This group includes nine races, none of which appears to have direct progenitors in Colombia and all of which have counterparts in other countries. Since these races cannot be shown to have originated in Colombia, it is assumed, for the purpose of this classification, that they originated elsewhere and have been introduced into this country. This is not, however, an established

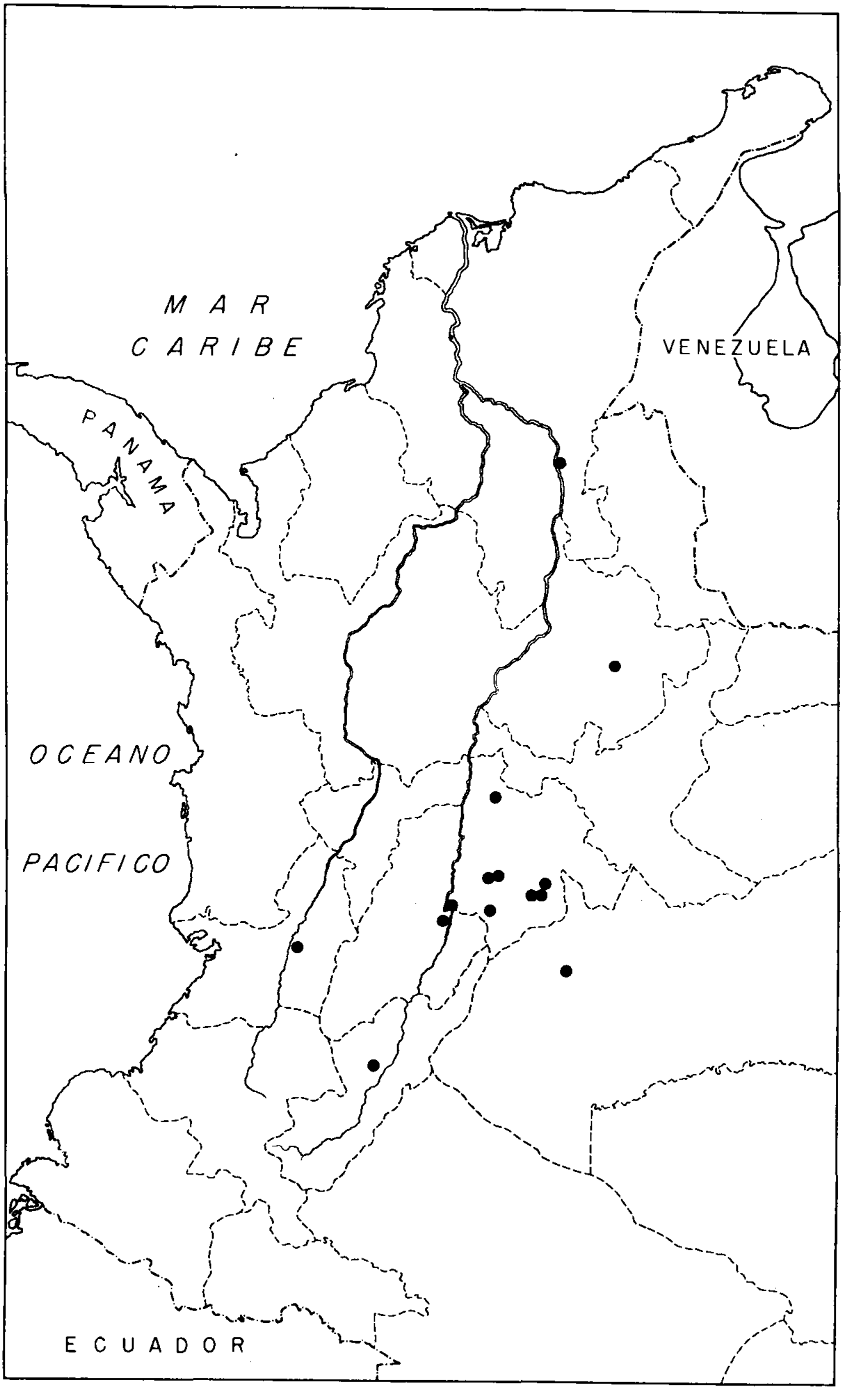

FIG. 9. The distribution of Pira.

fact and additional studies on the races of other countries may show that some of these races now regarded as introduced have had their origin in Colombia.

There is no way of determining whether the introduction was ancient or recent. However, when a race, for example Sabanero, is not only widely grown but has also been the progenitor of a number of hybrid races, it seems reasonable to conclude that it represents an ancient introduction.

PIRA NARANJA

Plants. Very tall; latest maturing of all races grown at Medellín; few tillers; very many long, broad leaves; venation index medium to high; plant color and pilosity intermediate; moderately susceptible to races of corn rust and Helminthosporium in central Antioquia; number of knobs intermediate to high, average 7.0. Adapted to intermediate elevations, 1,000 to 1,800 meters.

Tassels. Long, very high number of branches arising in about two-fifths the length of the central axis; secondaries and tertiaries very numerous; condensation slight to absent.

Ears, External Characters. (Fig. 10) Of intermediate length, slender, with slight gradual taper from base to tip; butt often slightly enlarged; average number of rows 14.7. Shank of intermediate length and thickness; average number of husks high, 16.0. Midcob color present in all ears examined; glumes colored in 17 per cent of ears studied; lemma color lacking. Kernels narrow, nearly round in cross section, relatively long, with hard, pop-type orange endosperm. Aleurone colors rare; pericarp colors lacking.

Ears, Internal Characters. (Fig. 11) Average ear diameter 28 mm.; average cob diameter 15 mm.; average rachis diameter 8 mm.; estimated rachilla length 1.1 mm.; cob/rachis index high, 1.88; glume/kernel index low, 0.41; rachilla/kernel index intermediate, 0.12; cupule densely hairy. Lower glumes soft-fleshy, sparsely pubescent, the margins deeply cordate. Upper glumes chaffy, venation strong, weakly hairy, tunicate allele *tu* or tu^w; rachis tissue spongy.

Distribution. Pira Naranja is probably an introduction from the south. Only a few farmers are growing it in the Department of

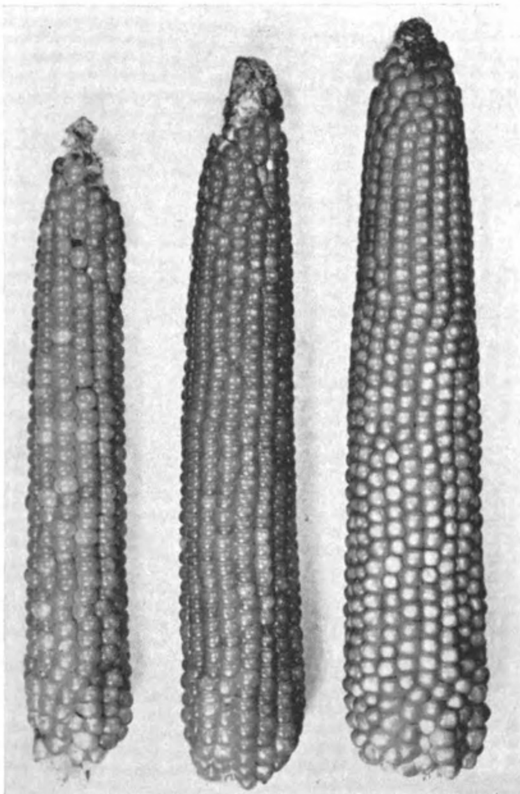

FIG. 10. Pira Naranja, a rather large-eared popcorn with orange-colored endosperm, is found in Colombia, only in Nariño, but counterparts of it have been collected in Bolivia and Chile.

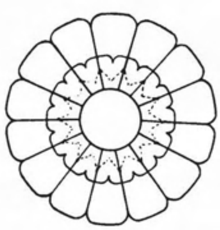

FIG. 11. Ear cross-section diagram of Pira Naranja.

Nariño at elevations of 980 to 1800 meters with an average of 1410 meters (Fig. 5). It also occurs in Ecuador and Chile.

Origin and Relationships. This race of popcorn is quite restricted in its geographical distribution (Fig. 5), having been found in Nariño, the southernmost state of Colombia. It is distinctive in appearance, especially in ear characters (Figs. 10 and 11), differing from the other Colombian race of popcorn, Pira, which is always white. The ears are long and very slender and have grains that vary from lemon yellow to a fairly deep orange color. In many respects the ear characters resemble those of the flint race, Cateto, common in Brazil.

Pira Naranja may be the parent of Montaña. It has the characteristics which are needed to account for those found in Montaña, especially tallness and lateness. (Cf. Table 2.)

Derivation of Name. Pira Naranja means "orange popcorn". The endosperm in this race is a deep orange color similar to the Cateto Flint corn found in Argentina and Brazil.

CLAVO

Plants. Medium height; early; no tillers; many long leaves of intermediate width; venation index medium; plant color and pilosity intermediate; moderately susceptible to races of corn rust and Helminthosporium in central Antioquia; number of knobs high, average 8.6. Adapted to intermediate elevations, 1,000 to 2,000 meters.

Tassels. Long, high number of branches arising in almost one-half the length of the central axis; secondaries numerous, tertiaries frequent, condensation slight.

Ears, External Characters. (Fig. 12). Long, slender, with slight taper toward tip; enlarged base with irregular rows common; average number of rows 11.1; shank very long, thick, hard, frequently breaking a centimeter or so below base of ear; average number of husks medium, 15.5. Midcob color in 83 per cent and glumes colored in 28 per cent of ears examined, lemma colors lacking. Kernels of medium length, width and thickness, well rounded; without denting. Endosperm hard, white; aleurone and pericarp colors lacking.

Ears, Internal Characters. (Fig. 13) Average ear diameter 32

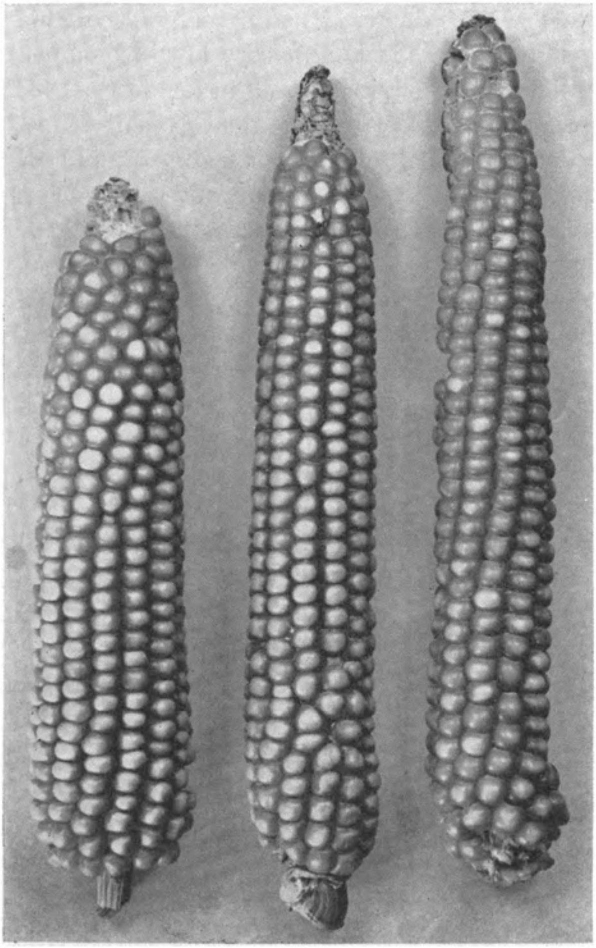

FIG. 12. Clavo, a race with slender flexible cobs, is seldom found in pure form in Colombia, but its introgression into other races is common. It is believed to be the progenitor of the slender-eared races of the Caribbean.

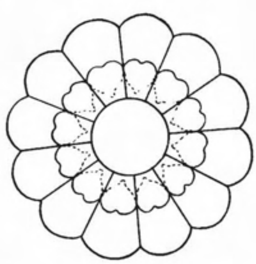

FIG. 13. Ear cross-section diagram of Clavo.

mm.; average cob diameter 18 mm.; average rachis diameter 10 mm.; estimated rachilla length very low, 0.1 mm.; cob/rachis index medium, 1.78; glume/kernel index low, 0.38; rachilla/kernel index very low, 0.01; cupule densely hairy. Lower glumes fleshy, moderately pubescent, the margins sinuate to angulate. Upper glumes papery to fleshy, glabrous, venation moderately strong. Tunicate allele *tu;* rachis tissue horny.

Distribution. Very little of this race is now found in its "pure" state although it has undoubtedly had a profound effect upon several other races in Colombia. This is demonstrated in Figure 14 which shows the distribution of collections of Clavo and its mixtures with other races.

The "pure" Clavos were found growing from 670 to 2,600 meters, with an average of 1,460 meters, in Nariño, Tolima, Caldas and Norte de Santander and Chocó.

Origin and Relationships. Clavo is probably an ancient introduction from Peru. No exact counterpart of it is found in Peru today but types with slender, flexible cobs are not uncommon, especially in the primitive Peruvian popcorn, Confite Morocho, which might well have been the ancestral form of this race. Clavo has been widely distributed. Types similar to it have been collected in Bolivia, Venezuela and Costa Rica.

Clavo or a precursor of it now extinct has entered into the ancestry of many races of maize. In Colombia it may have been one of the parents of Montaña, which is the progenitor of Capio, Amagaceño, Común and Yucatán. Hybridizing with Tuxpeño or something like it, in the northern coastal region of Colombia or the adjoining coastal regions of Venezuela, Clavo has become the progenitor of Puya and Puya Grande. Puya is probably the source of the slender-eared dent corns of the Caribbean, Chandelle and Tusón.

Clavo, as has been mentioned earlier, may also be one of the parents of Cabuya, which is a counterpart of the slender, flexible-cobbed, Harinoso Flexible of Mexico, one of the parents of Olotillo which is the progenitor of Tuxpeño, Zapalote Chico, Zapalote Grande, Vandeño, Chalqueño and Celaya and of the Corn Belt Dent of the United States.

The chromosome-knob number of Clavo, 8.6, is surprisingly

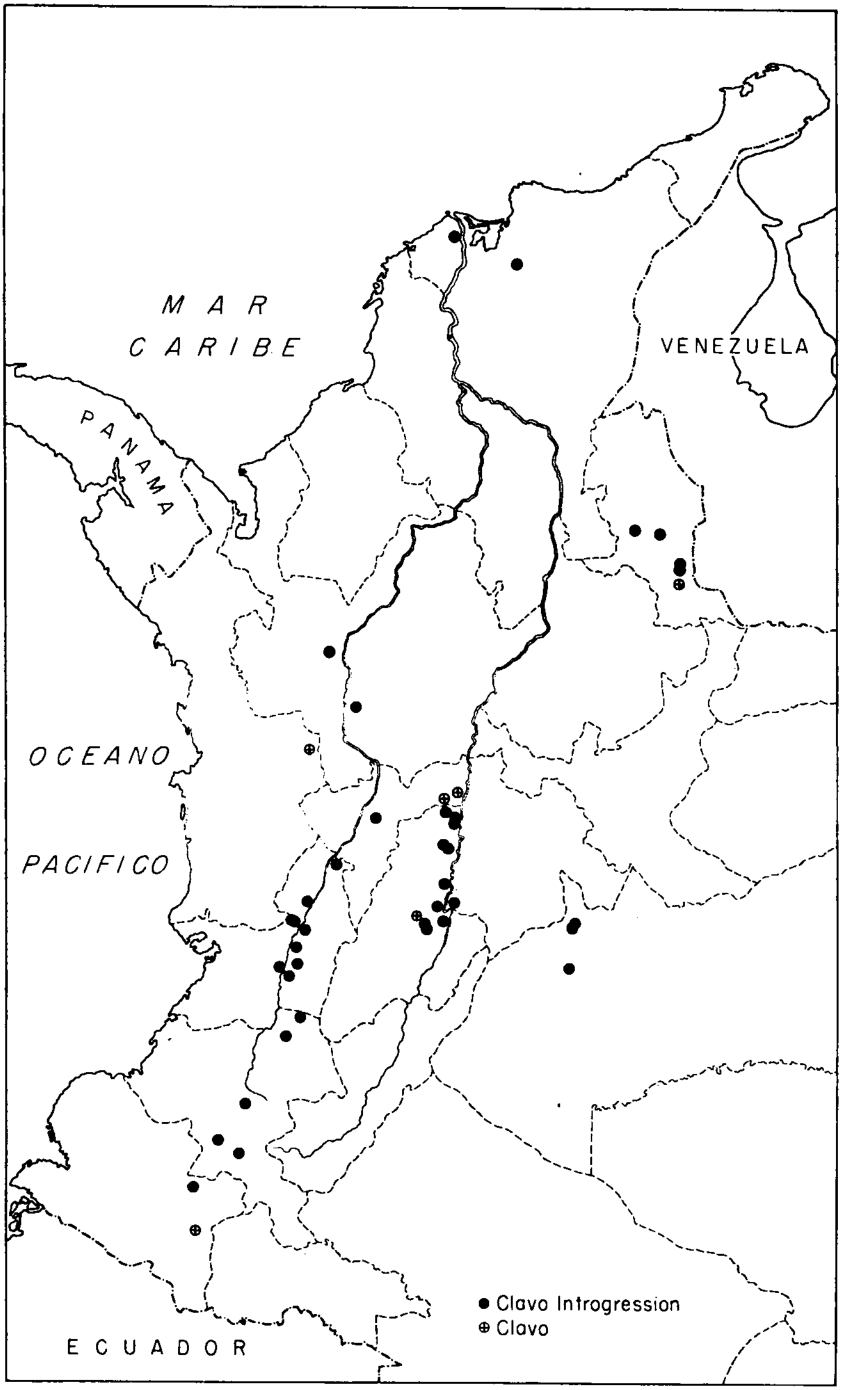

FIG. 14. The distribution of Clavo and Clavo introgression.

high for an ancient "pure" race of maize. However, virtually all of the collections of Clavo from Colombia show admixture with other races. It may be that pure Clavo has disappeared, but certainly its germplasm has become widely distributed.

Because of the lack of tangible evidence, no genealogy is postulated for this race.

Derivation of Name. Clavo is a type which has long, slender, slightly conical ears so the term, which means "nail", is a descriptive one. It is the name most commonly used by the farmers growing this type of corn.

GÜIRUA

Plants. Medium height to tall, early; no tillers; low to medium number of broad leaves of intermediate length; venation index medium; plant color and pilosity intermediate to high; moderately susceptible to races of corn rust and Helminthosporium in central Antioquia. Adapted to intermediate to high elevations, 1,800 to 1,900 meters.

Tassels. Long, with high number of branches arising in almost one-half the length of the central axis; secondaries and tertiaries numerous; condensation low to medium.

Ears, External Characters. (Fig. 15) Predominantly long, slender, tapering slightly from base to tip; some short, thick, conical ears, however, present in all collections; average number of rows 12.2. Shank thick, of medium length; average number of husks 12.7. Midcob color present in 40 per cent of ears studied; glumes colored in 25 per cent and lemmas in 20 per cent of ears examined. Kernels of intermediate length, width, and thickness, well rounded, with denting absent or very shallow. Endosperm moderately hard, white; aleurone blue in all ears studied; red pericarp color common.

Ears, Internal Characters. (Fig. 16) Average ear diameter 34 mm.; average cob diameter 22 mm.; average rachis diameter 11 mm.; estimated rachilla length 2.3 mm.; cob/rachis index high, 1.97; glume/kernel index medium, 0.55; rachilla/kernel index medium, 0.24; cupule sparsely pubescent. Lower glumes papery to fleshy, weakly hairy, the margins nearly straight or sinuate. Upper glumes chaffy, weakly pubescent, venation strong. Tunicate allele tu^{w}; rachis tissue spongy.

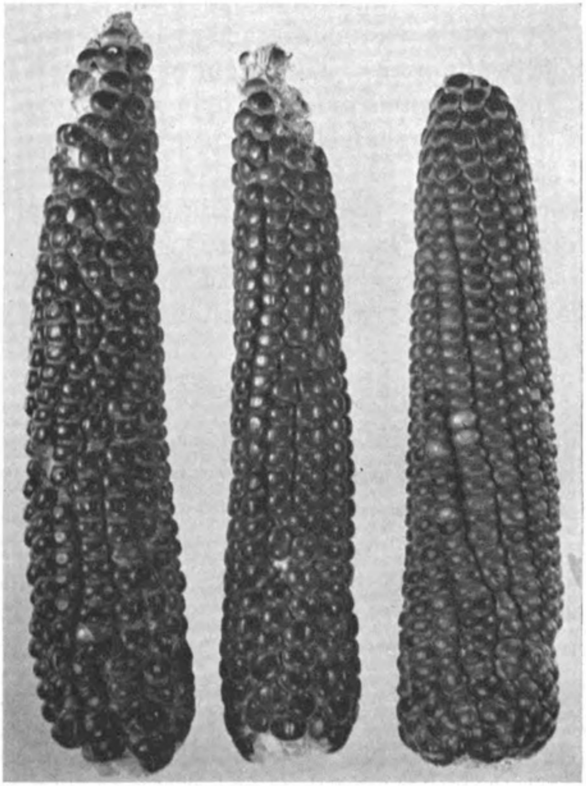

FIG. 15. Güirua, characterized by the deep blue color of the aleurone and long, soft glumes, has been collected only in Magdalena. It has a counterpart in the Guatemalan race, Negro de Chimaltenango, Fig. 46, Wellhausen *et al* (1957).

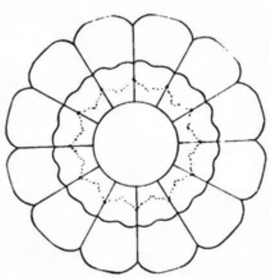

FIG. 16. Ear cross-section diagram of Güirua.

Distribution. Güirua is found only in the Department of Magdalena near the Sierra Nevada de Santa Marta at elevations of 1850 and 1870 meters with an average of 1861 meters (Fig. 17).

Origin and Relationships. The origin of Güirua is not known and it has had no obvious influence upon other races. The long, soft glumes suggest a relatively pure race which may have been introduced early.

Derivation of Name. The name Güirua was applied to this maize by every farmer from whom it was collected. The meaning of the name is unknown, but it is undoubtedly of Indian origin since the race was collected only from Indians who spoke no Spanish.

MAÍZ DULCE

Maíz Dulce (Fig. 18) was found in only two locations in Colombia. Since it is of no importance in the country, the ears and plants were not studied in detail.

Distribution. Maíz Dulce is most probably an introduction from Ecuador or Peru. It was found in Nariño growing at about 2,580 meters (Fig. 17).

Origin and Relationships. Maíz Dulce is not common in Colombia and one of the two collections of it was badly mixed. It undoubtedly had its origin in Peru where a race of sweet corn, Chullpi, related to Confite Puneño, is widely grown for the preparation of *chicha,* the native maize beer. The Maíz Dulce of Mexico resembles that of Colombia more closely than it resembles any of the sweet corn of Peru and is probably derived from it. Neither in Colombia nor in Mexico has Maíz Dulce had any obvious influence on other races.

Derivation of Name. Maíz Dulce is the name applied to the type of endosperm in which the principal carbohydrate is sugar rather than starch. Since very little sweet corn is found in Colombia, there apparently is no other term generally applied to this type.

MAÍZ HARINOSO DENTADO

Maíz Harinoso Dentado (Fig. 19) is seldom found in Colombia and has had no apparent influence on other races. Therefore, no detailed study was made on the plants and ears of this race.

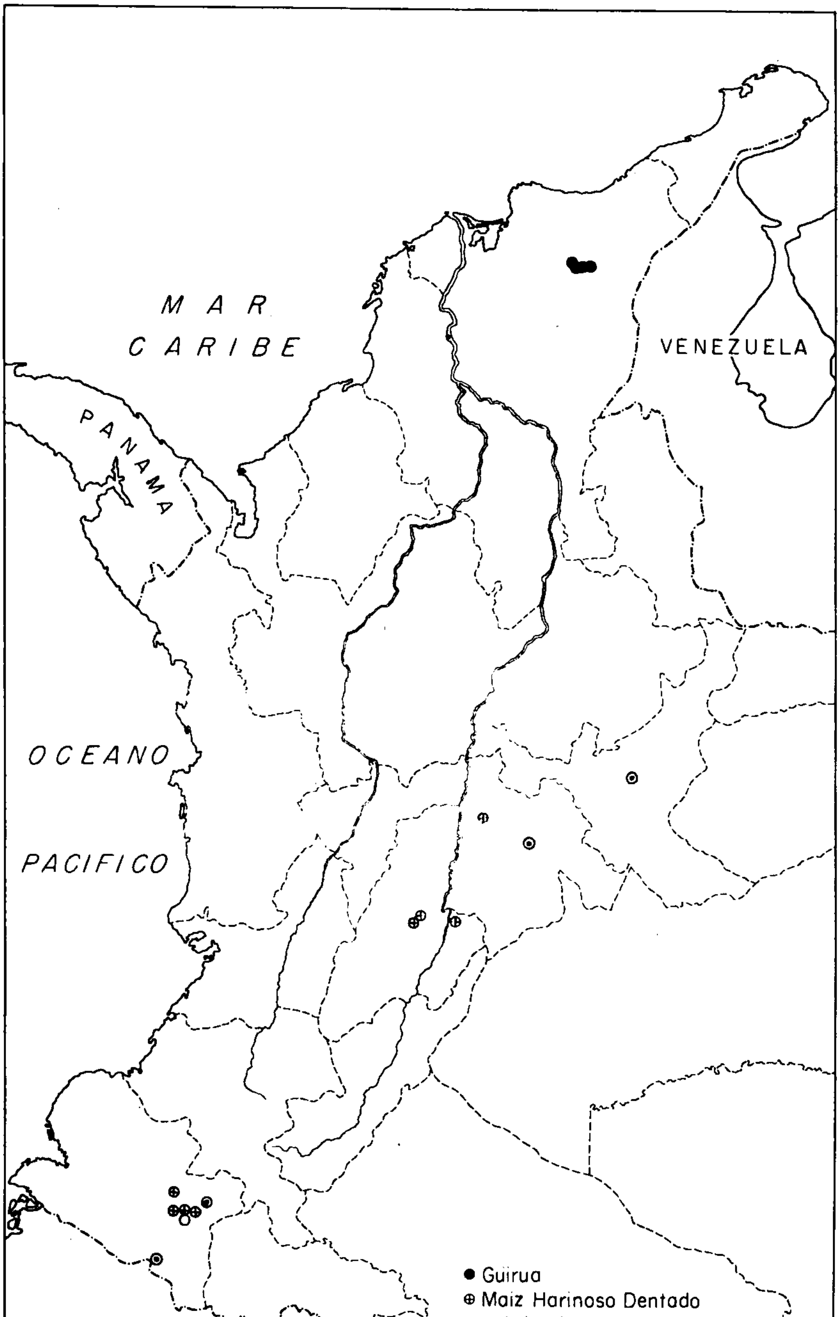

FIG. 17. The distribution of Güirua, Maíz Harinoso Dentado, Imbricado, and Maíz Dulce.

Distribution. Only a few collections have been found in Colombia in the Departments of Cundinamarca, Nariño and Tolima (Fig. 17). It ranges in elevation from 380 to 2600 meters with an average of 1155 meters.

Origin and Relationships. This race may be a recent introduction, probably from Venezuela. A few of the collections are light

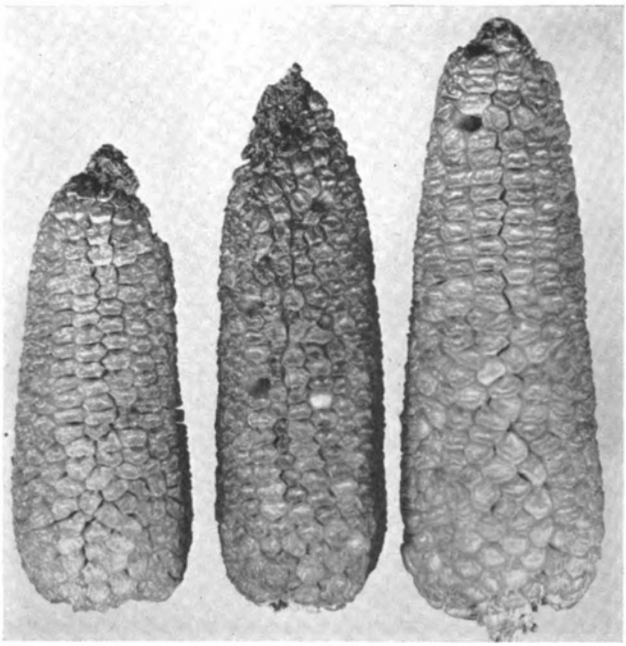

FIG. 18. Maíz Dulce, collected only in Nariño, is similar to the sweet corn race of Mexico (cf. Wellhausen *et al*, 1952, Fig. 27). Sweet corn is rare in Colombia but common in Peru.

yellow in color and extremely dented, which indicates that they may possibly be related to a corn introduced from the United States. Other collections are white and floury, very similar to a Venezuelan race, while others are similar in characteristics to Cariaco.

Derivation of Name. Maíz Harinoso Dentado means "dented flour corn". Hence the name.

CARIACO

Plants. Very short, early; few tillers; medium number of leaves of medium length and width; venation index medium to high; plant color medium, pilosity weak; highly susceptible to races of corn rust and Helminthosporium in central Antioquia; number

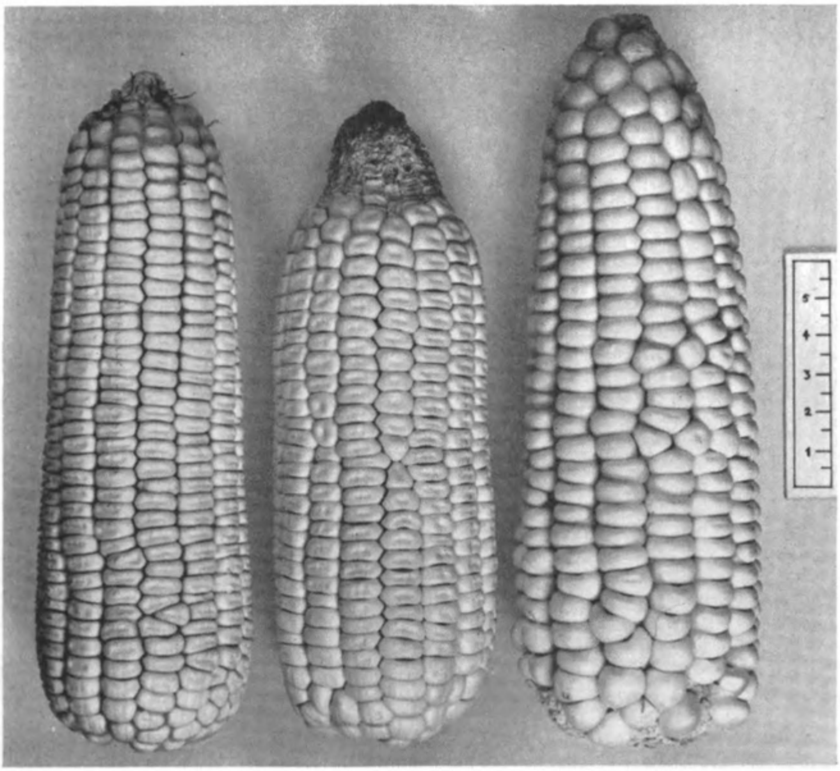

FIG. 19. Maíz Harinoso Dentado, a race with slightly dented, floury seeds, found only rarely in Colombia. It may be related to Cariaco.

of knobs medium, average 5.3. Adapted to low elevations, 0 to 400 meters.

Tassels. Of medium length, very high number of branches arising in one-half the length of the central axis; secondaries numerous, tertiaries common; condensation slight.

Ears, External Characters. (Fig. 20) Short to medium length, very thick, with strong taper from base to tip; average number of rows high, 15.8; shank short and slender; average number of husks very high, 16.0. Midcob color present in 49 per cent of ears examined; glumes colored in 38 per cent and lemmas colored in 41 per cent of ears studied. Kernels of medium length, width, and thickness, slightly rounded to flat with moderate denting. Endosperm soft, floury, white or yellow; aleurone colors not

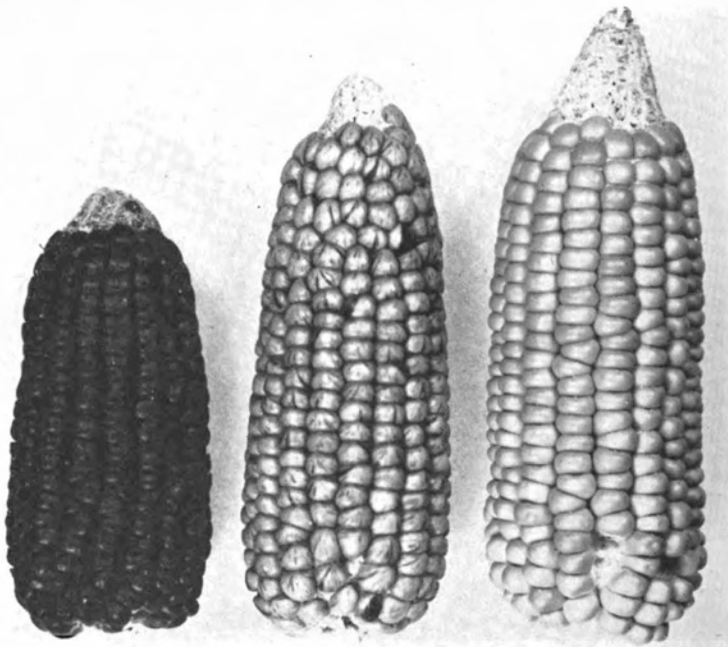

FIG. 20. Cariaco, a flour corn with a high frequency of orange aleurone color. The origin of this aleurone color in Cariaco is unknown, but it may be derived from the lowland corns of Brazil.

uncommon; pericarp colored in nearly one-half of ears studied, stripes especially characteristic.

Ears, Internal Characters. (Fig. 21) Average ear diameter 48 mm.; average cob diameter 29 mm.; average rachis diameter 18 mm.; estimated rachilla length 3.7 mm.; cob/rachis index medium, 1.59; glume/kernel index low to medium, 0.50; rachilla/kernel index high, 0.34; cupule pubescence medium. Lower glumes horny, pilose, the margins angulate to sinuate. Upper glumes papery to fleshy, strongly pubescent, venation moderately strong. Tunicate allele *tu* or tu^w; rachis tissue horny.

Distribution. This race is very similar in its characteristics to Costeño and is adapted to approximately the same region, which includes the northern coastal plain and the Magdalena and Cauca river valleys (Fig. 22). It is not nearly as widely grown as Costeño, however. Cariaco has been collected from 15 to 400 meters elevation with an average of 244 meters.

Origin and Relationships. The close relationship between Cariaco and Negrito and their similarities to Costeño will

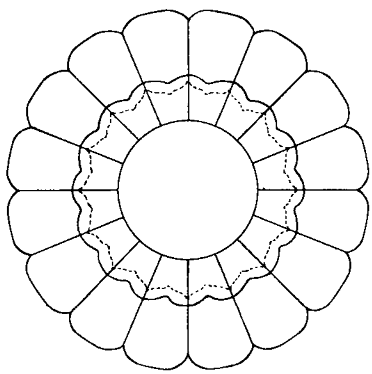

FIG. 21. Ear cross-section diagram of Cariaco.

be noted later in the discussion of the origin of Negrito. It is also suggested that a Brazilian race with large grains and floury endosperm, which was reported by Dr. F. G. Brieger as occurring in the Amazon basin, may have been involved in the origin of Cariaco as well as Negrito. Cariaco, like Negrito, is grown very commonly in the same general region where Costeño is adapted. It is difficult to distinguish between the plants of Costeño, Cariaco and Negrito, although plants of the latter two are on the average shorter. Cariaco has shorter, broader ears with higher row number than Costeño. It has rather large, soft, floury kernels and contains perhaps the highest frequency and most varied combinations of grain colors of any of the Colombian races. Brown and purple aleurone, red and variegated pericarp, and yellow and white endosperm are commonly present in vari-

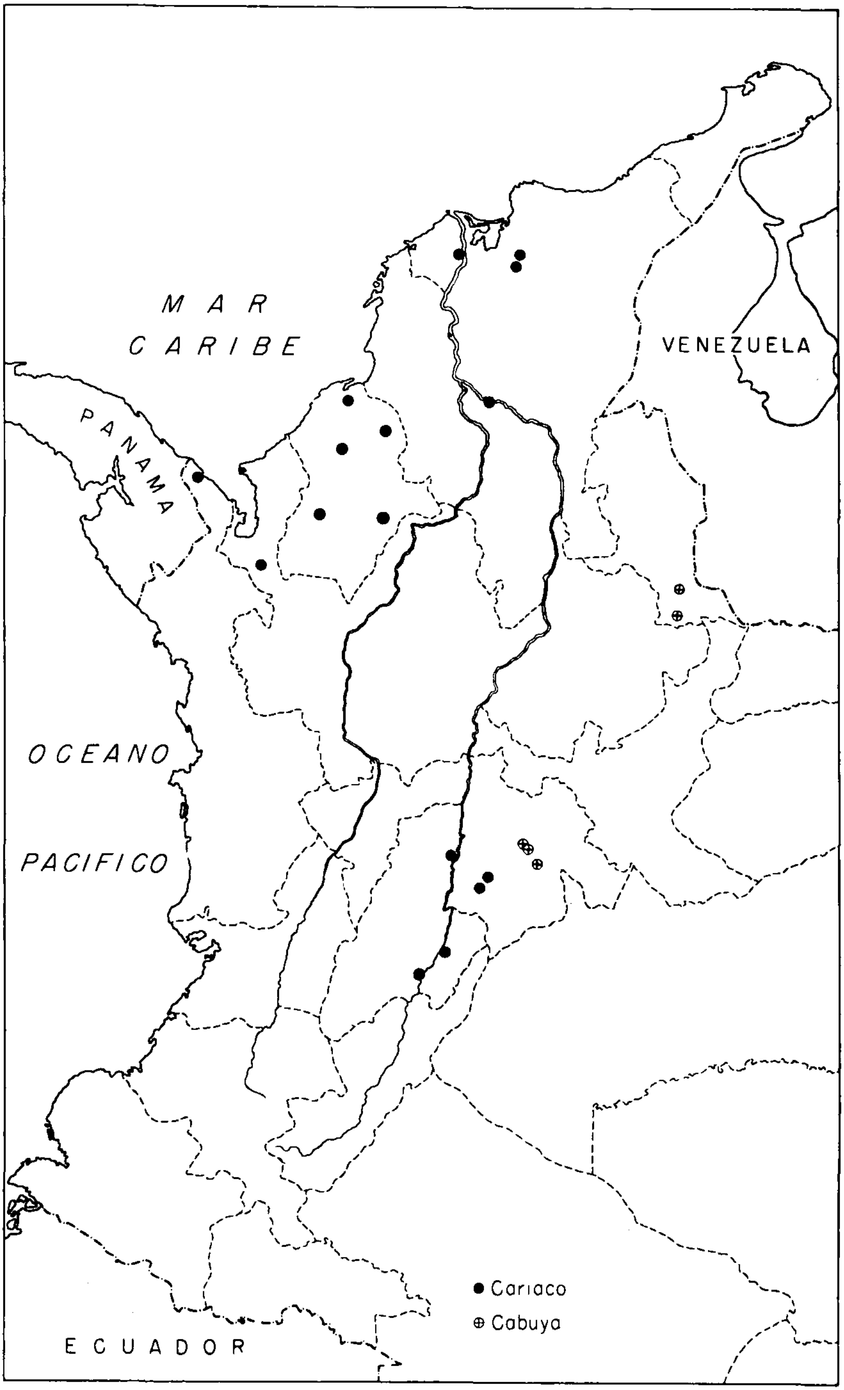

FIG. 22. The distribution of Cariaco and Cabuya.

ous combinations. Cacao is the only other Colombian race that approaches Cariaco in both frequency and variation in grain colors but the Bolivian race Coroico has a high frequency of bronze alleles. This fact, with other evidence, led to a consideration of the possibility that Cacao contributed to the parentage of Cariaco. While this possibility cannot be entirely dismissed at present, it seems more likely that the Brazilian race mentioned above, or one similar to it, rather than Cacao, has been the other parent which combined with Costeño.

Cariaco is used mostly for a special purpose. Fine meal or flour from the dried grain is mixed with dried ground chocolate. This mixture is called "Bola de Chocolate" and is added to hot milk to produce a thickened hot chocolate drink.

Derivation of Name. Cariaco is the name most commonly used for this race by the farmers growing it. The term has no common meaning, but it is probably related to the Gulf of Cariaco on the northern coast of Venezuela.

ANDAQUÍ

Plants. Medium height to tall; very early; no tillers; intermediate number of long leaves of medium width; venation index medium; plant color intermediate to strong; pilosity intermediate; moderately susceptible to races of Helminthosporium and rust in central Antioquia; number of knobs very high, average 10.8. Adapted to low to intermediate elevations, 500 to 700 meters.

Tassels. High number of long branches arising in slightly more than one-half the length of the central axis; secondaries and tertiaries numerous; condensation slight.

Ears, External Characters. (Fig. 23) Short to medium length and diameter, with strong taper toward tip; tip end of cob, usually about 1 cm., seldom sets seed. Slightly enlarged base with irregular rows common; average number of rows low, 10.3; shank of intermediate length and thickness; average number of husks high, 16.6. Midcob color in 83 per cent of ears studied. Kernels wide but relatively short and thin, mostly rounded, with no denting. Endosperm hard, white or yellow; aleurone and pericarp colorless.

Ears, Internal Characters. (Fig. 24) Average ear diameter 36 mm.; average cob diameter 22 mm.; average rachis diameter 14 mm.; cob/rachis index low to medium, 1.59; glume/kernel index low, 0.43; rachilla/kernel index medium, 0.19; cupule pubescence medium to dense. Lower glumes fleshy to horny, weakly to strongly pubescent; margin shape tuniform to angulate. Upper glumes fleshy. Venation none or weak, weakly to densely hairy. Tunicate allele *tu;* rachis tissue spongy to horny.

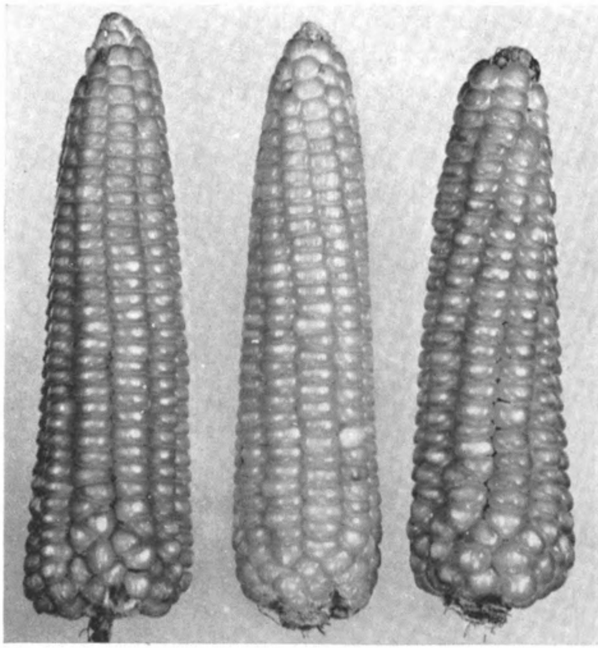

Fig. 23. Andaquí, a race from low altitudes in southern Colombia with tapering ears, flinty kernels, which segregates for a weak pericarp color.

Distribution. Andaquí comes primarily from the Intendencia of Caquetá at elevations of 480 to 700 meters, with an average of 610 meters. It is also found in the upper Magdalena river valley and overlaps to some extent with Yucatán and Común in that region (Fig. 25). This race is also found further south in Peru and Ecuador.

Origin and Relationships. Little is known or can at this time be postulated about the origin of Andaquí. It has the highest chromosome-knob numbers of any race in Colombia and the source of these knobs is a mystery, since neither Chococeño nor teosinte-contaminated maize appears to be involved in its ancestry. Andaquí is probably one of the parents of Yucatán.

Derivation of Name. Andaquí is the name of a tribe of Indians in southern Colombia and of a village in Caquetá where most of the collections of this race were found.

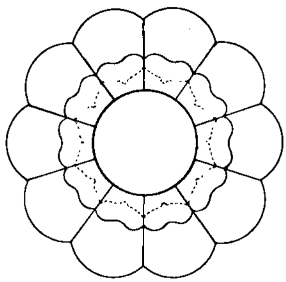

FIG. 24. Ear cross-section diagram of Andaquí.

IMBRICADO

Plants. Medium height, relatively early maturity in the savanna of Bogotá; few short, relatively broad leaves; venation index low; plant color and pilosity very high; moderately susceptible to races of corn rust and slightly resistant to races of Helminthosporium in savanna of Bogotá; knob number very low, average 2.8. Adapted to high elevations, 2,000 to 2,600 meters.

Tassels. Of medium length, high number of branches arising in two-fifths to one-half the length of the central axis; secondaries numerous, tertiaries infrequent.

Ears, External Characters. (Fig. 26) Short, medium thick, conical, with strong tendency to irregular or spirally arranged rows; average number of rows intermediate, 14.3; shank of medium length and thickness, average number of husks low, 8.2. Midcob color present in 92 per cent of ears examined; pith color common; glumes colored in 72 per cent and lemmas colored in 36 per cent of ears studied. Kernels of medium length and thickness, narrow, the apex terminating in a curved beak which overlaps the base of the next higher kernel on the ear. Endosperm

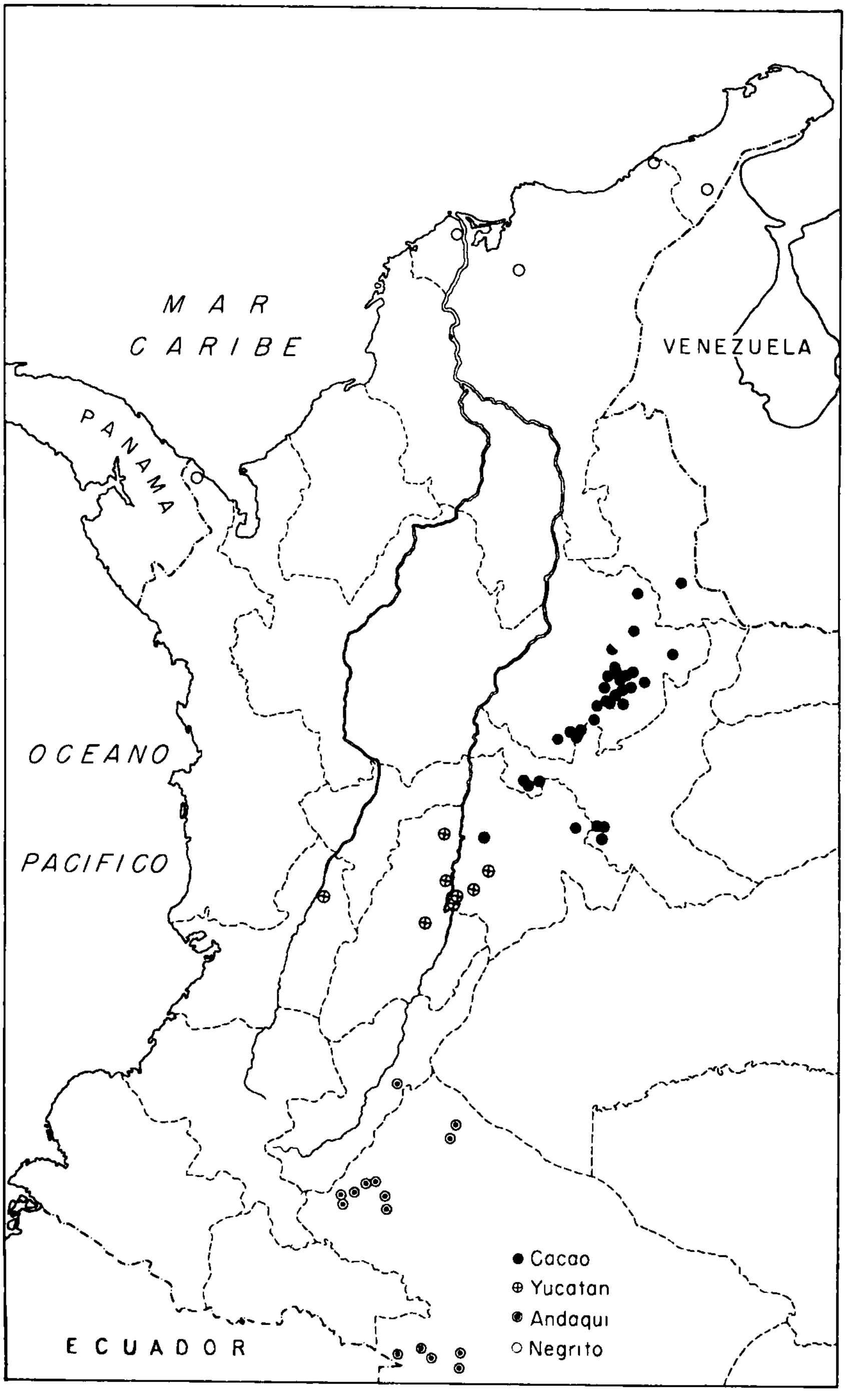

Fig. 25. The distribution of Cacao, Yucatán, Andaquí, and Negrito.

hard, pop-type, white, pericarp colors very common, aleurone colors lacking.

Ears, Internal Characters. (Fig. 27) Average ear diameter 39 mm.; average cob diameter 23 mm.; average rachis diameter 14 mm.; estimated rachilla length 1.9 mm.; cob/rachis index medium, 1.63; glume/kernel index high, 0.77; rachilla/kernel index medium, 0.17; cupule pubescence intermediate. Lower glumes horny, glabrous, the margins cordate. Upper glumes

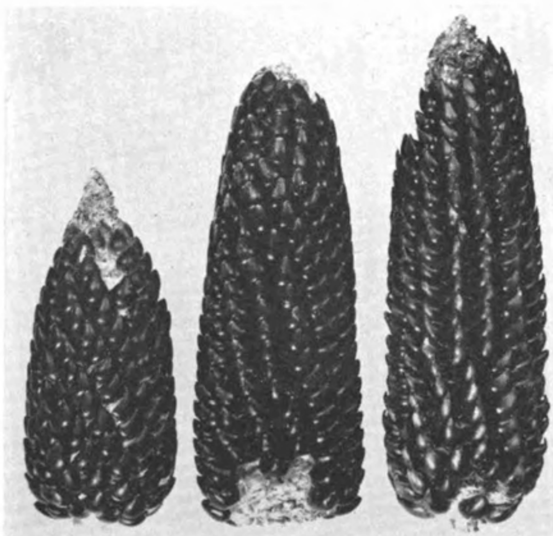

FIG. 26. Imbricado, characterized by pointed, overlapping kernels, is similar to the prehistoric maize of Peru and to the ancient indigenous Mexican race, Polomero Toluqueño (cf. Fig. 8, Wellhausen *et al*, 1952). It also has a counterpart in the Imbricado of Guatemala (cf. Fig. 18, Wellhausen *et al*, 1957).

fleshy, glabrous, venation weak. Tunicate allele *tu* and tu^w; rachis tissue horny.

Distribution. Imbricado is found in abundance further south in Ecuador and Peru. It has introgressed into several of the high altitude Colombian races, especially Sabanero, and the effect of the pointed grain and twisted row in some collections is conspicuous. Only four pure collections of Imbricado have been found in Colombia (Fig. 17). These collections ranged from 2,000 to 2,625 meters elevation; the average was 2,310 meters.

Origin and Relationships. Imbricado is a highland corn with affinities in Ecuador and Peru. Its chief characteristic, imbricated or overlapping kernels, is common in Peru today and was even more common in prehistoric times. Ears with imbricated, pointed kernels are frequent among archaeological maize and among the representations on ancient ceramics.

Imbricado has had little influence upon other races in Colombia, except in the southern part where it has introgressed into Sabanero (Fig. 28).

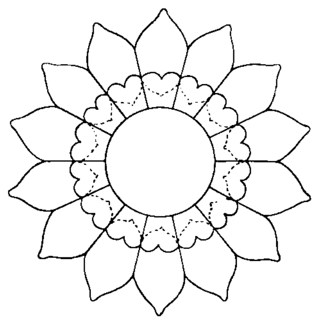

FIG. 27. Ear cross-section diagram of Imbricado.

Derivation of Name. The rows of this race are characteristically twisted and the long pointed grains seem to overlap one another much like the tiles on a roof, hence the name, Imbricado.

SABANERO

Plants. Short to medium height; maturity highly variable even within a single collection, very early to late; no tillers; few short, broad leaves; venation index low; plant color very high; leaf-sheaths strongly pilose, especially so in collections in Cundinamarca and Boyacá (many collections made in Nariño have slight or only moderate plant pubescence); highly resistant to races of corn rust and somewhat resistant to race of Helminthosporium in the savanna of Bogotá; number of knobs very low, average 1.5; many collections knobless. Adapted to high elevations, 2,000 to 2,800 meters.

Tassels. Of medium length, intermediate number of branches arising in two-fifths the length of the central axis; secondaries numerous; tertiaries infrequent; condensation none to slight.

Ears, External Characters. (Figs. 29–31) Of medium length, thick, strongly conical; average number of rows 11.7; shank long, thick, relatively hard, often breaking a centimeter or so below base of ear; husk number medium, 11.5. Midcob color present in

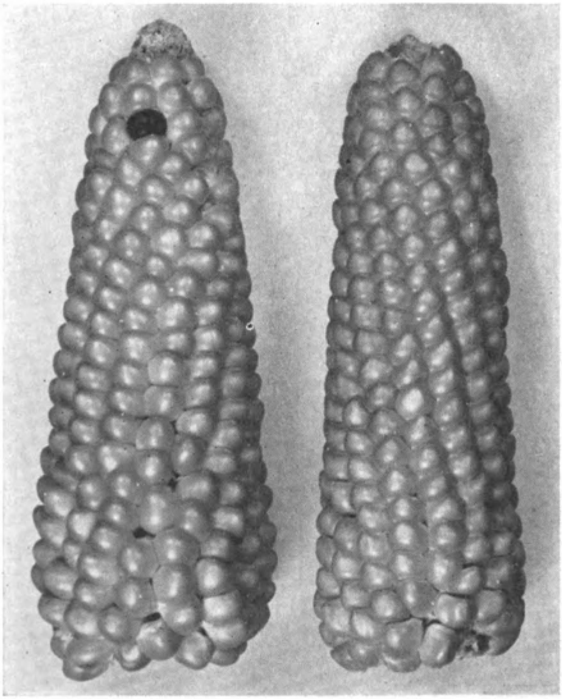

FIG. 28. Introgression of Imbricado into Sabanero. These two races are grown at the same altitudes in Nariño and there has been some hybridization between them. Compare with similar ears in Guatemala, Fig. 17, Wellhausen *et al* (1957).

62 per cent of ears examined; pith color common; glumes colored in 44 per cent and lemmas colored in 12 per cent of ears studied. Kernels wide, thick, of medium length, well rounded without denting. Endosperm very soft, floury, or flinty, white or yellow; aleurone colors frequent, especially those at the bronze locus; pericarp colors common.

Ears, Internal Characters. (Fig. 32) Average ear diameter 44 mm.; average cob diameter 25 mm.; average rachis diameter

16 mm.; estimated rachilla length 2.5 mm.; cob/rachis index medium, 1.60; glume/kernel index low, 0.42; rachilla/kernel index medium, 0.22; cupule slightly hairy. Lower glumes fleshy to horny, weakly pubescent, the margins shallowly cordate. Upper glumes fleshy, sparsely hairy, venation medium. Tunicate allele *tu* and tu^{w}; rachis tissue spongy.

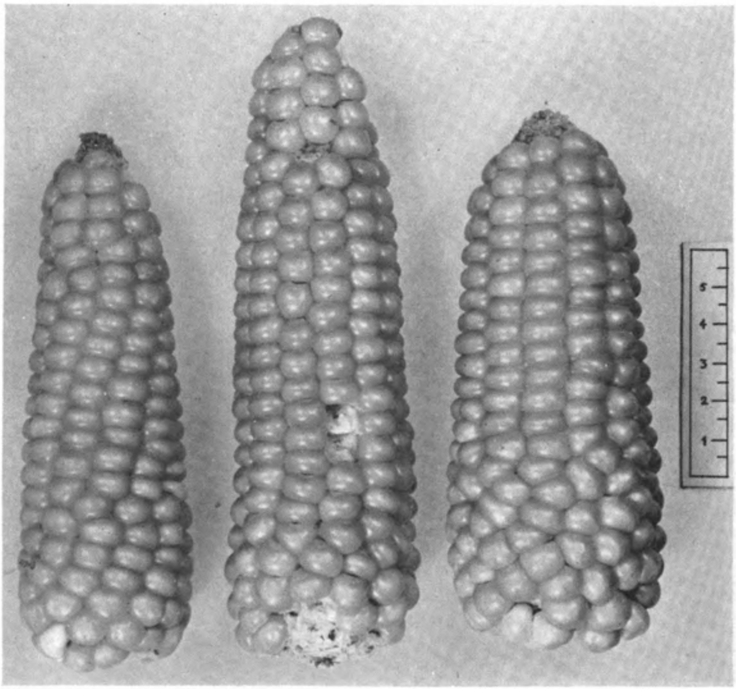

FIG. 29. Sabanero, the most widely grown highland race in Colombia. It has been the parent of three Colombian hybrid races, Cabuya, Montaña and Cacao, and through them has been the progenitor of numerous races in Colombia and other countries.

Distribution. Sabanero is distributed along the eastern cordillera from Venezuela to Ecuador (Fig. 33). A few collections have been made along the central cordillera but very little of this race is grown west of the Magdalena river. This race is the highest altitude corn in Colombia. A few collections were made as high as 3,104 meters while others came from elevations as low as 800 meters. The average elevation for the collections is 2,410 meters.

Origin and Relationships. Sabanero is the most widely grown race at high altitudes in Colombia. It occurs as well in Venezuela, Ecuador and northern Peru. It is also widely grown at high altitudes in Guatemala where it is known as Serrano.

Sabanero is related to the race Morocho of Peru, which is regarded as a derivative of Confite Morocho. Sabanero has some

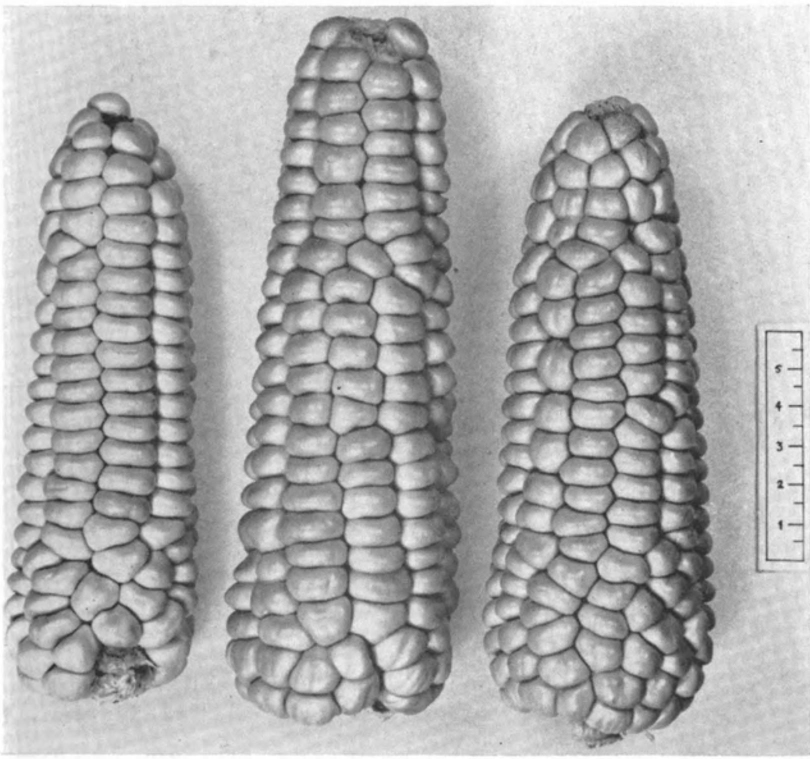

FIG. 30. Sabanero Harinoso Amarillo. Sabanero has both flinty and floury endosperm and both yellow and white endosperm color. These ears are yellow floury. This race has a counterpart in the Guatemalan race Serrano (cf. Figs. 20 and 22, Wellhausen *et al,* 1957).

relationship to the primitive race Pollo of Colombia, but apparently is not, as we once supposed, a derivative of it. The relationship is probably one of reciprocal introgression.

There are five more or less distinct types of Sabanero. The most common is the white flint, but yellow flint, yellow floury, white floury and bronze floury are also found.

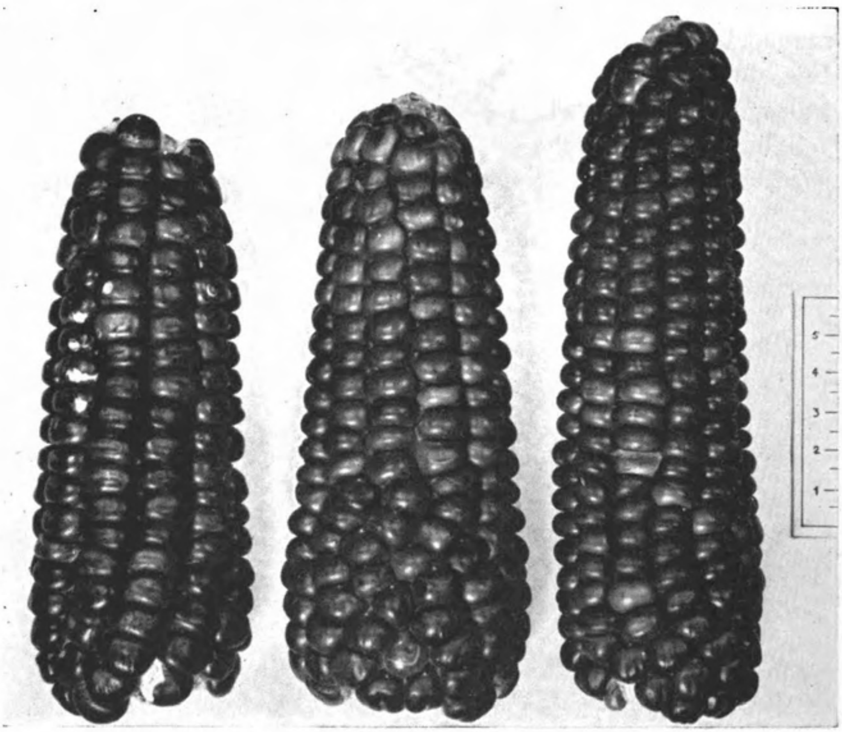

FIG. 31. Sabanero Harinoso Bronce. Some collections of this race are pure for bronze aleurone. Genetically related colors are found in the race Coroico of Bolivia and in lowland Brazilian races. The relationship, if any, between Sabanero and these lowland races is not clear.

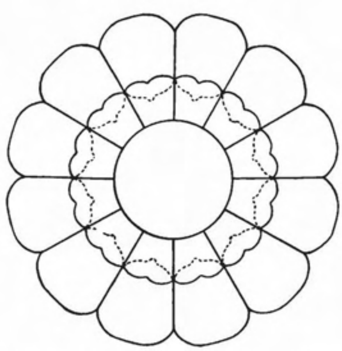

FIG. 32. Ear cross-section diagram of Sabanero.

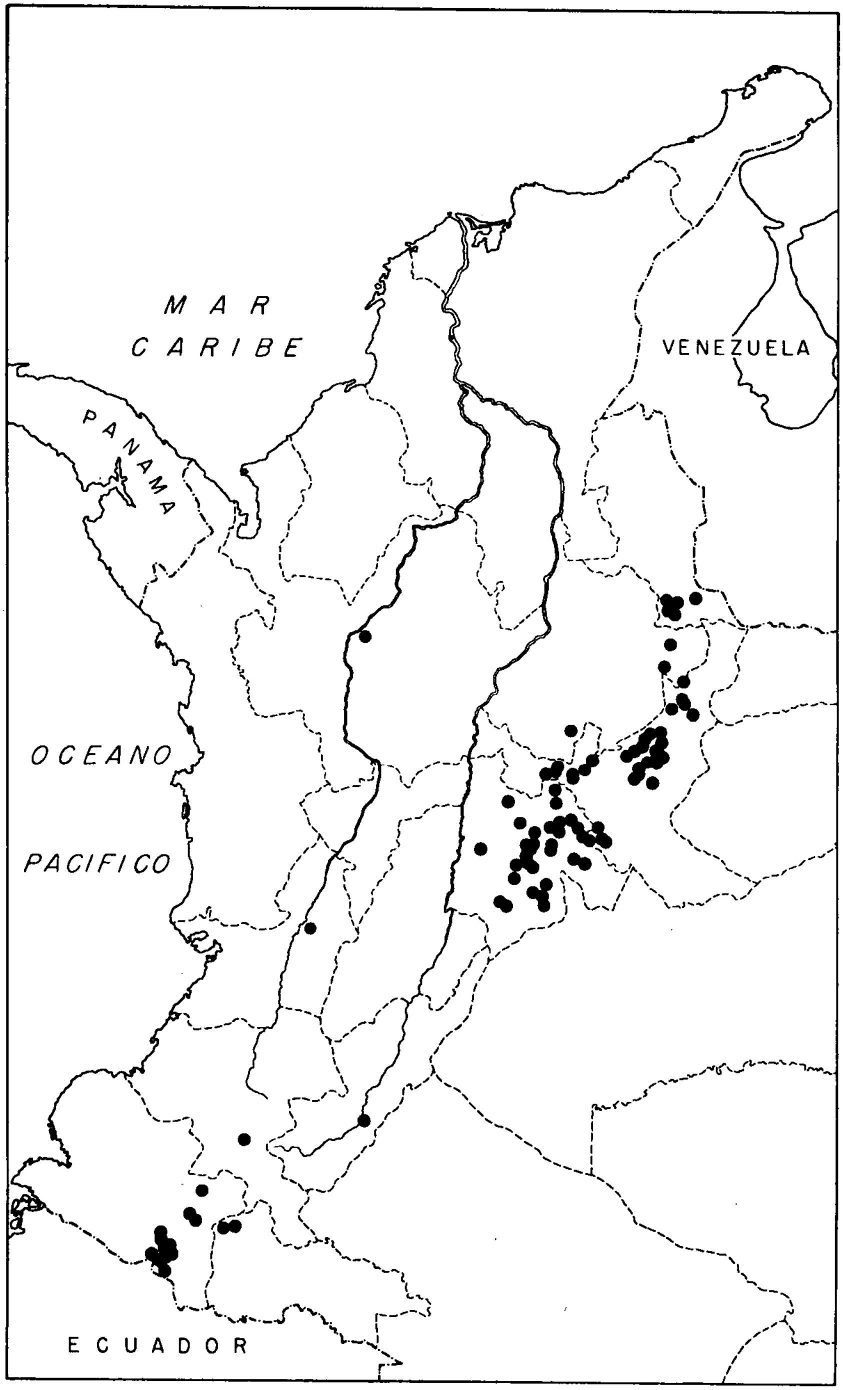

FIG. 33. The distribution of Sabanero.

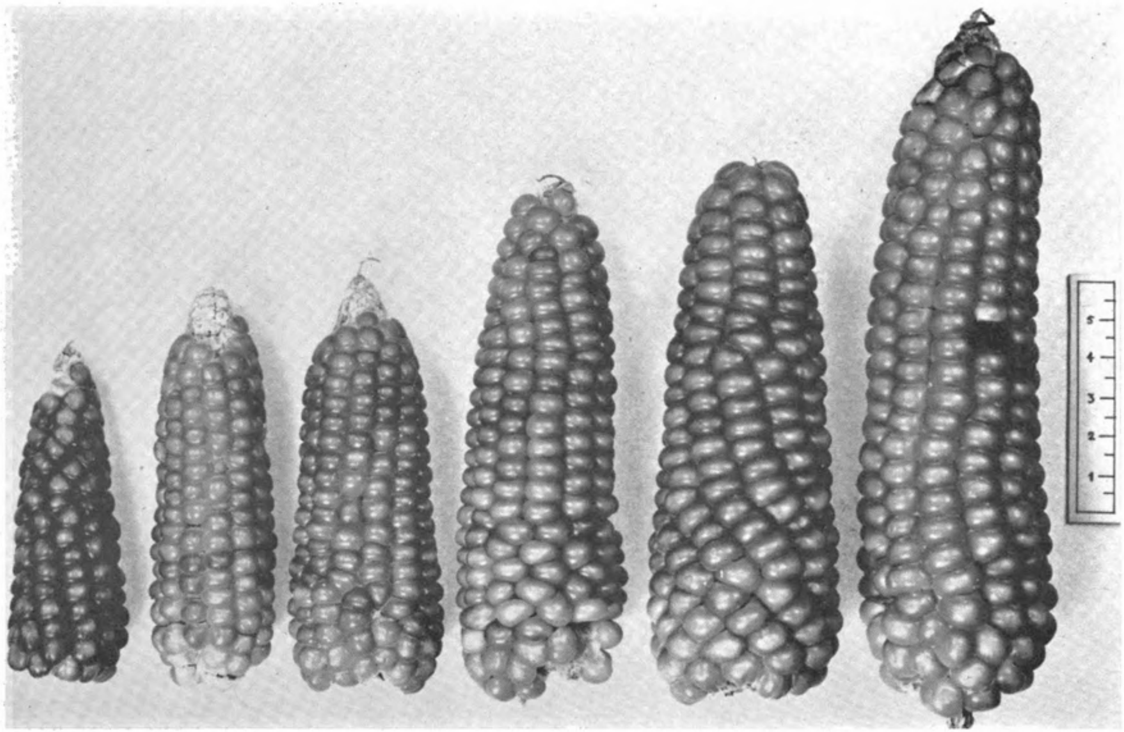

Fig. 34. Introgression of Pollo into Sabanero Cristalino. These two races have overlapping ranges and there is reciprocal introgression between them. No distinctly new race seems to have arisen from this hybridization.

The high incidence of bronze aleurone in Sabanero is puzzling. This color is governed by an allele of brown aleurone, a gene on chromosome 7. There are at least three alleles in the series, brown, orange and bronze. Brown aleurone is quite common in yellow-seeded corn varieties throughout the world but orange and bronze are much rarer. Their frequency is highest in the races Sabanero of Colombia and Coroico of Bolivia, two races which are in other respects quite different and which do not appear to be at all related. No primitive race with orange and bronze aleurone is known. These colors are sometimes found in Pollo but always in collections which, in other characteristics, show admixture with Sabanero.

Sabanero has been the progenitor of numerous races in Colombia and elsewhere. It is one of the parents of Cacao and of Montaña. The latter is the progenitor in Colombia of Capio, Amagaceño, Común and Yucatán. Olotón, the Guatemalan-Mexican counterpart of Montaña, is the progenitor of the Mexican races, Comiteco and Jala.

Sabanero or its derivatives have played a part in the formation of other Mexican races. The Mexican race, Cacahuacintle, is almost an exact counterpart, in ear characteristics, of Sabanero Harinoso Blanco (compare Fig. 35 with Fig. 18 of Wellhausen *et al,* 1952). Cacahuacintle is one of the parents of Cónico, the principal race of the Mexican Plateau, and Cónico is the progenitor of two modern Mexican races, Cónico Norteño and Chalqueño.

Sabanero has participated in still another line of descent in Guatemala and Mexico. Recent studies of Central American maize (Wellhausen *et al,* 1957) indicate that the Harinoso de Guatemala described by Wellhausen *et al,* (1952) is nothing more than a slightly fasciated form of Sabanero Harinoso Blanco. This race is the progenitor of Tepecintle and Tuxpeño and through them has entered into the ancestry of the Mexican races, Zapalote Chico, Zapalote Grande, Vandeño, Celaya, Cónico Norteño and Bolita, as well as the Corn Belt Dent of the United States.

No other race in Colombia has influenced the formation of so many races as Sabanero.

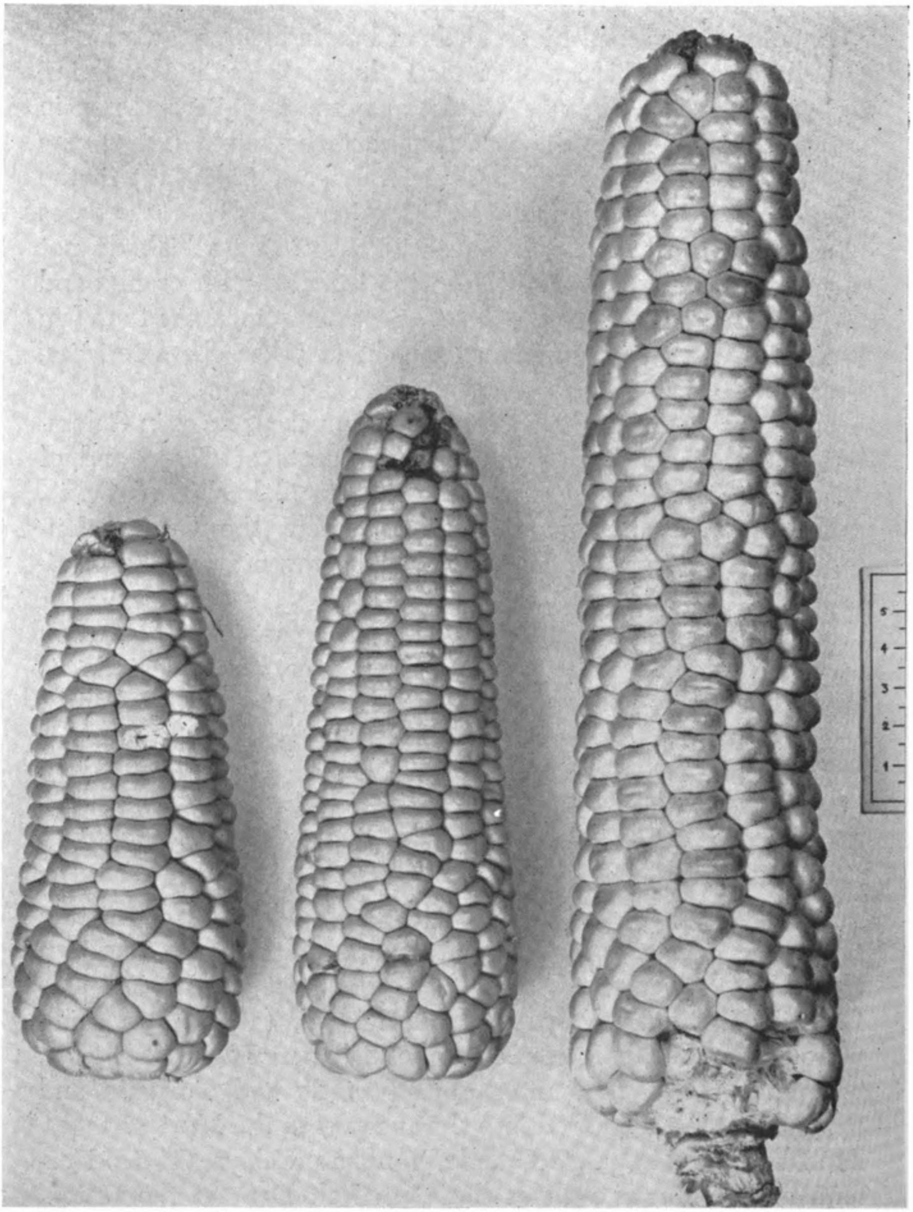

FIG. 35. Colombian counterparts of Mexican races. The two ears of Sabanero (left and center) are similar to Cacahuacintle and the ear of Capio (right) resembles Salpor. Compare with Fig. 18 of Wellhausen *et al* (1952).

Derivation of Name. Sabanero comes from the word "Savanna" (plain) which, in this case, is represented by the "Sabana de Bogotá". Since there are at least four variations of this race, so far as grain type is concerned, all growing in the same region, this designation probably is more generally descriptive. The name "Arroz" (rice) is generally applied to the flinty types, and "Porva" is used for the floury endosperm.

COLOMBIAN HYBRID RACES

The twelve races included in this group are believed to have originated in Colombia through the hybridization of previously existing races. In some cases the evidence for a hybrid origin is quite convincing; in others it is less so. In all instances there is at least some evidence which points to a hybrid origin, and the hybridization would have been possible from the standpoint of the geographical distribution of the putative parents.

There is no evidence to show when the hybridization occurred. However, when a hybrid race, for example Montaña, has been the progenitor of several additional hybrid races in Colombia or in other countries, the inference is strong that the initial hybridization occurred many years ago, probably in prehistoric times. On the other hand, a race such as Yucatán, the final product of a succession of hybridizations, is probably of comparatively recent origin, perhaps coming into existence within the past century.

CABUYA

Plants. Tall; medium to late maturity; no tillers; medium number of broad leaves of medium length; venation index low; plant highly colored with strongly pubescent leaf sheaths; highly susceptible to races of rust in the savanna of Bogotá but moderately resistant to Helminthosporium; number of knobs very low, average 2.2. Adapted to high elevations, 2,100 to 2,600 meters.

Tassels. High number of branches of medium length arising in about one-half the length of the central axis; secondaries and tertiaries numerous; condensation slight.

Ears, External Characters. (Fig. 36) Medium to long, narrow, with slight taper from base to tip; average number of rows very low, 9.3. Shank long and thick; average number of husks low, 9.1. Midcob color in 78 per cent of ears examined; glumes colored in 44 per cent and lemmas colored in 7 per cent of ears studied.

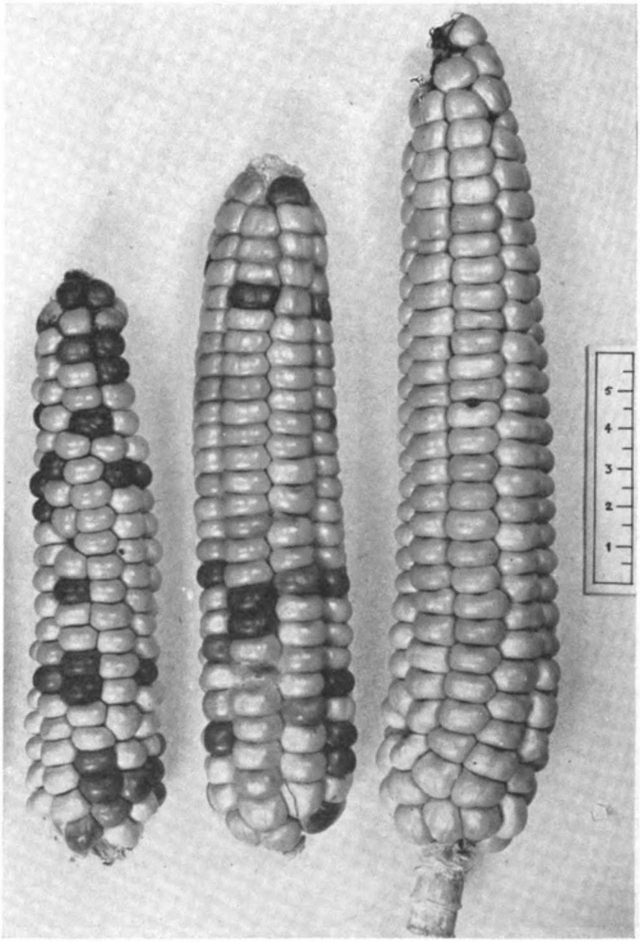

FIG. 36. Cabuya is an eight-rowed flour corn with slender, flexible cobs. It is the Colombian counterpart of the Mexican races, Harinoso Flexible and Harinoso de Ocho which have been the progenitors of a number of important modern races.

Kernels wide to very wide, thick, of medium length, well rounded, with no denting. Endosperm of two types, very soft, floury, or flinty, white or yellow; aleurone colors common; pericarp color infrequent.

Ears, Internal Characters. (Fig. 37) Average ear diameter 37 mm.; average cob diameter 18 mm.; average rachis diameter 8 mm.; estimated rachilla length 1.9 mm.; cob/rachis index very high, 2.14; glume/kernel index low, 0.43; rachilla/kernel index medium, 0.17; cupule pubescence sparse. Lower glumes spongy, strongly pubescent; margin shape shallowly cordate. Upper glumes papery to fleshy, venation strong, moderately pubescent. Tunicate allele *tu* and tu^w; rachis tissue soft.

Distribution. (Fig. 22) Cabuya occupies approximately the same region as Sabanero, although it is not nearly as widely grown. It is often found in field mixtures with Sabanero. Collections have been made from 2,100 to 2,645 meters with an average of 2,380 meters.

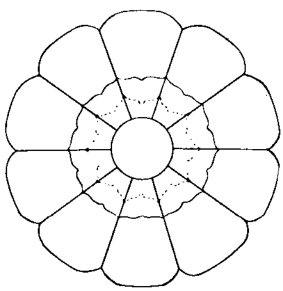

FIG. 37. Ear cross-section diagram of Cabuya.

Origin and Relationships. The origin of Cabuya is reasonably clear. It definitely has affinities with Sabanero and may well be a hybrid of Sabanero and Clavo (Figs. 38–39). It is intermediate in many characteristics between these two races but is significantly outside of the range of either parent in others. Also the cross of Sabanero and Clavo resembles Cabuya very closely in plant characteristics.

Cabuya has remained at high altitudes in Colombia and appears to have had little influence upon other Colombian races. In Mexico, however, it, or something very much like it, has had a wide influence. Wellhausen *et al* assumed that one of the parents of Olotillo was a flexible-cobbed eight-rowed flour corn, Harinoso Flexible, which had since disappeared. Cabuya may represent this hypothetical ancestor or it may be the counter-

FIG. 38. The origin of Cabuya.

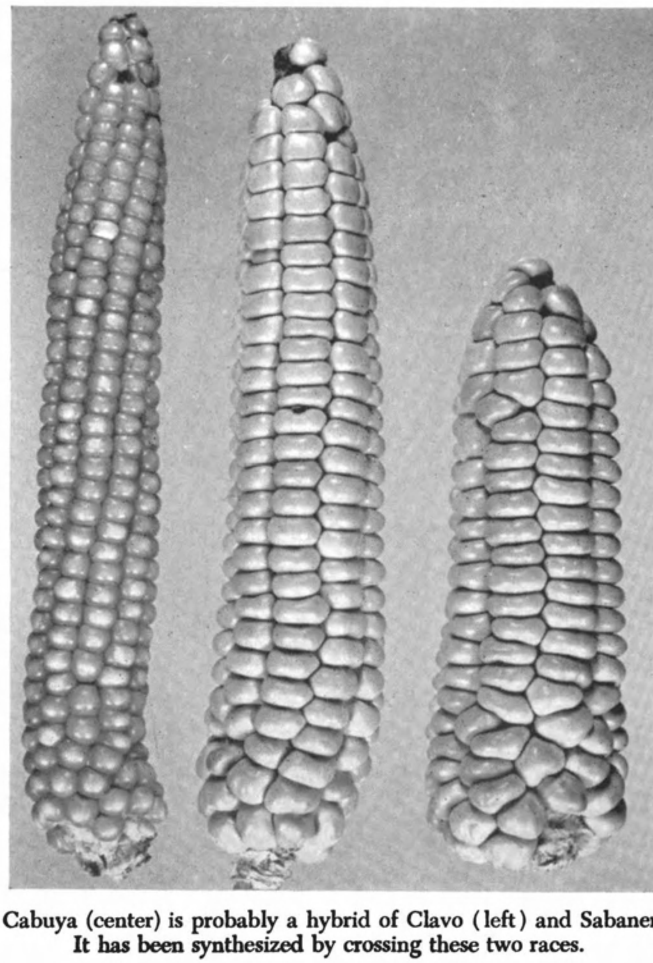

FIG. 39. Cabuya (center) is probably a hybrid of Clavo (left) and Sabanero (right). It has been synthesized by crossing these two races.

part of the Mexican Harinoso de Ocho (compare Figure 40 with Figure 21 of Wellhausen *et al*, 1952). An eight-rowed flour corn with purple aleurone color has recently been collected in Guatemala. Cabuya in Colombia has a high frequency of aleurone color.

If Cabuya is the parent of the Mexican Olotillo, it has had a very wide influence indeed, for Olotillo is one of the parents of Tuxpeño, which enters into the ancestry of a number of additional Mexican races, including Zapalote Chico, Zapalote Grande, Vandeño, Chalqueño, Celaya and Cónico Norteño as well as the Corn Belt Dent of the United States.

Derivation of Name. Cabuya is the name applied to common American agave, sisal or hemp cord used extensively in Colombia. This term, although an exaggeration, is appropriate in describing the long, slender, flexible ears of this race and is commonly applied by the farmers in the regions where it is grown.

MONTAÑA

Plants. Tall, very late; no tillers; many very broad leaves of medium length; venation index very low; plants highly colored; pubescence moderate; highly resistant to races of corn rust and somewhat resistant to races of Helminthosporium in the savanna of Bogotá; number of knobs intermediate, average 5.2. Adapted to high elevations, 2,000 to 2,400 meters.

Tassels. Medium to long, very high number of branches arising in one-half the length of the central axis; secondaries and tertiaries numerous; condensation slight.

Ears, External Characters. (Fig. 41) Very long, thick (although slender in relation to length), tapering slightly from base to tip; enlarged base with irregular rows common; average number of rows 13.2. Shank very long, thick, and hard, usually breaking a centimeter or so below base of ear; husk number intermediate, average 11.6. Midcob color present in 83 per cent of ears examined; glumes colored in 56 per cent and lemmas in 1 per cent of ears studied. Kernels wide and thick, of medium length, denting absent or shallow. Endosperm medium hard, white or yellow; aleurone colors lacking; pericarp colors infrequent.

Ears, Internal Characters. (Fig. 42) Average ear diameter 48 mm.; average cob diameter 26 mm.; average rachis diameter

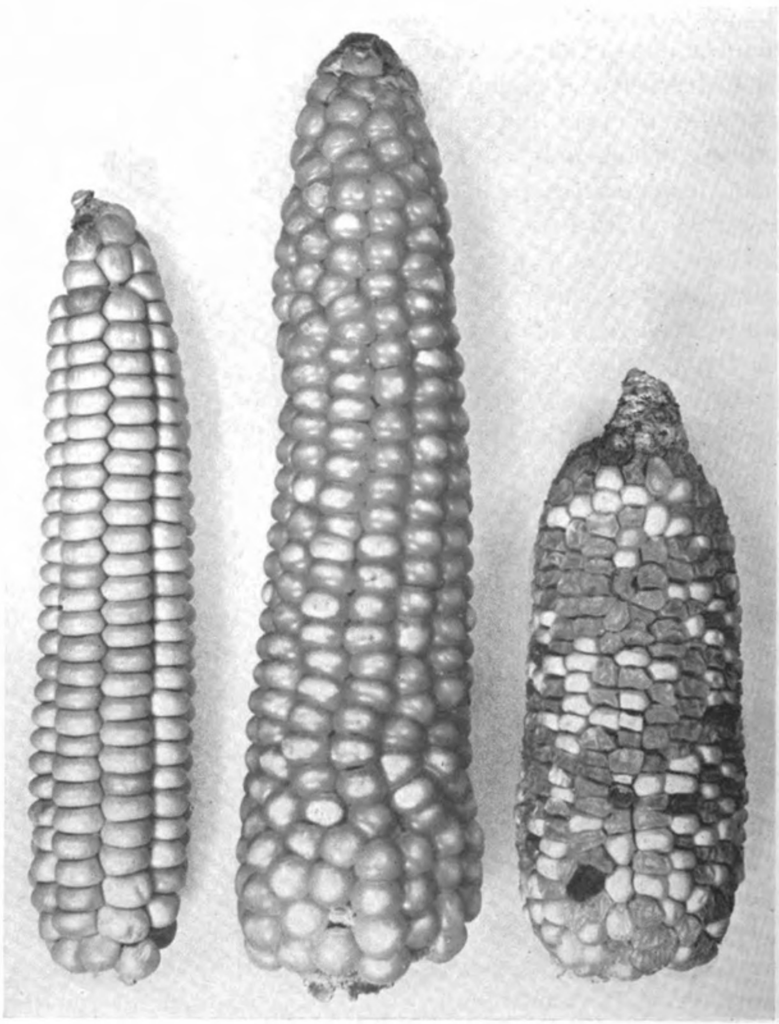

FIG. 40. Ears of Cabuya, Montaña and Maíz Dulce of Colombia which resemble respectively the Mexican races Harinoso de Ocho, Olotón and Maíz Dulce. Compare with Figs. 21, 25 and 27 of Wellhausen *et al*, (1952).

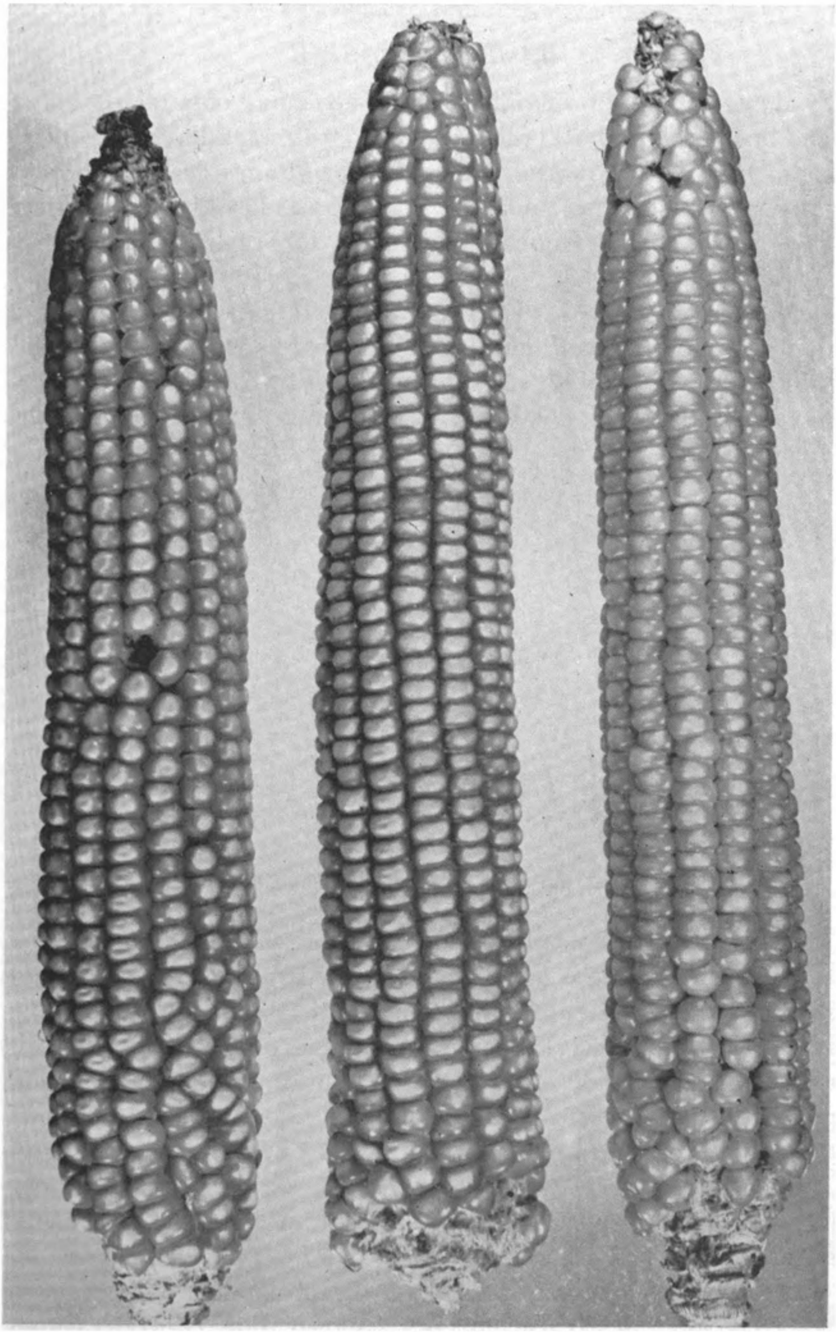

FIG. 41. Montaña is the largest-eared race in Colombia. It is the counterpart of the Guatemalan-Mexican race, Olotón, which is the progenitor of the giant corn of the Jala valley of Mexico. Compare with Fig. 25 of Wellhausen *et al* (1952) and with Figs. 57-60 of Wellhausen *et al* (1957).

15 mm.; estimated rachilla length 4.3 mm.; cob/rachis index medium, 1.78; glume/kernel index low, 0.49; rachilla/kernel index high, 0.36; cupule densely hairy. Lower glumes fleshy to horny, glabrous, the margins sinuate. Upper glumes fleshy, weakly hairy, the venation weak. Tunicate allele *tu* or tu^w; rachis tissue spongy to horny.

Distribution. (Fig. 43) Montaña is found growing mainly along the central cordillera, with one center of concentration in Antioquia and another in Nariño. It is grown principally at elevations between 1,600 and 2,600 meters with an average of 2,230 meters.

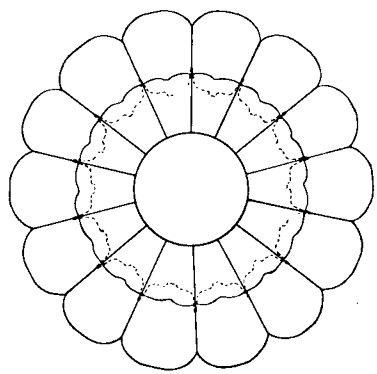

FIG. 42. Ear cross-section diagram of Montaña.

Origin and Relationships. (Figs. 44 and 45) Montaña may be a hybrid of Sabanero and Pira Naranja. It is reasonably certain that one of its parents is Sabanero and, among the races now grown in Colombia, Pira Naranja is the only one which can qualify as the other parent. Montaña is intermediate between its putative parents in many characteristics. In others it appears to combine the characteristics of both or to exhibit hybrid vigor. The extremely large ear of Montaña may be the result of bringing together genes for large diameter from Sabanero and genes for length from Pira Naranja.

In Colombia, Montaña has been the progenitor of four additional races: Capio, Amagaceño, Común and Yucatán. Capio appears to be a direct derivation of Montaña, differing from it primarily in having slightly fasciated ears and grains with floury

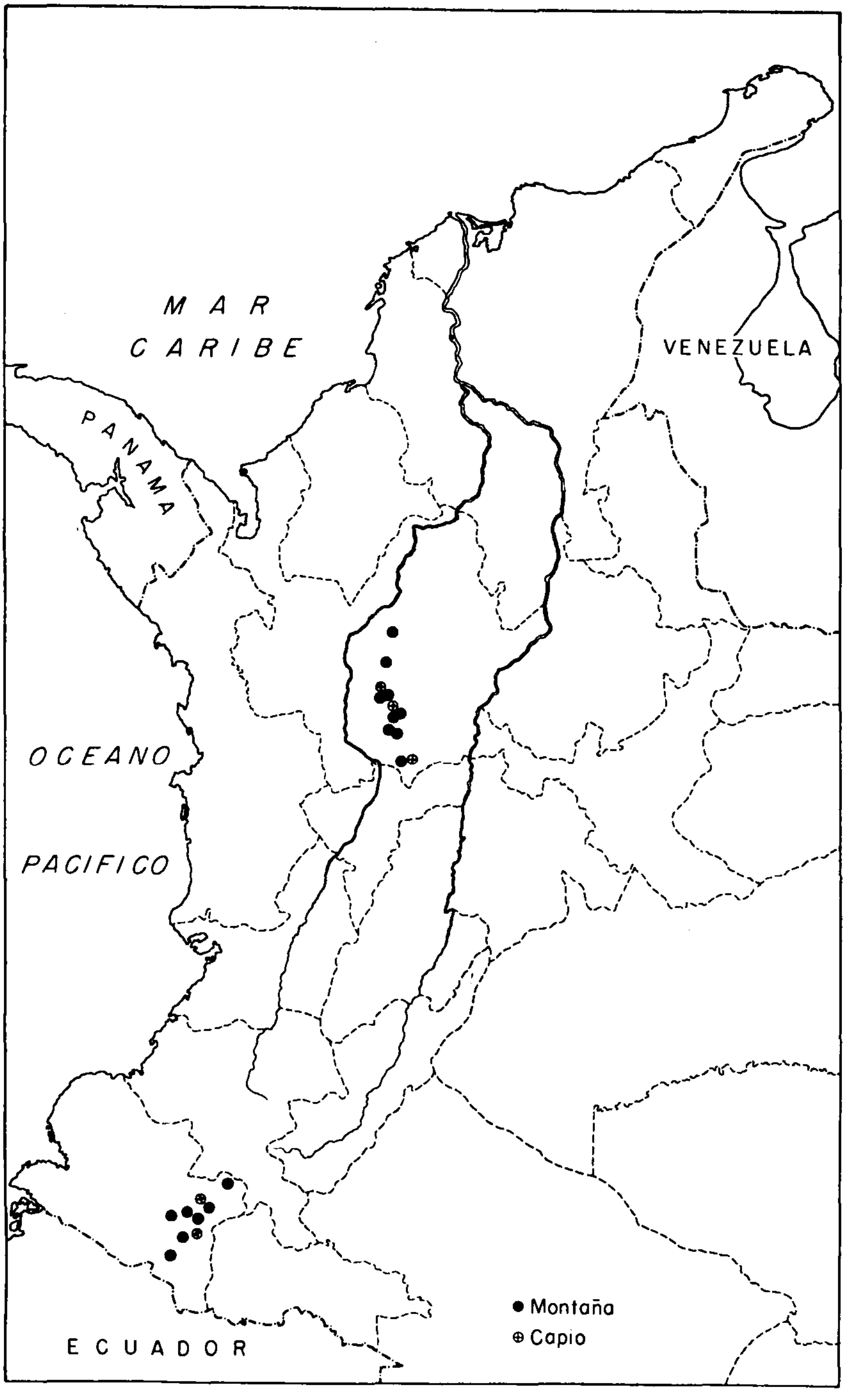

FIG. 43. The distribution of Montaña and Capio.

endosperm. Amagaceño, Común and Yucatán involve additional hybridizations with other races.

Montaña, or something closely related to it, has spread to Guatemala and Mexico, where it is known as Olotón. This race has been one of the progenitors of the Mexican races, Comiteco and Jala.

Derivation of Name. Montaña or "mountain" corn is the name most commonly used for this race. It is also called "Campo Alegre" and "Limeño". However, the term Montaña is more descriptive since this type is mostly grown on the steep hillsides in small fields at high elevations.

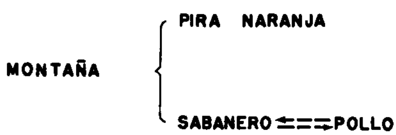

FIG. 44. The origin of Montaña.

CAPIO

Plants. Tall, very late maturing; no tillers; medium number of very broad leaves of medium length; venation index very low; plant color very strong, pilosity medium; highly susceptible to races of rust in the savanna of Bogotá; moderately susceptible to Helminthosporium; number of knobs medium, average 6.2. Adapted to high elevations, 2,100 to 2,400 meters.

Tassels. Medium to long, high number of branches arising in one-half the length of the central axis; secondaries and tertiaries very numerous; condensation slight.

Ears, External Characters. (Fig. 46) Very long and thick, with strong taper from base to tip; enlarged base with irregular rows common; average number of rows medium, 13.0. Shank very long, hard, and thick, usually breaking a centimeter or so below base of ear; average number of husks high, 15.0. Midcob color in 73 per cent of ears examined; glumes colored in 54 per cent and lemmas colored in 19 per cent of ears studied. Kernels wide, very thick, of medium length, rounded, with denting absent or very shallow. Endosperm very soft, floury, white or yellow; aleurone color rare; pericarp color frequent.

Fig. 45. Montaña (center) appears to be a hybrid of Sabanero (right) and Pira Naranja (left). It is intermediate between the putative parents in many characteristics and often exhibits the orange endosperm color of Pira Naranja.

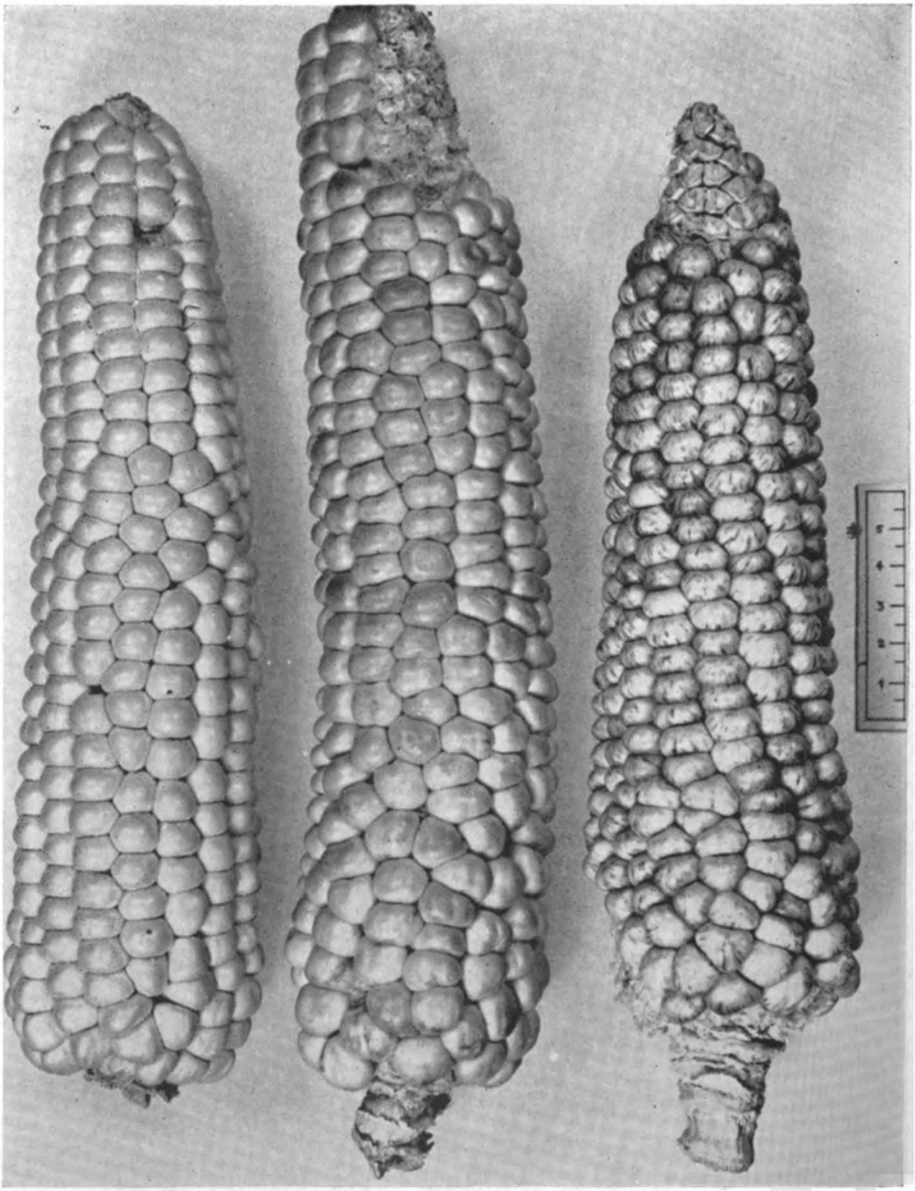

FIG. 46. Capio is little more than a sub-race of Montaña, differing from its parent race in having floury endosperm and a slightly fasciated ear. Capio is the Colombian counterpart of the Guatemalan-Mexican race, Salpor. Compare with Fig. 18 of Wellhausen *et al* (1952) and Fig. 54 of Wellhausen *et al* (1957).

Ears, Internal Characters. (Fig. 47) Average ear diameter 50 mm.; average cob diameter 29 mm.; average rachis diameter 17 mm.; estimated rachilla length 5.1 mm.; cob/rachis index medium, 1.73; glume/kernel index low to medium, 0.51; rachilla/kernel index very high, 0.42; cupule pubescence medium. Lower glumes horny, moderately pubescent; the margins sinuate. Upper glumes fleshy, venation weak, strongly pubescent. Tunicate allele *tu;* rachis tissue spongy to horny.

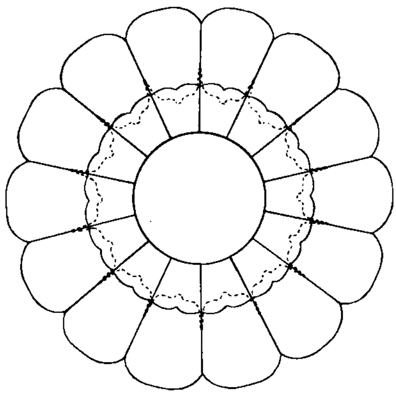

FIG. 47. Ear cross-section diagram of Capio.

Distribution. (Fig. 43) Capio is grown in approximately the same area as Montaña from 2,120 to 2,600 meters with an average of 2,370 meters. With this race there seems to be a color preference; the white endosperm is concentrated in Antioquia and the yellow endosperm is found in Nariño.

Origin and Relationships. (Fig. 48) The evidence is almost conclusive that Capio originated directly from Montaña. In fact, a comparison of the data in Tables 8–13 suggests that Capio is no more than a sub-race of Montaña, differing from it primarily in its floury endosperm. The distinction is of minor importance in indicating natural relationships between races since it depends largely on a single gene difference. These two races have almost the same geographical distribution in Colombia and are adapted to the same elevation (Fig. 43 and Table 13). The similarities in general ear characteristics are shown in the cross-sectional ear diagrams in Figures 42 and 47. There are some differences to be noted, however, such as the longer and broader ear and the thicker rachis and peduncle of Capio. This could have resulted from an introgression into Capio from sources other than Montaña, perhaps from Sabanero Harinoso (Fig. 30).

Capio has a counterpart in the highlands of Guatemala which was described by Wellhausen *et al* (1952) as the race Salpor. A comparison of the photograph of the ears of Salpor (Wellhausen *et al,* Fig. 18) with that in Figure 35 of Capio in the present bulletin illustrates the similarities between these two races.

Derivation of Name. Capio is the name most commonly used for this race of maize by the farmers growing it. The term is a Quechua one for soft, floury maize.

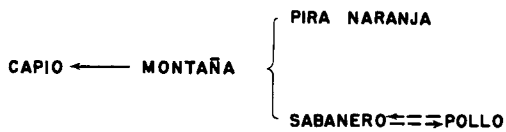

FIG. 48. The origin of Capio.

AMAGACEÑO

Plants. Tall; early to medium maturity; few tillers; many long leaves of medium width; venation index medium; plant color medium to strong, pubescence medium; moderately susceptible to races of Helminthosporium and rust in central Antioquia; number of knobs high, average 8.3. Adapted to intermediate elevations, 1,500 to 2,000 meters.

Tassels. Long, large number of branches arising in one-half the length of central axis; secondaries numerous, tertiaries frequent; condensation slight to absent.

Ears, External Characters. (Fig. 49) Long, thickness medium, with strong taper toward tip; enlarged base with irregular rows common; average number of rows 12.6; shank very long, of medium diameter; average number of husks medium, 10.8. Midcob color present in 86 per cent of ears examined; glumes colored in 56 per cent and lemmas colored in 5 per cent of ears studied. Kernels of medium width, length, and thickness, with denting absent or shallow. Endosperm medium hard, white or yellow; aleurone and pericarp colors frequent.

Ears, Internal Characters. (Fig. 50) Average ear diameter 42 mm.; average cob diameter 23.5 mm.; average rachis diameter

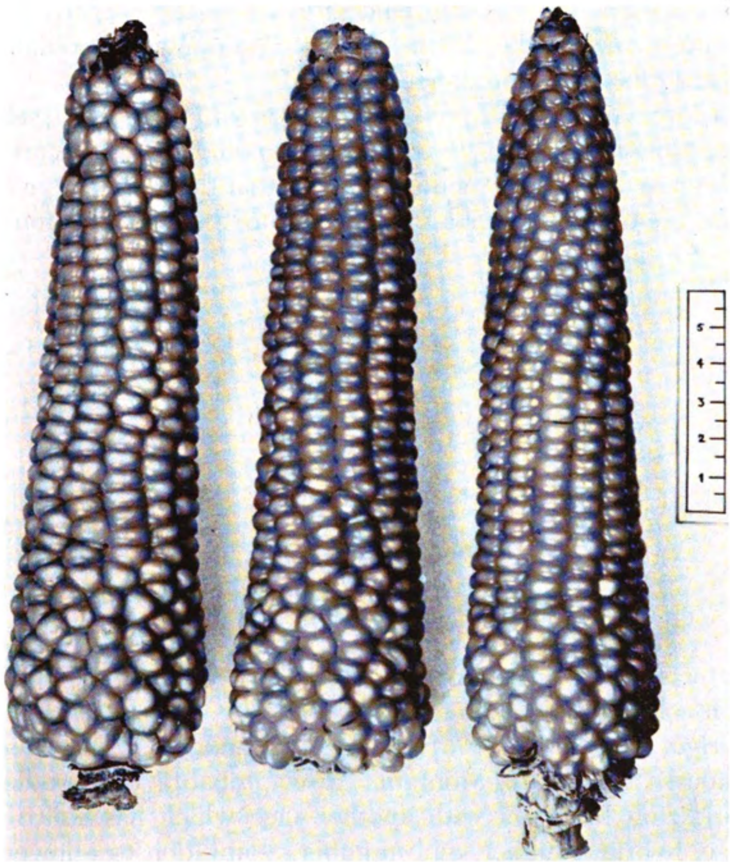

Fig. 49. Amagaceño, a race related to Montaña, is widely grown at somewhat lower altitudes than Montaña.

15 mm.; estimated rachilla length 2.3 mm.; cob/rachis index low to medium, 1.57; glume/kernel index low, 0.39; rachilla/kernel index medium, 0.22; cupule pubescence sparse to medium. Lower glumes horny, glabrous to sparsely pubescent; margin shape angulate to sinuate. Upper glumes fleshy, venation none or weak, glabrous. Tunicate allele *tu;* rachis tissue horny.

Distribution. (Fig. 51) Amagaceño is found along all three cordilleras at elevations from 600 to 2,594 meters with an average of 1,750 meters. From the present viewpoint it is quite difficult to account for the rather wide distribution of this race, since, in general, it is late maturing and low yielding. However, it is found in the medium cold climates in the Departments of Nariño, Cauca, Valle, Huila, Caldas, Antioquia, Cundinamarca, Boyacá, Chocó and Santander.

In fact, Amagaceño probably is more widely spread than any other Colombian race. It may also be noted that it occurs with both white and yellow endosperm and that the yellow type seems to be concentrated further south while the white is found in

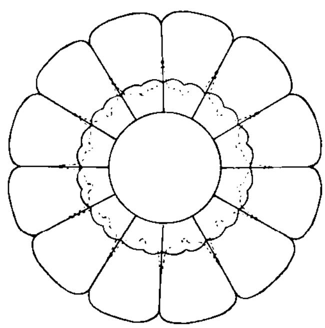

FIG. 50. Ear cross-section diagram of Amagaceño.

greater amount further north. This only indicates that there is a slight color preference in the two regions.

Origin and Relationships. (Figs. 52 and 53) Amagaceño is obviously related to Montaña. It is probably the product of hybridizing Montaña with another race which has contributed to the hybrid a higher knob number, adaptation to a lower altitude and a tendency to produce tillers. This points to Chocoseño as the putative parent. Amagaceño is intermediate between Montaña and Chococeño in the majority of its characteristics (Table 3). The only objection to this postulated origin is that the ranges in altitude of Montaña and Chocoseño do not ordinarily overlap, the one being adapted to about 1,800 to 2,600 meters, the other from sea level to 200 meters.

Their ranges do, however, overlap geographically (Figs. 43

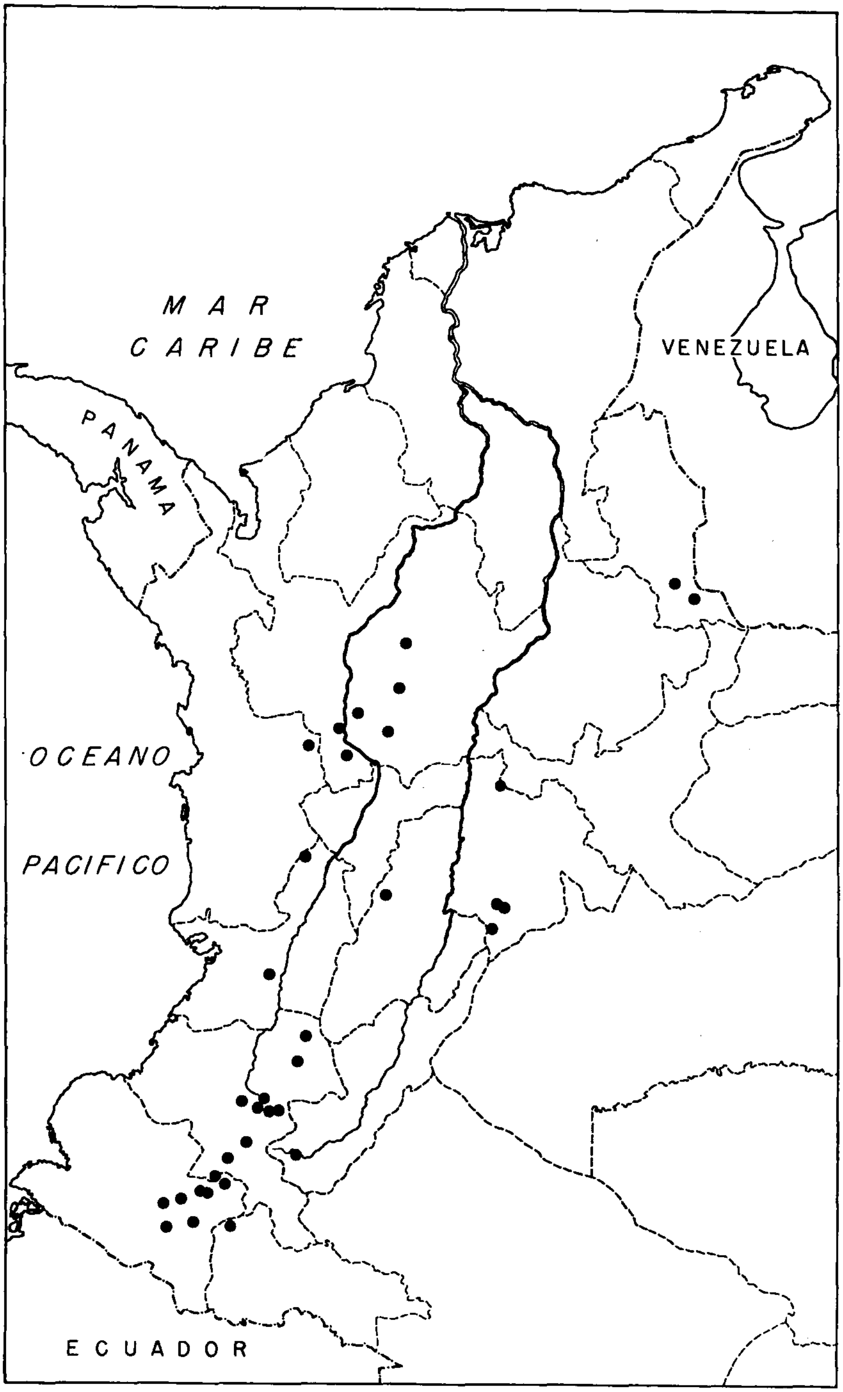

FIG. 51. The distribution of Amagaceño.

and 75) and in the vicinity of Urrao, which is on the main highway between Medellín and the coast, all three races, Chocoseño, Montaña and Amagaceño occur. Amagaceño has been synthesized by crossing Montaña and Chocoseño. In plant characteristics the cross is quite similar to Amagaceño. On the basis of the evidence now available, Amagaceño is regarded as a hybrid of Montaña and Chococeño. The genealogy postulated for it is shown in Figure 52.

Amagaceño, in addition to being widely grown in Colombia, appears to have played a part in the ancestry of Común, another of the most widely grown of all Colombian races. Neither of these seems to have diffused beyond Colombia.

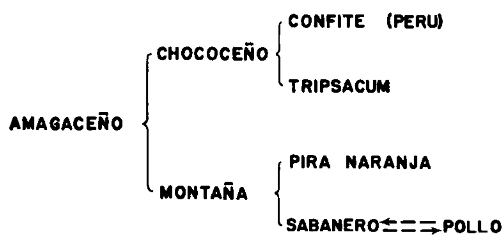

FIG. 52. The probable origin of Amagaceño.

Derivation of Name. Amagaceño comes from the village of Amagá, the locality where this type was first collected. It is commonly called Amagaceño by the populace around Amagá, but elsewhere it is known by several other names such as "De Año", (of a year) and "Yunga".

COMÚN

Plants. Medium to tall; maturity early; few tillers; many long leaves of medium width; venation index medium to high; plant color medium to strong; pilosity moderate; moderately susceptible to races of corn rust and Helminthosporium in central Antioquia; number of knobs high, average 9.8. Adapted to low to intermediate elevations, 800 to 1,400 meters.

Tassels. Long, with high number of branches arising in one-half the length of central axis; secondaries and tertiaries numerous; condensation slight to absent.

FIG. 53. Amagaceño (center) appears to be a hybrid of Chococeño (left) and Montaña (right).

Ears, External Characters. (Fig. 54) Long, thick, nearly cylindrical or with slight taper toward tip; average number of rows medium, 12.7; shank of intermediate length and thickness; average number of husks medium, 12.6. Midcob color present in 64

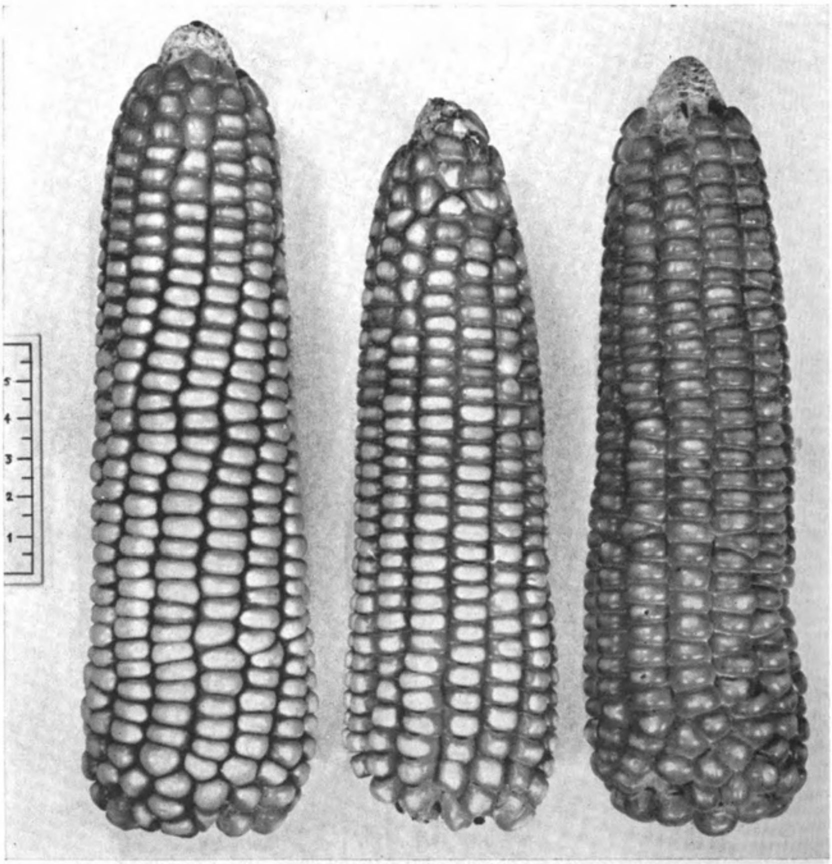

FIG. 54. Común, as its name suggests, is one of the most widely grown races in Colombia, especially at altitudes of 500 to 1,200 meters. It has both white and yellow varieties. This photograph illustrates the yellow variety.

per cent of ears examined; glumes colored in 73 per cent and lemmas colored in 8 per cent of ears studied. Kernels wide, of medium thickness and length, usually flattened and somewhat dented. Endosperm medium hard, with soft-starch column extending to apex of kernel, white or yellow; aleurone and pericarp colors infrequent.

Ears, Internal Characters. (Fig. 55) Average ear diameter 48 mm.; average cob diameter 34 mm.; average rachis diameter 25 mm.; estimated rachilla length 1.3 mm.; cob/rachis index low, 1.35; glume/kernel index low, 0.37; rachilla/kernel index medium, 0.11; cupule pubescence medium. Lower glumes horny, moderately hairy; margin shape undulate. Upper glumes fleshy to horny; venation none or weak, moderately pubescent. Tunicate allele *tu*; rachis tissue horny.

Distribution. (Fig. 56) This race is one of the best agronomic types found among those of Colombia. It is widely grown, especially in the Cauca and Magdalena river valleys at elevations

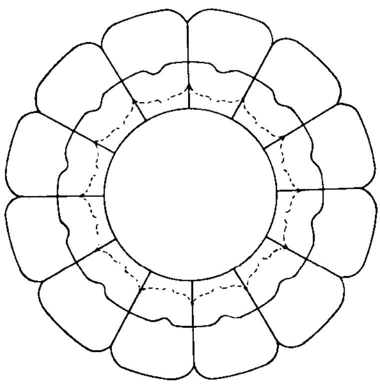

FIG. 55. Ear cross-section diagram of Común.

of 127 to 2,193 meters; the average is 1,040 meters. Very little Común is grown at the higher elevations.

Común occurs in both white- and yellow-seeded forms. There seems to be no particular color preference, since both are found throughout the country from north to south.

Origin and Relationships. (Figs. 57 and 58) It is almost certain that Común is basically Costeño modified sufficiently through hybridization with a high-altitude race to adapt it to the temperate climatic zone. There is strong evidence that the other putative parent is Amagaceño. Común is intermediate or essentially the same as one of the parents in 47 of the characters studied and is outside the limits of either one of the two parents for 11 characters (Table 4). It is intermediate or almost the same as one or the other parent in all plant characters and

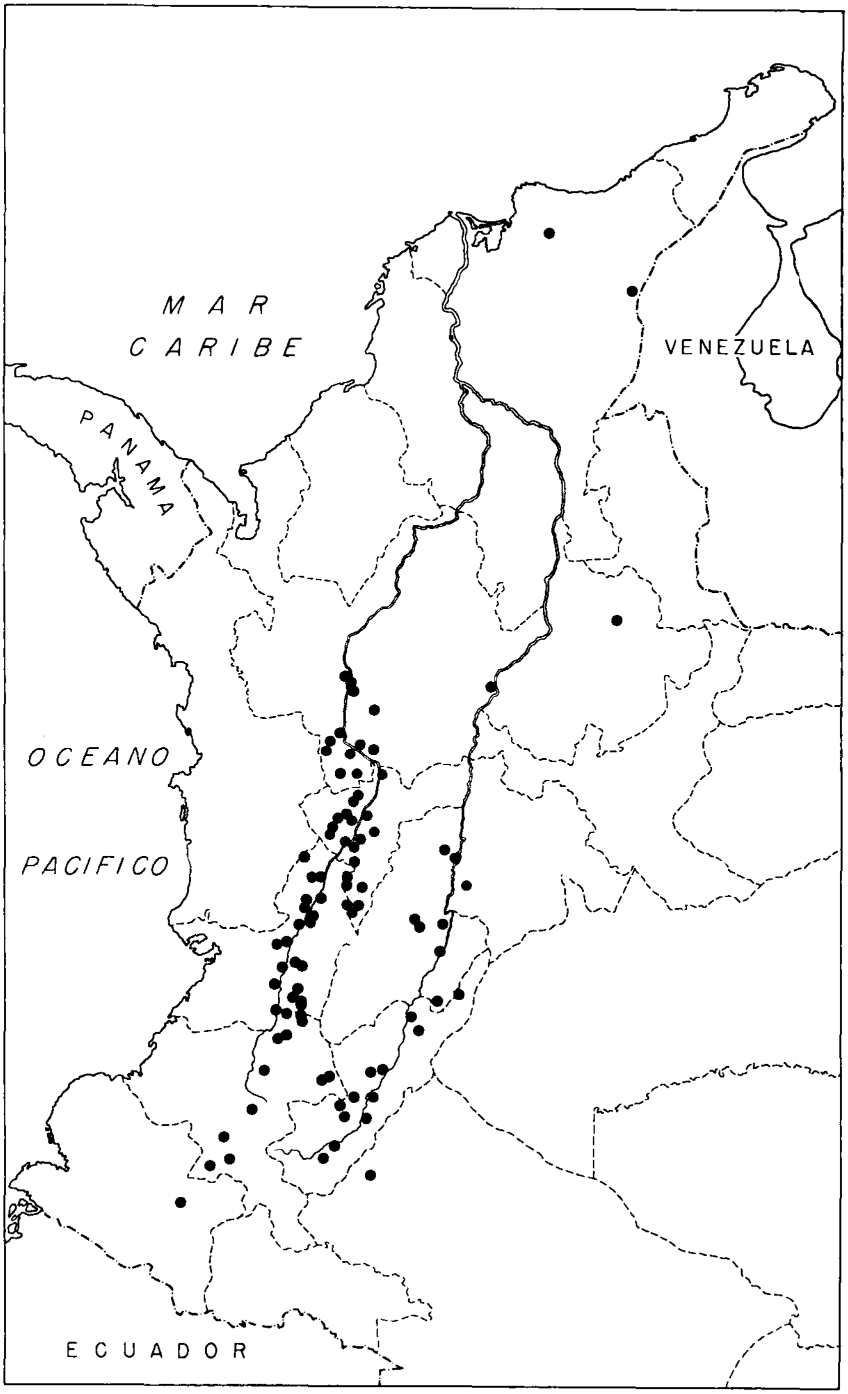

Fig. 56. The distribution of Común.

external ear characters. Costeño has a mean knob number of 9.4 which is among the highest of all the races (Andaquí with 10.8 is the highest). Both of its parents have high knob numbers, with Costeño averaging 9.4 and Amagaceño 7.4. As can be seen from the postulated genealogy of Común, these parents have in turn probably received their high knob numbers from Venezuela Cylindrical Dent, one of the parents of Costeño, and from Chococeño, one of the parents of Amagaceño. There is an overlapping in both range of adaptation to altitude and geographical distribution (Figs. 51, 56 and 75) between Común and its parents,

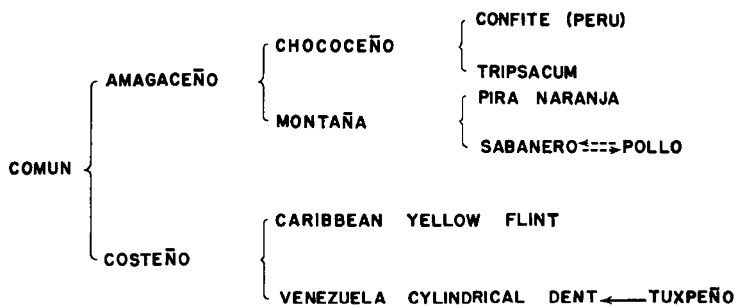

FIG. 57. The probable origin of Común. The Caribbean Yellow Flint in this diagram is actually the Coastal Yellow Flint referred to in the discussion of the origin of Costeño.

Costeño and Amagaceño. Común is principally concentrated in its present distribution in the upper part of the Cauca river valley, with a secondary concentration in the upper Magdalena river valley. It has been the most popular commercial variety in its region of adaptation for at least the past fifty years, according to reports of some of the older living residents in this area. Only in the last five years has it been rather rapidly replaced by some of the new improved varieties and hybrids that have been developed by the cooperative program of the Colombian Ministry of Agriculture and The Rockefeller Foundation. Since Común is one of the highest yielding and most desirable of the native Colombian races, it was thought that it would provide a good source of germplasm for the cooperative corn improvement program. Concentrated efforts to produce good inbred lines from it during the past six years have been disappointing.

Común is probably of recent origin, perhaps having come into existence since the Spanish conquest.

Derivation of Name. Común is a type widely grown in the

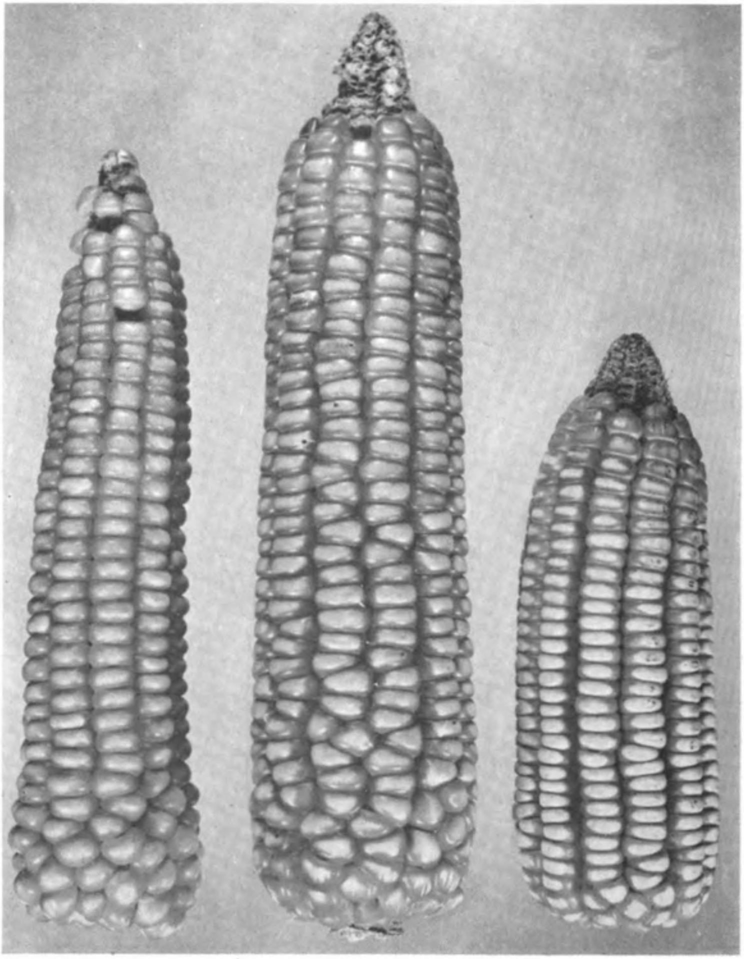

FIG. 58. Común (center) may be a hybrid of Amagaceño and Costeño. Although not intermediate between these races in all characteristics, it has affinities with both.

medium altitudes of Colombia and it is called by this name throughout the region where it is used. It is also called "Diente de Caballo", (horse tooth), a somewhat misleading name, in and around a few villages. "Común" means common or ordinary.

YUCATÁN

Plants. Medium to tall; early, no tillers; intermediate number of long leaves of medium width; venation index medium; plant color and pilosity intermediate; highly susceptible to races of rust and Helminthosporium in central Antioquia; number of

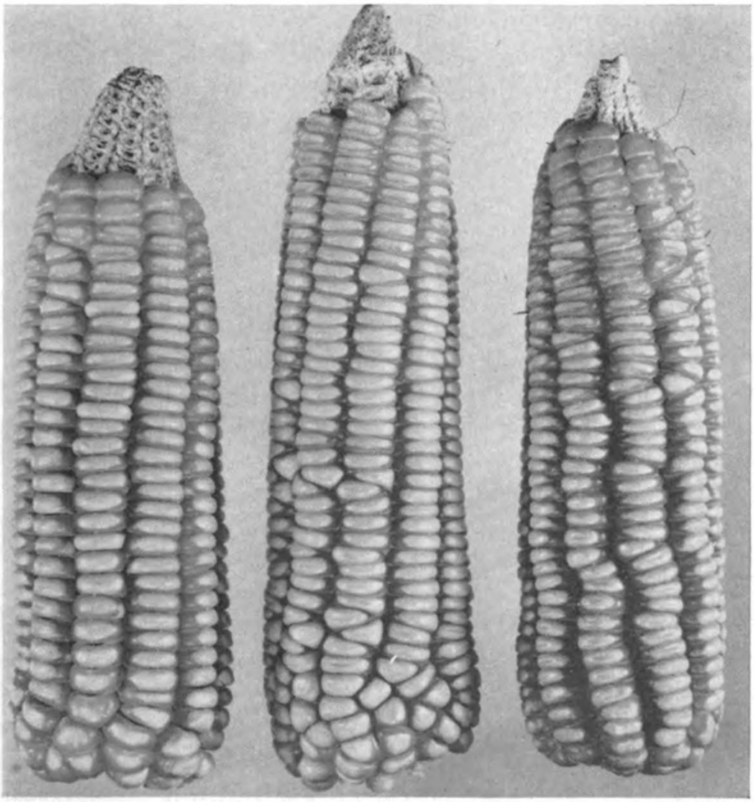

FIG. 59. Yucatán is closely related to Común but differs from it in having vitreous, somewhat translucent kernels and a weak brownish "dirty" pericarp color.

knobs high, average 10.2. Adapted to low to intermediate elevations, 500 to 1,000 meters.

Tassels. Long, high number of branches arising in one-half the length of the central axis; secondaries and tertiaries numerous; condensation slight or absent.

Ears, External Characters. (Fig. 59) Long, thick, nearly cylindrical or with slight taper toward tip, one to two centimeters of which seldom sets seed; average number of rows, 10.8. Shank relatively short, thick; average number of husks high, 15.1. Mid-cob color present in 56 per cent of ears examined. Kernels very wide, long, of intermediate thickness or thin; relatively flat, with shallow denting. Endosperm medium hard, white; aleurone color lacking; pericarp commonly greyish.

Ears, Internal Characters. (Fig. 60) Average ear diameter 47 mm.; average cob diameter 29 mm.; average rachis diameter 18 mm.; estimated rachilla length 3.0 mm.; cob/rachis index

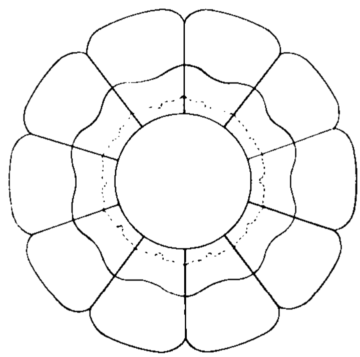

FIG. 60. Ear cross-section diagram of Yucatán.

medium, 1.63; glume/kernel index low to medium, 0.42; rachilla/kernel index medium to high, 0.25; cupule pubescence intermediate to strong. Lower glumes horny, mostly pilose; margin shape sinuate. Upper glumes fleshy, venation none or weak, pilose. Tunicate allele *tu;* rachis tissue horny.

Distribution. (Fig. 25) Yucatán is found principally in the upper Magdalena valley where the river borders Cundinamarca and Tolima. The elevations range from 350 to 1,350 meters with an average of 585 meters. Very similar maize is found in the upper Cauca river valley in the vicinity of Cartago. The most apparent difference between the two is that the Cauca material has a red cob and most of the Yucatán from the Magdalena valley has a white cob. In all other characteristics they appear to be identical.

Origin and Relationships. Early in the studies of the Colombian races, Yucatán was considered only a sub-race of Común that had been changed somewhat through selection under semi-isolated conditions. Most of its characters are similar to those of Común. Additional information obtained as the studies progressed made it evident that some other race had entered into the parentage of Yucatán. Otherwise it would be difficult to explain the degree of differences found between Yucatán and Común in certain characters. Although the plants of Yucatán have the same general appearance as those of Común, they are

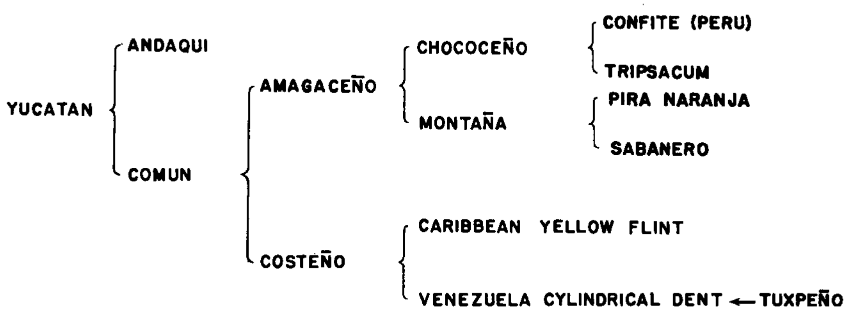

FIG. 61. The probable origin of Yucatán. The Caribbean Yellow Flint in this diagram is actually the Coastal Yellow Flint referred to in the discussion of the origin of Costeño.

considerably more susceptible to both rust and Helminthosporium. The ears are shorter, with fewer rows and a smaller diameter, and the grains are wider, with an off-white pericarp color. Subsequent collection work has turned up the race Andaquí, which is probably the other parent of Yucatán. Andaquí is localized in its distribution in the south of Colombia, mostly on the eastern slope of the eastern mountain range in the Intendencia of Caquetá. Común, Yucatán and Andaquí overlap in their geographical distributions as well as in the range of altitudes to which they are adapted. In the characters in which Yucatán is not the same or approximately the same as Común, there is a tendency for Yucatán to be intermediate between Común and Andaquí (Fig. 62).

Derivation of Name. Yucatán is the name most commonly applied to this particular type by the farmers in the region where it is grown. So far as we have determined, this name has nothing to do with the Yucatán Peninsula of Mexico.

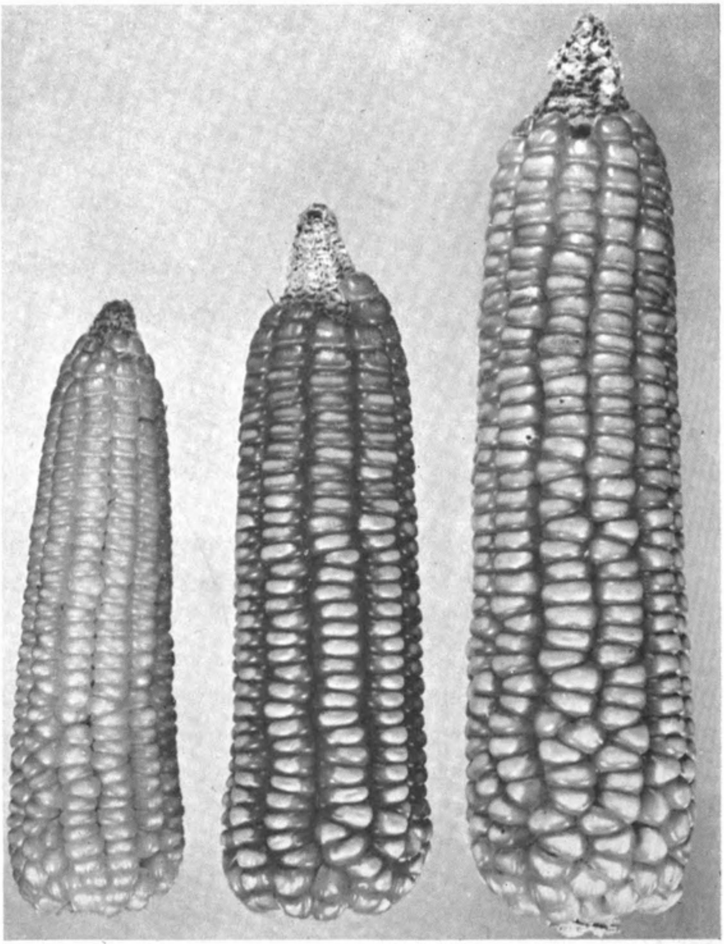

FIG. 62. Probable origin of Yucatán. This race (center) may well be a hybrid of Andaquí (left) and Común (right).

CACAO

Plants. Medium to tall; early maturity; no tillers; medium number of leaves of medium length and width; venation index medium to high; plant color medium, pilosity low; moderately susceptible to races of rust and Helminthosporium in central Antioquia; number of knobs very high, average 10.2. Adapted to intermediate elevations, 1,300 to 1,700 meters.

Tassels. Of intermediate length, with high number of branches arising in two-fifths the length of the central axis; secondaries numerous; tertiaries frequent; condensation slight.

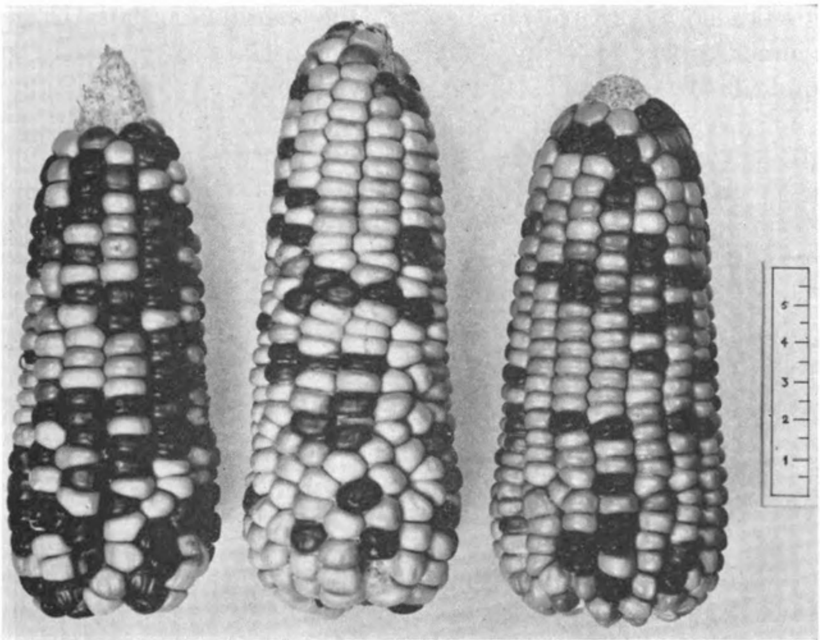

Fig. 63. Cacao is characterized by floury endosperm and a high frequency of aleurone color both blue and bronze. It is grown as a special purpose corn, its meal being mixed with chocolate to prepare a beverage.

Ears, External Characters. (Fig. 63) Of medium length, thick, with strong taper from base to tip; average number of rows medium, 12.6. Shank of medium length, slender. Average number of husks medium to high, 12.2. Midcob color in 78 per cent of ears examined; glumes colored in 70 per cent and lemmas colored in 18 per cent of ears studied. Kernels wide, of medium length and thickness, rounded or somewhat flattened with slight denting. Endosperm soft, mostly floury, white or yellow; high frequency of aleurone colors, especially those at the brown-bronze locus, are a characteristic feature of this race; pericarp colors common.

Ears, Internal Characters. (Fig. 64) Average ear diameter 46 mm.; average cob diameter 28 mm.; average rachis diameter 18 mm.; estimated rachilla length 3.5 mm.; cob/rachis index low to medium, 1.56; glume/kernel index low, 0.43; rachilla/kernel index high, 0.30; cupule pubescence sparse to medium. Lower glumes horny, sparsely pubescent, the margins cordate. Upper glumes papery to fleshy, venation strong, glabrous or nearly so; tunicate allele *tu*; rachis tissue spongy to bony.

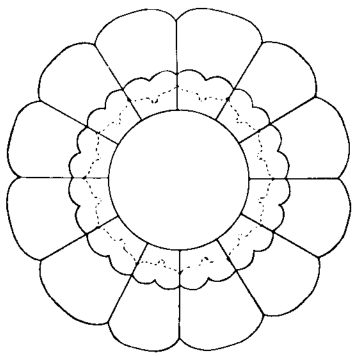

FIG. 64. Ear cross-section diagram of Cacao.

Distribution. (Fig. 25) Cacao is found principally in the Departments of Santander, but it extends north into Norte de Santander and south into Boyacá and Cundinamarca. It is found from 800 to 1,800 meters elevation with an average of 1,530 meters. This race seems to be concentrated into a single region and is not grown to any extent outside this general area.

Sabanero is also grown at the higher elevations in the same region and there has been considerable interchange between it and Cacao. This is especially evident in the bronze, orange and brown aleurone found in both of these races.

Origin and Relationships. (Figs. 65 and 66) Cacao is intermediate between Costeño and Sabanero in many characteristics and is probably a hybrid of these two races. Of the characters studied, 29 were intermediate between the putative parents, 13 were greater than either of the parents (of these 6 were color

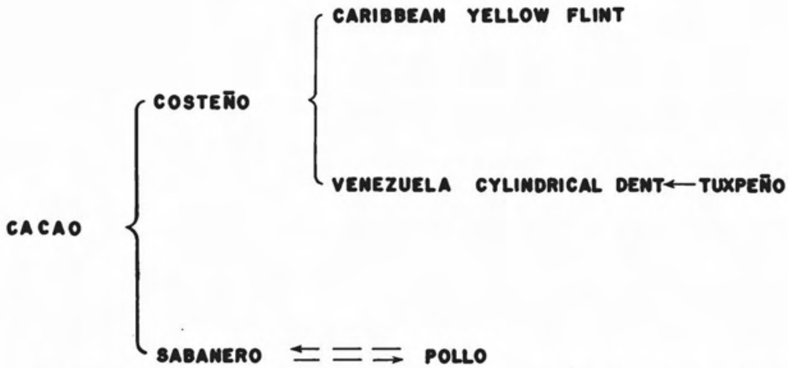

FIG. 65. The origin of Cacao. The Caribbean Yellow Flint in this diagram is actually the Coastal Yellow Flint referred to in the discussion of the origin of Costeño.

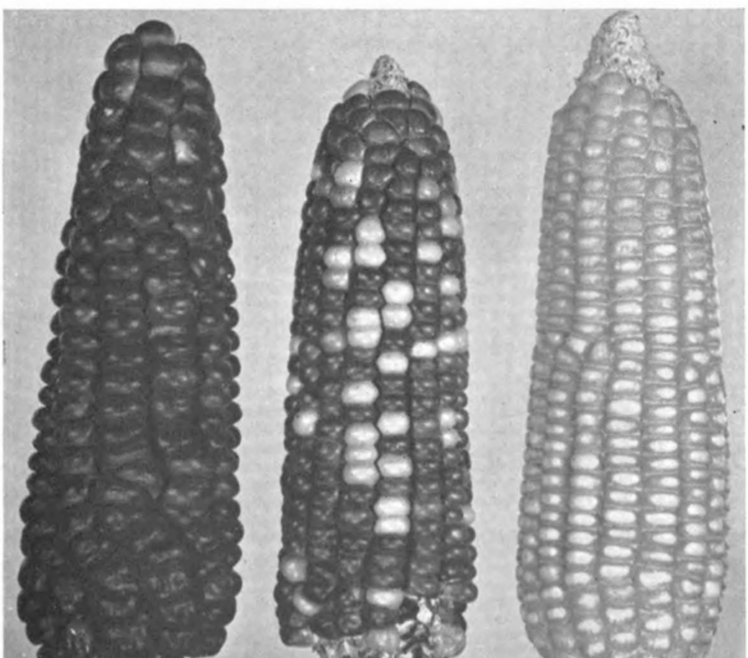

FIG. 66. Origin of Cacao. This race (center) is believed to be a hybrid of a Sabanero having floury endosperm and bronze aleurone (left) and Costeño (right).

characteristics) and 7 were lower than both of the parents. Most of the characters that averaged lower were very close to the low parent. The chromosome knobs of Cacao are slightly higher than in Costeño (av. 9.4) which is the higher of the postulated parents.

The data on maturity of Cacao and its postulated parents require explanation. In an extremely mountainous country such as Colombia, it is possible to predict the maturity of a given variety of maize when it is planted at various altitudes. This reaction reaches such extremes that the plant may never form grain at high altitudes if it is of lowland origin. The data shown in Table 13 for Costeño and Cacao were taken in Medellín (elevation 1,500 meters) and the data for Sabanero were taken in Bogotá (elevation 2,650 meters). In this case, Cacao was grown in what is essentially its natural habitat where it should flower normally. However, Costeño was grown well above its normal range and flowered about 30 days later than it does in Montería (elevation 50 meters). Taking these facts into consideration, Cacao is more nearly intermediate in maturity than the actual data indicate. In fact, when grown at Medellín, all three races flower at approximately the same time.

It may be noted that of the external and internal characters of the ear, Cacao is between the two suggested parents in all characters except rachilla length, rachilla-grain index, and induration of rachis. In general appearance the ear is almost identical with Costeño except for aleurone and pericarp colors, which are seldom found in Costeño, but which are common in Sabanero.

Finally, the hybrid of Costeño and Sabanero is virtually indistinguishable from Cacao. This is the strongest possible evidence that Cacao is indeed a hybrid of these two races.

Derivation of Name. Cacao is the Spanish name for the tree from which cocoa is obtained. After the cacao kernel is roasted and ready for grinding into chocolate it becomes a dark brown, much the same color as the dark brown and bronze aleurone found in this race. Hence the name, Cacao.

COSTEÑO

Plants. Medium height; early maturity; very few tillers; intermediate number of very long, relatively narrow leaves; venation index medium to high; plant color and pubescence medium; highly susceptible to races of corn rust and Helminthosporium

FIG. 67. Costeño is the most common race in the northern coastal region of Colombia. It has affinities with the flint corns of Brazil and the Caribbean.

in central Antioquia; number of knobs high, average 9.4. Adapted to low elevations, 0 to 800 meters.

Tassels. Of intermediate length, with high number of branches arising in nearly half the length of the central axis; secondaries numerous; tertiaries frequent. Condensation slight.

Ears, External Characters. (Fig. 67) Of intermediate length, relatively thick, cylindrical to very slightly conical; average number of rows medium, 13.1. Shank short to medium length, slender; average number of husks high, 15.6. Midcob color present in 41 per cent of ears examined; glumes colored in 29 per cent and lemmas in 8 per cent of ears studied. Kernels thin, wide, of intermediate length, usually flattened and somewhat dented, as soft starch column extends to apex of grain. Endosperm of semi-flint type, moderately hard, white or yellow. Aleurone colors uncommon; weak pericarp colors common.

Ears, Internal Characters. (Fig. 68) Average ear diameter 47 mm.; average cob diameter 30 mm.; average rachis diameter 20 mm.; estimated rachilla length 2.5 mm.; cob/rachis index low, 1.51; glume/kernel index low, 0.44; rachilla/kernel index medium, 0.14; cupule densely pubescent. Lower glumes horny, moderately to densely hairy, the margins undulate. Upper glumes fleshy to horny, moderately hairy, venation weak or lacking. Tunicate allele *tu;* rachis tissue horny.

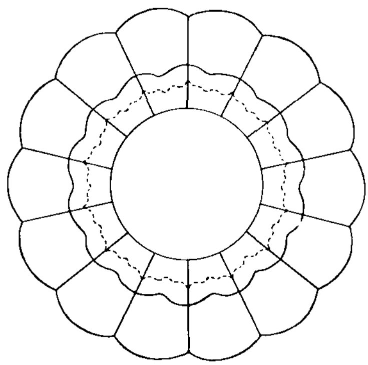

FIG. 68. Ear cross-section of diagram of Costeño.

Distribution. (Fig. 69) Costeño is one of the most widely distributed races in Colombia. It is grown throughout the northern coastal plain from the Chocó to the Guajira penisula at elevations between 3 and 2,170 meters with an average of 221 meters. It extends along the Magdalena and Cauca river valleys almost to their headwaters.

Most of the collections of Costeño made from the higher altitudes probably have been recently introduced and show much evidence of being unadapted. Both white and yellow endosperm occur in this race and both forms are distributed over the same area.

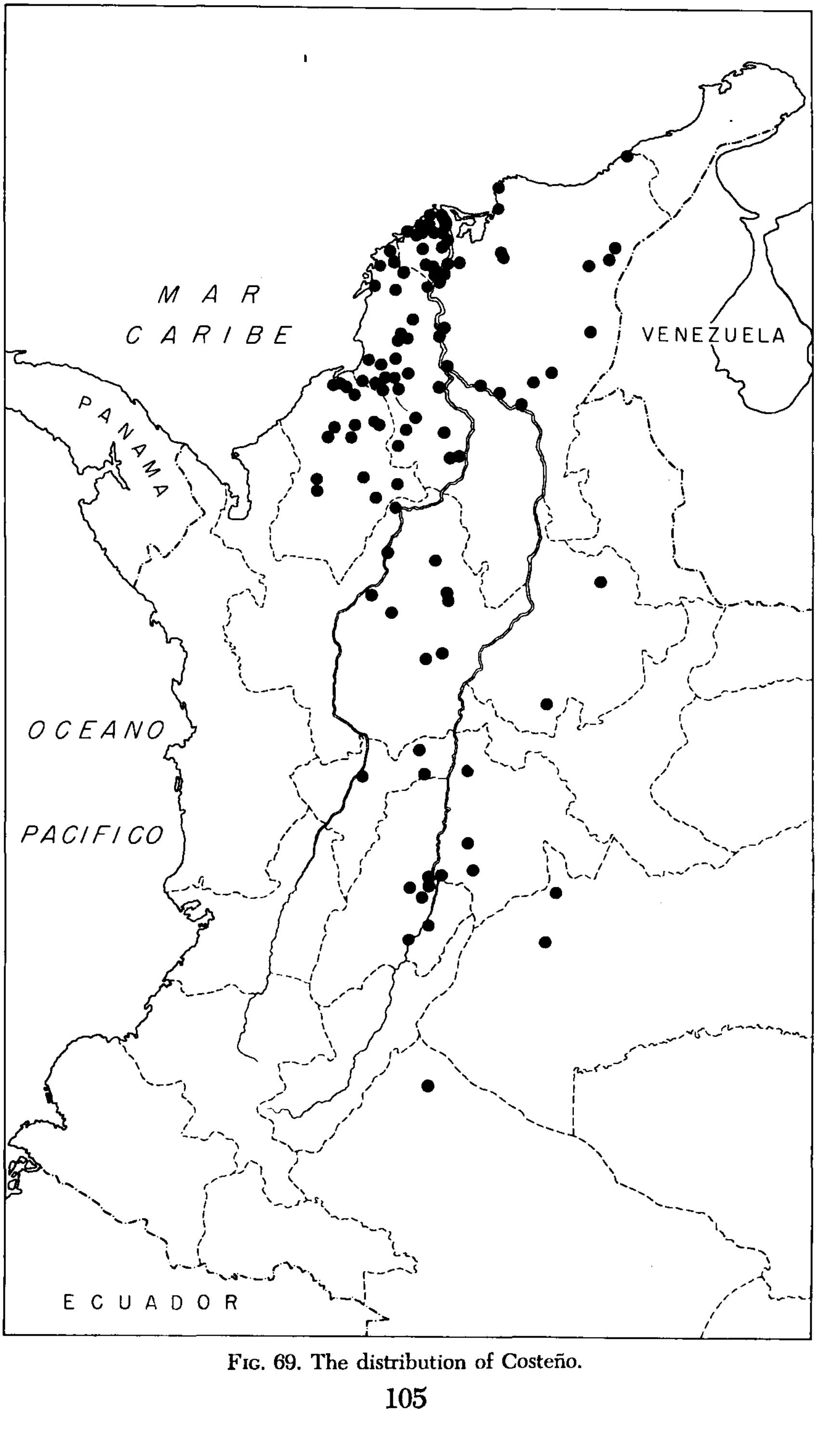

FIG. 69. The distribution of Costeño.

Origin and Relationships. (Fig. 70) Costeño has undoubtedly influenced more Colombian races in the hot and temperate climates than any other one race. For example, it has hybridized with Amagaceño to produce Común, the most productive and widely grown indigenous race in the temperate climate zone at present. Común in turn has been one of the parents of Yucatán, which is also commercially important in the hot climate zone of the upper Magdalena river valley. Costeño has also crossed with Sabanero to produce the race Cacao. By introgressing, it has directly influenced the races Negrito and Cariaco. Costeño gives the definite impression of having originated from a cross between a yellow flint and white cylindrical dent race. These postulated parents do not presently exist as races in Colombia. They are

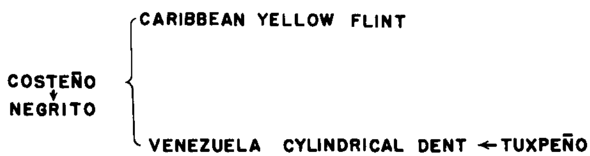

FIG. 70. The probable origin of Costeño and Negrito. The Caribbean Yellow Flint in this diagram is actually the Coastal Yellow Flint referred to in the discussion of the origin of Costeño.

found, however, relatively close by in the neighboring country of Venezuela. We have given the names "Coastal Yellow Flint" and "Venezuela Cylindrical Dent" to these races which apparently have entered into the parentage of Costeño. Coastal Yellow Flint, found along coastal region of eastern South America, has proved to be an excellent source of germplasm for the practical corn improvement program for the hot humid areas of Colombia, and when used in diluted form, this germplasm has also greatly contributed to produce better varieties and hybrids for the temperate climate zone. Coastal Yellow Flint has many characteristics in common with the yellow flint race Cateto, of Brazil, Uruguay and Argentina. Although we suspect a natural relationship between these two races, the determination of its actual existence and nature must await additional information from future studies. The Venezuelan Cylindrical Dent has many similarities with the white cylindrical dent race, Tuxpeño, of Mexico (Wellhausen *et* *al*, 1952). This is also an excellent source of germplasm for improving the corns for the hot humid climatic regions. Costeño has been the recipient of good germplasm from both of its parents, if our hypothesis of its origin shown in Figure 70 is correct. This could account for Costeño having played such an important role in the development of the best commercial varieties presently

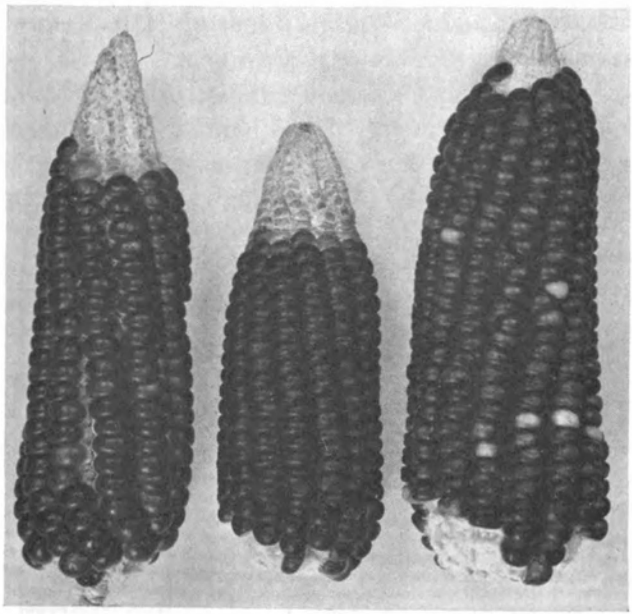

Fig. 71. Negrito is closely related to Costeño, differing from it primarily in having a blue aleurone. Negrito is grown for making a special bread, "Bollo."

grown in the hot and temperate climate zones. Costeño is found in both white and yellow forms, with the white predominating.

Derivation of Name. Costeño is grown over a wide area, and many names such as "Cuba" have been given to it by farmers growing it. However, the name Costeño denotes that it is a coastal corn growing generally at low altitudes and seems to be the most descriptive.

NEGRITO

Plants. Very short, early; no tillers. Medium number of short leaves of intermediate width; venation index high. Plant color and pilosity intermediate; highly susceptible to races of corn rust and Helminthosporium in central Antioquia; knob number high, average 8.5. Adapted to low elevations, 0 to 250 meters.

Tassels. Short, intermediate number of branches arising from two-fifths the length of the central axis; secondaries few; tertiaries infrequent; condensation slight.

Ears, External Characters. (Fig. 71) Of medium length, relatively thick, cylindrical to slightly tapering from base to the tip which frequently sets no seed; average number of rows 14.4. Shank short, and slender; average number of husks 10.5. Midcob color present in 54 per cent of ears studied; glumes colored in 29 per cent and lemmas in 11 per cent of ears examined. Kernels

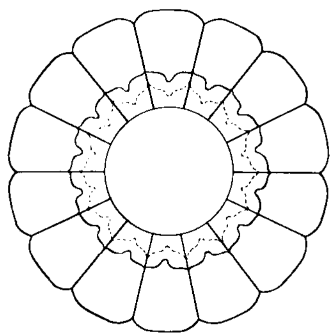

Fig. 72. Ear cross-section diagram of Negrito.

thin, of intermediate length and width, denting shallow. Endosperm soft, white or yellow; blue aleurone color present in all ears studied; pericarp colors lacking.

Ears, Internal Characters. (Fig. 72) Average ear diameter 42 mm.; average cob diameter 24 mm.; average rachis diameter 17 mm.; estimated rachilla length 1.5 mm.; cob/rachis index low, 1.44; glume/kernel index low, 0.32; rachilla/kernel index medium, 0.13; cupule densely hairy. Lower glumes horny, moderately to strongly pubescent, the margins cordate. Upper glumes fleshy to horny, venation none or weak, densely hairy. Tunicate allele *tu*; rachis tissue spongy to horny.

Distribution. (Fig. 25) Negrito is found growing on the northern coastal plain in the Departments of Atlantico, Magdalena and Guajira. It is not grown to any great extent, but it apparently has been propagated by a few farmers primarily for its unusual color and use in making a special type of bread named "Bollo" which is commonly consumed in the Caribbean region of Colombia. "Bollo" is made either from the grain in the green dough stage or from dry corn meal. Negrito is found from 15 to 250 meters elevation at an average altitude of 79 meters.

Origin and Relationships. (Fig. 70) As the name Negrito implies, this race has ears that are almost black. This is the result of intense purple aleurone color in the grains, which are also characterized by a rather soft, floury endosperm.

Negrito is similar in many of its characters to Cariaco and it is almost certain that these two races share the same basic parentage. Both also have affinities to Costeño but are sufficiently different to indicate that Negrito and Cariaco have not originated simply as selections from Costeño but have resulted from the hybridization of some race, as yet unidentified, with Costeño. In a personal communication from Dr. F. G. Brieger of Piracicaba, Brazil, we have learned that a race exists in the southern and western margins of the Amazon basin which may be the other parent of both Negrito and Cariaco. The following is quoted from Dr. Brieger's communication: "Here we know, from the numerous samples received, that there is only one main race of corn, a many rowed soft corn, with interlocked rows, large kernels, colors varying from black to brown, orange and finally yellow". This Brazilian race found in the hot, humid lowlands of the Western Amazon basin could easily account for the characters of Negrito and Cariaco which, especially when accentuated, serve as the principal features which distinguish these two races from Costeño.

Derivation of Name. Negrito, the diminutive of "negro", is suggested by the dark blue aleurone color prevalent in this race.

PUYA

Plants. Medium height to tall; early; few tillers; many long leaves of medium width; venation index medium; plant color and pilosity medium; highly susceptible to races of corn rust and Helminthosporium in central Antioquia; number of knobs high, average 8.6. Adapted to low elevations, 0 to 500 meters.

Tassels. Medium length, medium number of branches arising in two-fifths to one-half the length of the central axis; secondaries common; tertiaries infrequent; condensation slight.

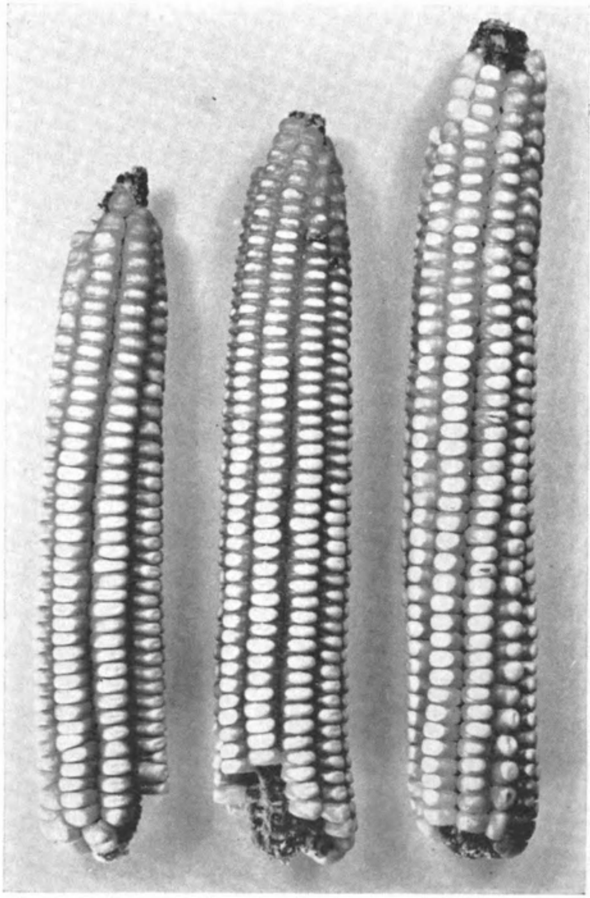

FIG. 73. Puya is a slender-eared, flexible-cobbed dent corn, which has counterparts in the races of Chandelle and Tusón of the Caribbean. The Mexican race, Tuxpeño, may have been one of its ancestors.

Ears, External Characters. (Fig. 73) Long, slender, with slight taper at both base and tip; average number rows 11.4. Shank of medium length, slender; average number of husks 12.0. Midcob color present in 31 per cent of ears examined; glumes colored in 14 per cent and lemmas in 30 per cent of ears studied. Kernels thin, of medium width and length, moderately dented. Endosperm medium hard, white or yellow; aleurone and pericarp colors infrequent.

Ears, Internal Characters. (Fig. 74) Average ear diameter 38 mm.; average cob diameter 19 mm.; average rachis diameter 11 mm.; estimated rachilla length 0.5 mm.; cob/rachis index medium, 1.67; glume/kernel index low, 0.34; rachilla/kernel index medium, 0.15; cupule moderately hairy. Lower glumes fleshy to horny, moderately pubescent, the margins shallowly cordate. Upper glumes chaffy, weakly hairy, venation strong. Tunicate allele *tu*; rachis tissue spongy to horny.

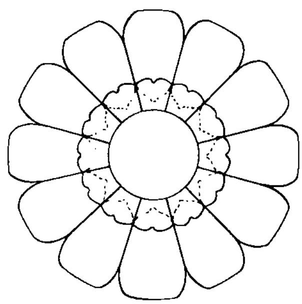

FIG. 74. Ear cross-section diagram of Puya.

Distribution. (Fig. 75) Practically all of the Puya in Colombia is concentrated east of the Magdalena river in the northern part of the country. It extends as far south as the northern border of Santander del Sur and north into the Guajira peninsula. Puya is found at elevations from 12 to 1,000 meters with an average for the collections of 215 meters.

Origin and Relationships. (Figs. 76 and 77) Puya is believed to be the progeny of a cross between Clavo and a cylindrical dent corn similar to Tuxpeño of Mexico. Except for recent introductions, no race resembling Tuxpeño is grown in Colombia today, but Tuxpeño or something similar to it, here called Venezuela Cylindrical Dent, is found in northern Venezuela. It may be this maize which is the other parent of Puya.

A race similar to Puya, but having larger ears, called Puya Grande, is believed to be the product of additional introgression of Venezuela Cylindrical Dent.

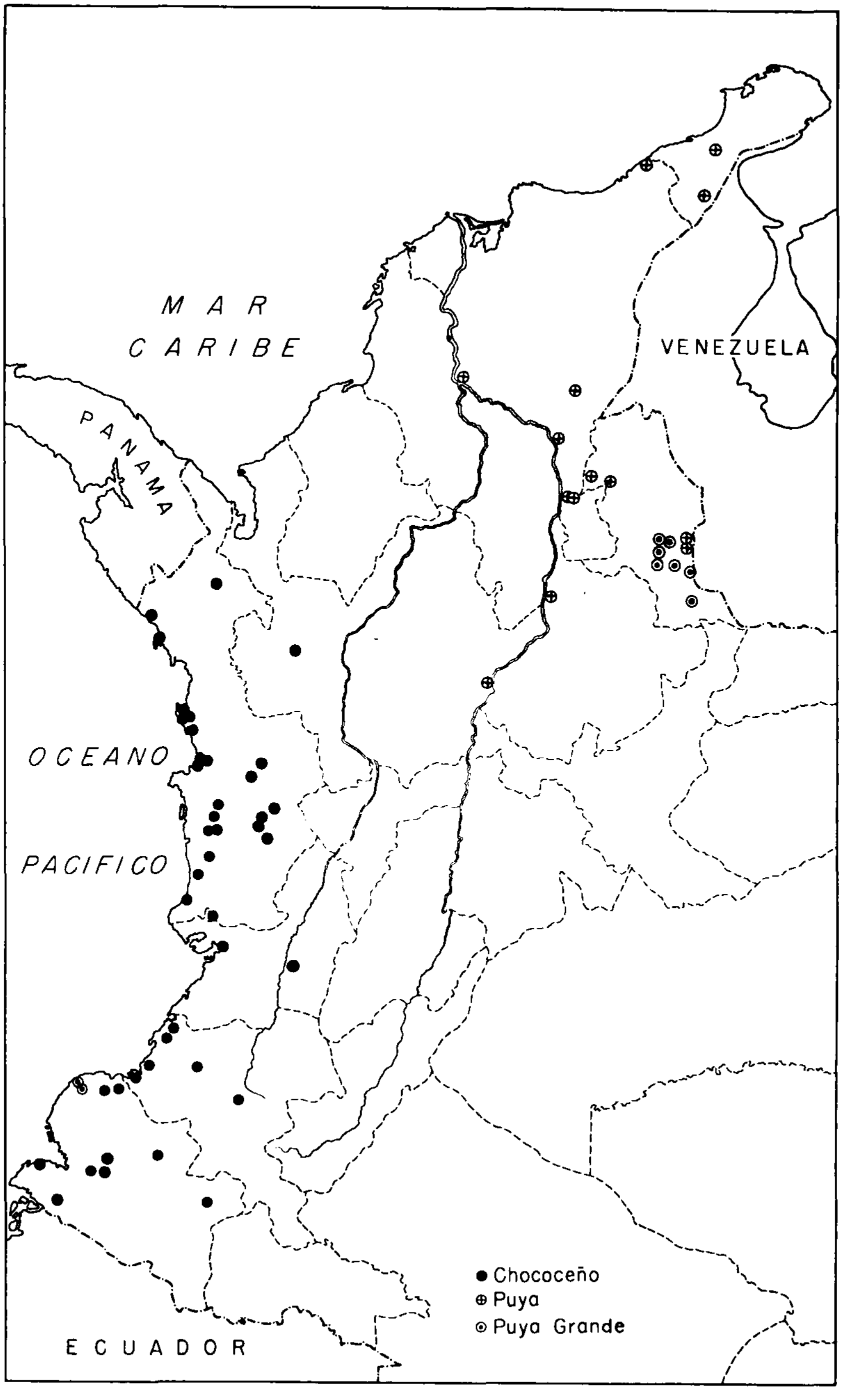

FIG. 75. The distribution of Chococeño, Puya, and Puya Grande.

CLAVO-------PIRA

PUYA
PUYA GRANDE

VENEZUELA CYLINDRICAL DENT----TUXPEÑO

FIG. 76. The origin of Puya and Puya Grande.

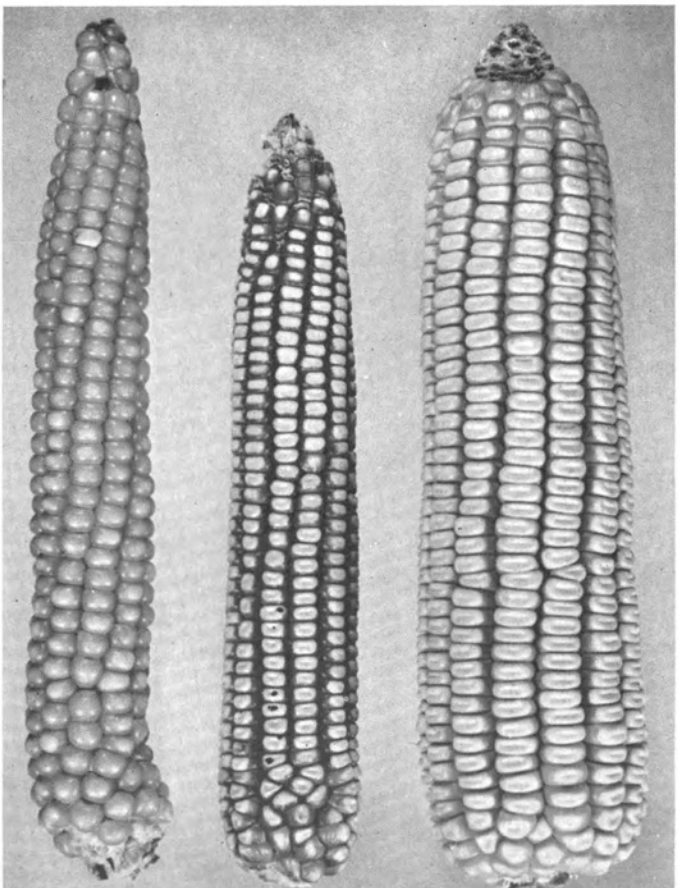

FIG. 77. Puya is believed to be the progeny of a cross between Clavo and a cylindrical dent maize similar to Tuxpeño of Mexico.

Data on the characteristics of Venezuela Cylindrical Dent are not available, consequently Puya can be compared only with one putative parent, Clavo, and with Puya Grande, which is thought to be similar to the other parent. The comparison is made in Table 7.

Puya is probably the ancestral form of the slender-eared dent corns Chandelle and Tusón of the Caribbean.

Derivation of Name. Puya means "goad stick". Since the race has a slender ear with low kernel-row number, this is an appropriate term. It is also called "De Aguja" or needle indicating the slender ear. Puya is also the term used in the Guajira peninsula for machete or cane knife.

PUYA GRANDE

Plants. Very tall; no tillers; many very long, wide leaves; venation index medium; number of knobs high, average 9.0. Adapted to low to intermediate elevations, 100 to 1,200 meters.

Tassels. Long, high number of branches arising in almost one-half the length of the central axis; secondaries and tertiaries numerous; condensation absent or slight.

Ears, External Characters. (Fig. 78) Long, medium thick, with slight taper from base to tip; average number of rows 11.4. Shank of medium length and thickness; average number of husks medium, 11.5. Midcob color present in 56 per cent of ears studied; glumes colored in 7 per cent and lemmas in 5 per cent of ears examined. Kernels of medium length and width, thin, flattened, denting absent or very shallow. Endosperm medium hard, yellow; aleurone colors lacking, pericarp colors not infrequent.

Ears, Internal Characters. (Fig. 79) Average ear diameter 39 mm.; average cob diameter 25 mm.; average rachis diameter 16 mm.; estimated rachilla length 2.5 mm.; cob/rachis index medium, 1.63; glume/kernel index low, 0.43; rachilla/kernel index medium, 0.18; cupule pubescence sparse to medium. Lower glumes spongy to horny, sparsely pubescent, the margins angulate. Upper glumes chaffy to fleshy, weakly hairy, the venation usually prominent. Tunicate allele *tu*; rachis tissue mostly spongy.

Distribution. (Fig. 75) Puya Grande is found along the border of Venezuela in the Department of Norte de Santander and is

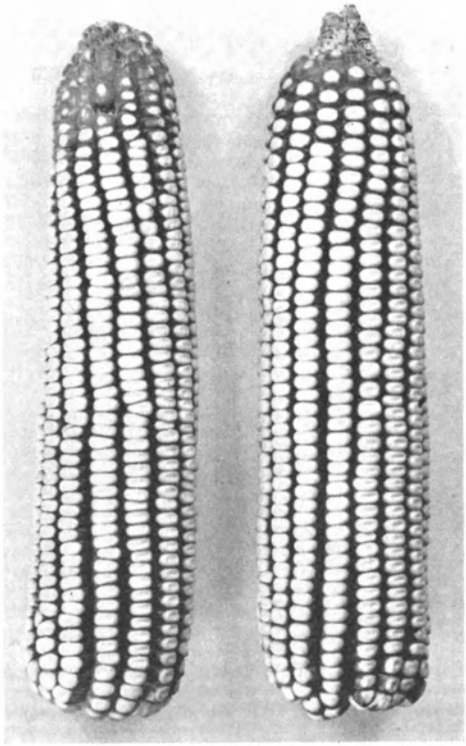

Fig. 78. Puya Grande is closely related to Puya but has larger, more rigid ears and is grown at slightly higher altitudes.

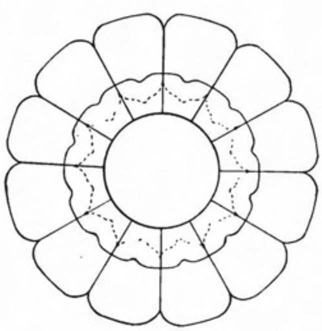

Fig. 79. Ear cross-section diagram of Puya Grande.

probably more abundant there than in Colombia. It is somewhat related to the Sicarigua race from Venezuela. In fact, the collections seem to be concentrated around Cucuta, a population center near the Venezuelan border.

Collections of Puya Grande have been made from 50 to 1,500 meters with an average of 937 meters. It probably is best adapted to the drier regions of Venezuela and Colombia. This type also exists in the Guajira peninsula near the region of Riohacha and Uribia.

Origin and Relationships. Puya Grande, as indicated in the discussion of Puya, is believed to be the product of additional introgression of Venezuela Cylindrical Dent into a hybrid of this race with Clavo.

Derivation of Name. Puya Grande is related to Puya but has a larger and longer ear; hence its name.

CHOCOCEÑO

Plants. Medium height when grown at Medellín, very tall at sea level; relatively late maturity; many tillers; many short leaves of intermediate width; venation index high; plant color and pubescence medium; moderately susceptible to races of corn rust and Helminthosporium in central Antioquia; number of knobs high, average 8.7. Adapted to low elevations, 0 to 200 meters.

Tassels. Short, medium number of branches arising in one-half the length of the central axis; secondaries numerous, tertiaries frequent; condensation slight.

Ears, External Characters. (Fig. 80) Short, thick, conical; average number of rows very high, 17.2. Shank short, mostly slender; average number of husks very high, 16.5. Midcob color present in 100 per cent of ears examined; glumes colored in 75 per cent and lemmas in 2 per cent of ears studied. Kernels narrow, short, and thin, denting lacking. Endosperm pop-type, very hard, or floury, white or yellow; aleurone colors common, pericarp colors infrequent.

Ears, Internal Characters. (Fig. 81) Average ear diameter 36 mm.; average cob diameter 24 mm.; average rachis diameter 16 mm.; estimated rachilla length, 2.0 mm.; cob/rachis index low, 1.53; glume/kernel index low to medium, 0.50; rachille/

kernel index medium, 0.19; cupule densely pubescent. Lower glumes spongy to horny, moderately hairy, the margins angulate. Upper glumes fleshy, venation none or very weak, moderately hairy. Tunicate allele *tu*; rachis tissue spongy.

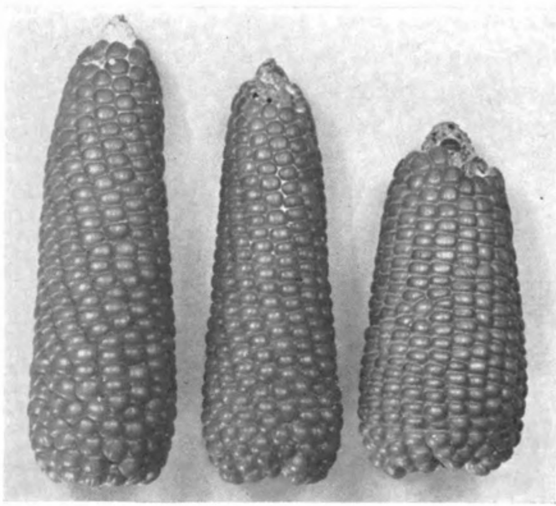

Fig. 80. Chococeño is grown under extremely primitive conditions in the western coastal region of Colombia. It is believed to be the product of hybridization with Tripsacum.

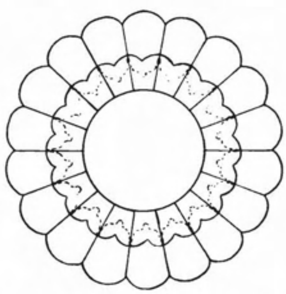

Fig. 81. Ear cross-section diagram of Chococeño.

Distribution. (Fig. 75) Chococeño is grown along the western coastal plain of Colombia, part of which is subjected to extremely high rainfall. It is found from 0 to 200 meters with an average of 82 meters elevation. The high rainfall region along the western coast extends into Ecuador where this type is also found.

Origin and Relationships. (Fig. 83) Chococeño is one of the most unusual races of this hemisphere, both in its characteristics and in the primitive way in which it is grown. Its culture is largely confined to the humid coastal region of western Colombia, where rainfall sometimes exceeds 400 inches annually. The maize is grown without cultivation. The fields are prepared by cutting down the small trees and brush. The seed, which is broadcast and not covered, germinates on the surface of the soil. The plants grow up through the branches of the cut vegetation (Fig. 82).

To succeed under these primitive conditions the maize must have unusual characteristics. Chococeño is highly tripsacoid. It has tough, slender stalks with tillers, narrow, drooping leaves and pendulous tassel branches. It has the general aspect of certain segregates from maize-teosinte or maize-Tripsacum hybrids. Since teosinte does not occur in this region, and Tripsacum is common, it has been assumed that Chococeño is the product of the hybridization of maize and Tripsacum.

Since Chococeño has short, thick ears with many rows of grain, the maize parent of the cross must have been one possessing those characteristics. Maize of this type is found commonly in Peru, especially in the race Confite Puneño and its larger counterpart Huayleño, both of which have short, plump, grenade-shaped ears with many rows of grain. At the present time these two races are confined to the highlands of Peru, but in prehistoric times they were more widely distributed. In the National Museum of Archaeology in Lima collections of prehistoric ears from the Paracas site include small, almost spherical many-rowed ears resembling Confite Puneño. A Chimu vase from the Valle de Chicama on the northern coast of Peru has representations of small, conical ears. In the absence of archaeological evidence from the west coast of Colombia, we can only assume that this type of maize also extended into this region. The origin of Chococeño as a cross of a Peruvian Confite and Tripsacum is postulated in Figure 83.

Chococeño has had some influence on other Colombian races. It was probably one of the parents of Amagaceño, which is the progenitor of Común and Yucatán.

In addition, Chococeño has almost certainly influenced the coastal races of maize of Ecuador and Peru, all of which are more or less tripsacoid. In both countries these coastal races

Fig. 82. A typical field of Chococeño in the western coastal region of Colombia. The brush and other vegetation is cut and the seeds are scattered among the debris. There is no preparation of the soil and no cultivation.

are now introgressing into the races of higher altitudes. It is possible that Ecuadorian and Peruvian maize has been even more influenced by Chococeño than has Colombian maize. The final answer to this question must await further study of the races of these countries.

Another possibility with respect to the origin of Chococeño is that one of its parents was Cariaco. Some collections of Chococeño have floury endosperm and some have orange aleurone color. Furthermore, Cariaco is grown to some extent in the northern part of the Chocó as well as in adjoining regions in Panamá.

Derivation of Name. The race is grown almost exclusively in the high rainfall region of the country, primarily in the Department of Chocó from which it takes its name. It is also called Chococito.

CHOCOCEÑO { CONFITE (PERU) / TRIPSACUM

FIG. 83. The probable origin of Chococeño.

THE VALUE OF THE MAIZE COLLECTIONS

The value of the maize collections from Colombia and the adjoining Andean countries has already been amply demonstrated. In the corn breeding program in Colombia exceptionally good lines now being used in hybrids have been obtained from a single collection, Nariño 330. Two other collections, designated Theobromina and Caldas 301, have yielded excellent lines. The increased yield which Colombian farmers can obtain from hybrids employing these lines will in a short time more than pay the cost of all collections made in the Andean region.

The usefulness of the collections for breeding purposes extends beyond the borders of Colombia. Breeding material from Colombia has been sent to many parts of the world, and its use has provided maize breeders with new opportunities to increase yields and to improve agronomic characteristics. The rust resistance of the improved variety Colombia 2 has proved useful in Kenya, Africa. Single crosses between lines extracted from Colombian varieties have shown promise for commercial use in Brazil and the Philippine Islands. Several countries in Central America are now ready, after extensive tests, to begin the commercial production of synthetic varieties and hybrids originating in Colombia. Tests in India have shown that both Colombian and Mexican varieties, although maturing somewhat late, are promising, especially if used in combination with local varieties.

Other Colombian races, not yet widely used, may possess characteristics which are valuable for breeding purposes. Chococeño, from the western coast of Colombia, grows under adverse conditions which include more than 400 inches of rainfall per year. This race, evolving under virtually aquatic conditions, must have the ability to withstand excessive moisture. Perhaps its germplasm can be used in developing new types of maize adapted to regions of heavy rainfall.

In contrast, the maize from the arid Guajira peninsula of Colombia must surely have characteristics which make it drought resistant or drought escaping.

Considerable resistance to *Helminthosporium turcicum* has been found in a number of races of Colombian maize (Cassalett and Chavarriaga, unpublished thesis). Resistance to other diseases will undoubtedly be found once a concerted search is made for it.

Resistance to insects in Colombian races has not yet been noted, but since resistance to grasshoppers is reported in the *maíz amargo* of Argentina we may expect to find resistance to other insects once the collections have been studied from this standpoint.

Genes for the restoration of fertility to cytoplasmic male-sterile maize have a high frequency in Colombian races (Edwardson, 1955) and may be useful in corn-breeding programs in the United States where cytoplasmic sterility is now widely used to avoid detasseling in the production of hybrid seed corn.

In addition to their usefulness in breeding programs, the maize collections of the Colombian and other centers can be valuable to geneticists working on theoretical problems. Geneticists such as Stadler, Laughnan, Brink and Nuffer, studying complex allelic systems, should have at their command as much as possible of the diversity which exists in a single system. All have drawn upon the collections centered in Colombia. Mangelsdorf, (1953) studying the phenomenon of genetic drift in maize, has analyzed varieties from a number of Latin American countries with respect to the frequency of four genes, *Ga* on chromosome 4, *Pr* on 5, *I* on 9, and *R* on 10. Nelson (1952) has made a similar survey of alleles at the *Ga* locus.

It is already clear that the maize of any one country represents only a small sample of the genetic and morphological diversity which the species as a whole possesses. As this fact becomes more generally recognized we may expect botanists, geneticists and plant breeders to make increasing use of the collections which have been assembled in Colombia and in other centers. The extent to which the collections have already been drawn upon is illustrated by the list of institutions and individuals (Table 15, Appendix) to which seed has been sent.

SUMMARY

1. In a systematic program of collecting the maize of Colombia, 1,999 separate collections were assembled. These have been thoroughly studied with respect to their geographical distribution and their botanical, physiological, genetic and cytological characteristics.
2. Twenty-three different races of Colombian maize have been recognized. These have been classified into three more or less distinct categories with respect to their probable origin.
3. Primitive Races are those which have a combination of characteristics usually found in popcorns, perhaps inherited, with little modification, from a wild progenitor. These characteristics include small ears, small seeds, a tendency to tillering or branching, and a high frequency of a gene for cross-sterility. Two races assigned to this category occur in Colombia.
4. A second category, called "Races Probably Introduced", includes nine races which have no obvious progenitors in Colombia and which have counterparts in other countries. These races are believed to have been introduced into Colombia from elsewhere, some in ancient times, others more recently.
5. The third category, "Hybrid Races Originating in Colombia", includes twelve races for all of which there is some evidence of a hybrid origin involving Colombian races as one or both parents. Some of these races have diffused widely and are believed to have originated in prehistoric times. Others have a more limited distribution and may be quite recent in origin.
6. Four evolutionary factors which may have contributed to the formation of races in Colombia are recognized: (1) geo-

graphical isolation, (2) hybridization between races, (3) hybridization with teosinte-contaminated maize from Mexico, (4) hybridization of maize with its wild relative Tripsacum.

7. Races of maize originating in Colombia have spread to other countries in all directions. The four races of maize of Mexico which Wellhausen *et al*, (1952) believed to be of South American origin, Cacahuacintle, Harinoso de Ocho, Olotón and Maíz Dulce, have all been found in Colombia. The Guatemalan races Nal-Tel, Imbricado, Serrano, Negro de Chimaltenango and Salpor, have counterparts in the Colombian races Pollo, Imbricado, Sabanero, Güirua and Capio, respectively. The slender-eared maize of the Caribbean appears to have had its origin in Colombia. The coastal lowland corns of Ecuador and Peru have been influenced by the Tripsacum-contaminated maize of the Colombian coast.
8. The conclusion of Birket-Smith, based on linguistic studies, that Colombia is the center of origin of maize cultivation is neither strongly supported nor invalidated by the data from races of maize. The evidence as a whole, however, suggests that Colombia has been a cultural crossroads and, as such, has been a center of both convergence and diffusion rather than the primary center of origin. There is no doubt, however, that Colombia has been an important center of origin of new races which have spread to other countries, to become the progenitors of still other new races, including the world's most widely grown maize, the Corn Belt Dent of the United States.

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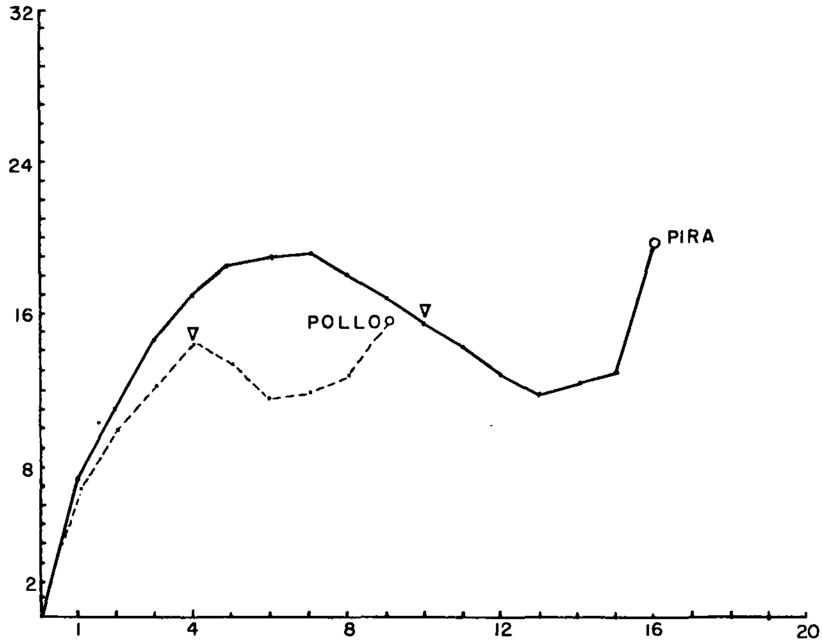
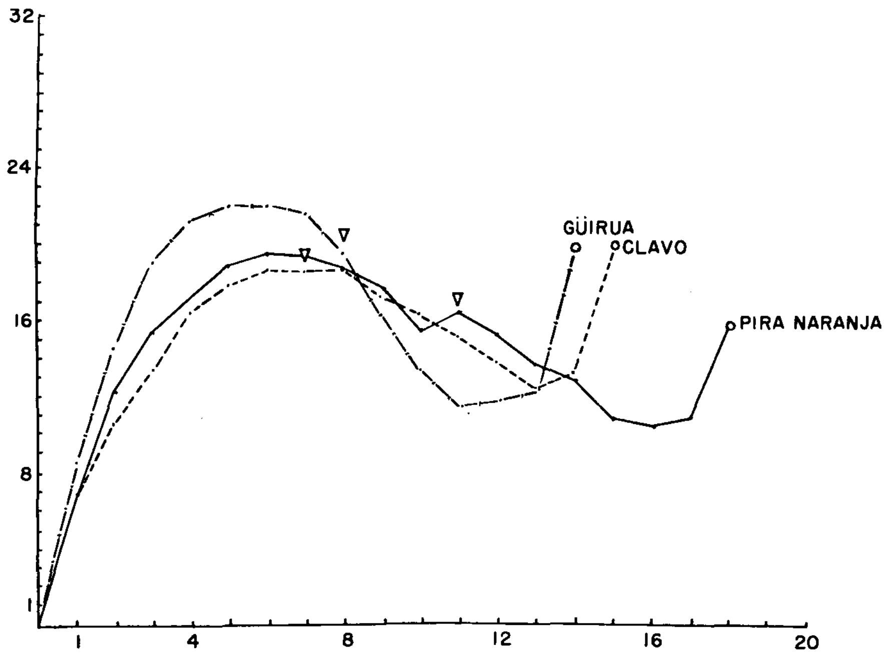
APPENDIX



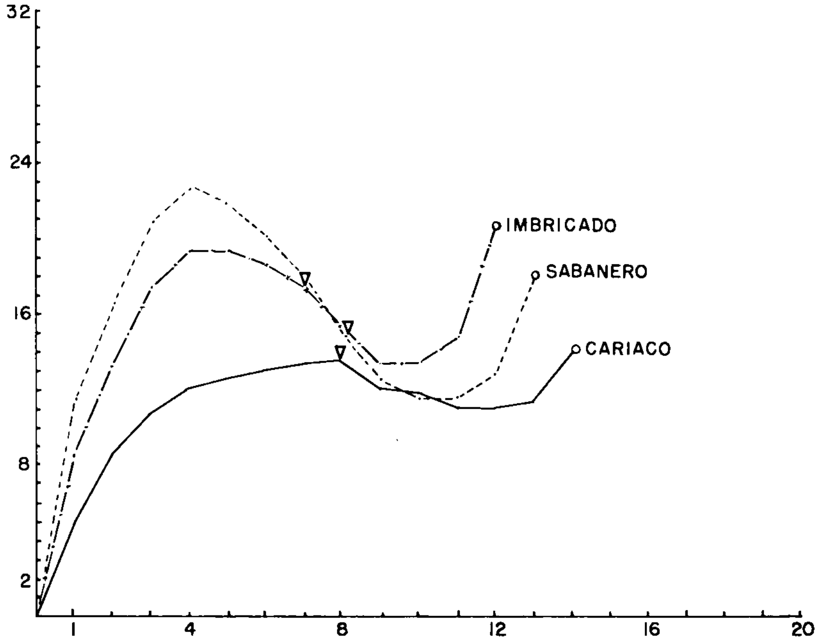
A. Pollo and Pira



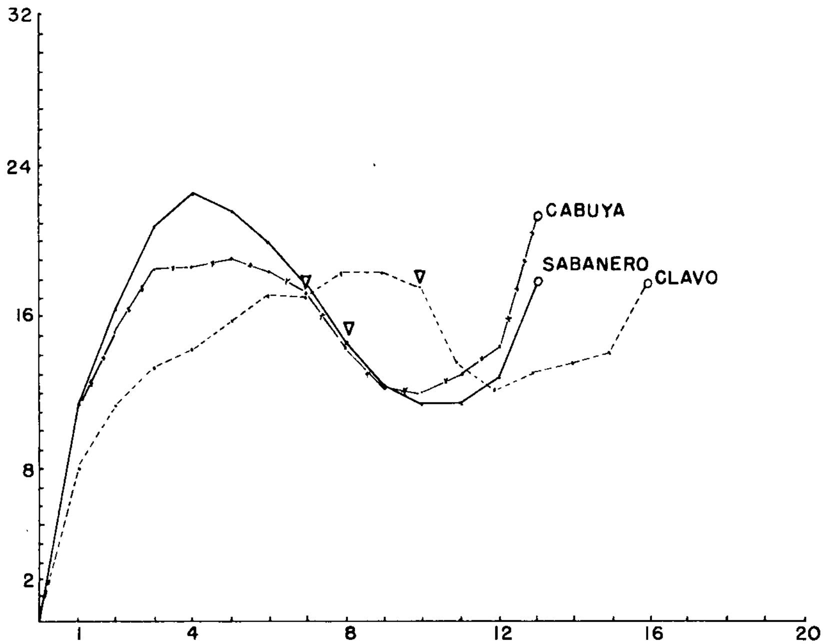
B. Güirua, Clavo, Pira Naranja

Vertical axis = Length of Internodes in centimeters
Horizontal axis = Number of nodes
▽ = Position of uppermost ear
○ = Tassel

FIG. 84. Internode Patterns



A. Imbricado, Sabanero, Cariaco

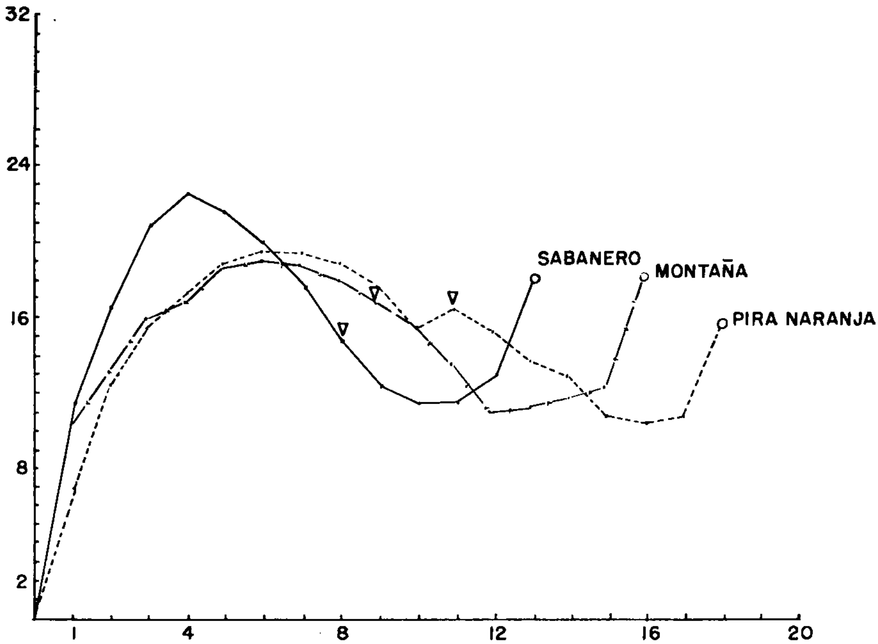


B. Sabanero, Cabuya, Clavo

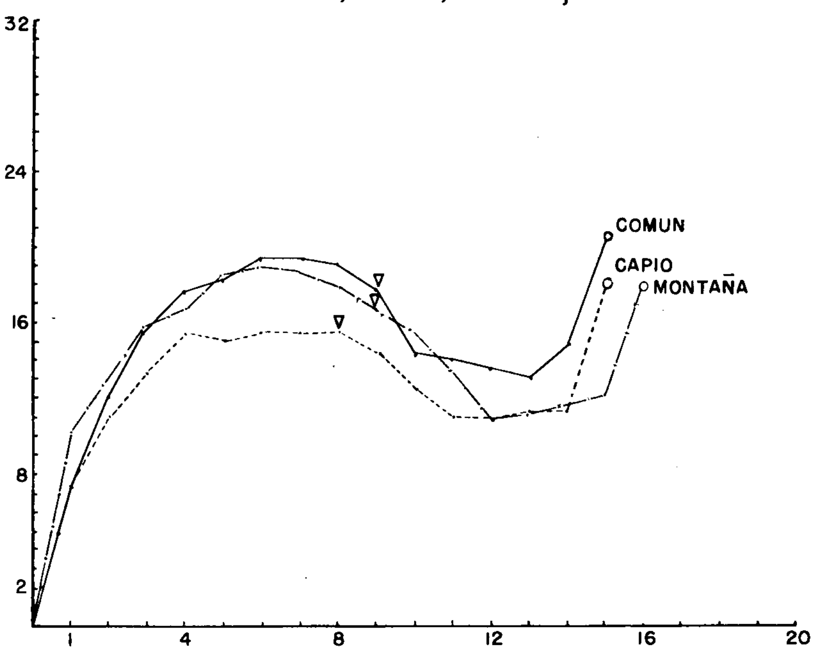
Vertical axis = Length of Internodes in centimeters
Horizontal axis = Number of nodes

▽ = Position of uppermost ear
○ = Tassel

FIG. 85. Internode Patterns



A. Sabanero, Montaña, Pira Naranja

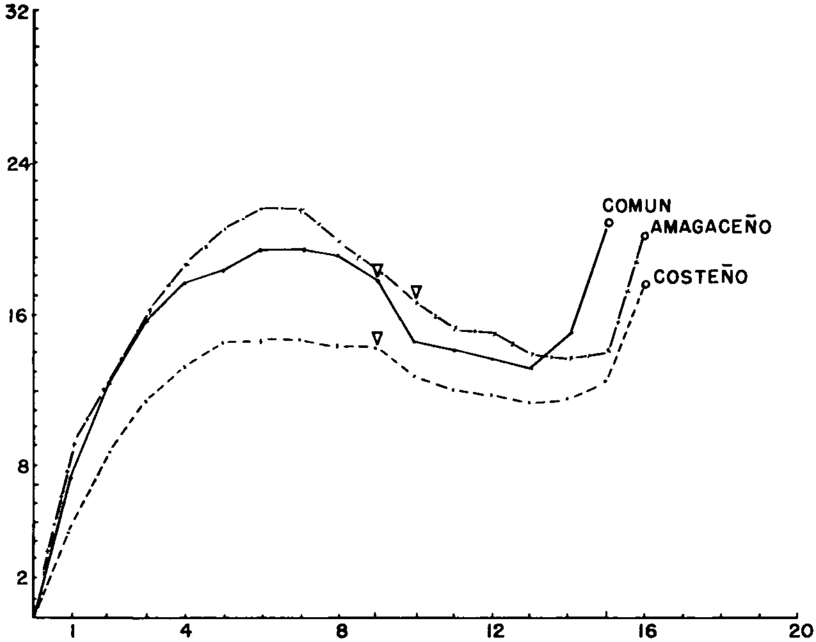


B. Común, Capio, Montaña

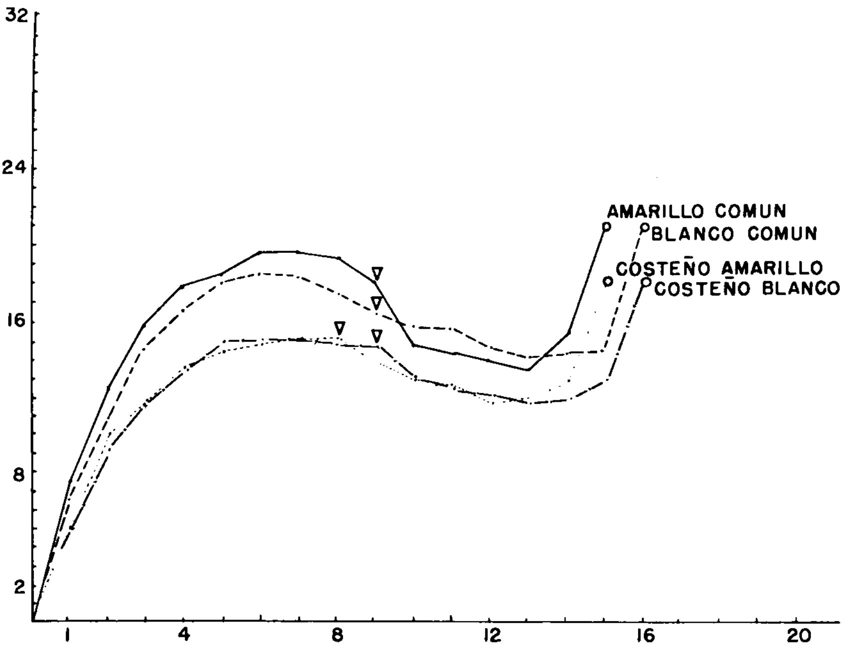
Note the similarity in the internode patterns of Común, Capio and Montaña which are related races.

Vertical axis = Length of Internodes in centimeters
Horizontal axis = Number of nodes
▽ = Position of uppermost ear
○ = Tassel

FIG. 86. Internode Patterns



A. Común, Amagaceño, Costeño

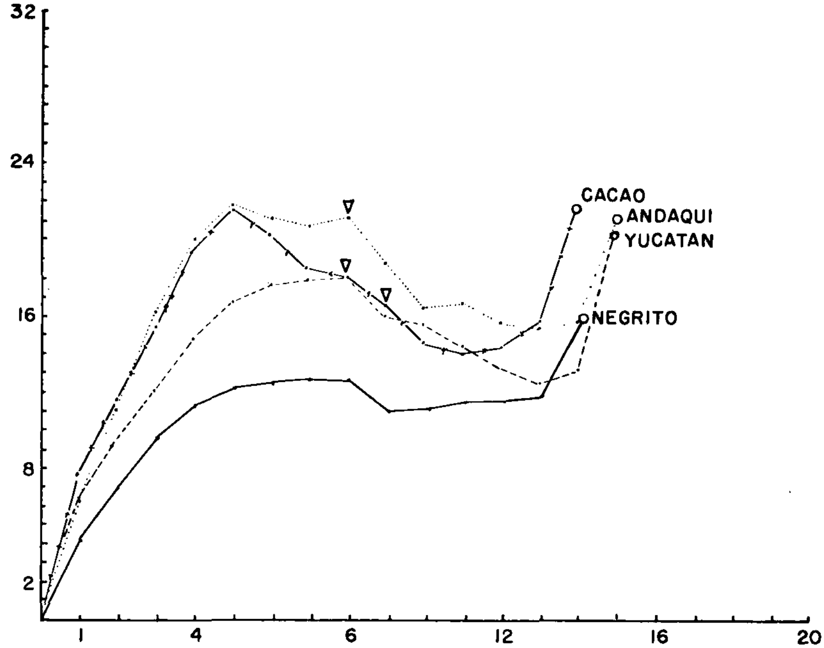


B. Amarillo and Blanco Común; Costeño, Amarillo and Blanco.

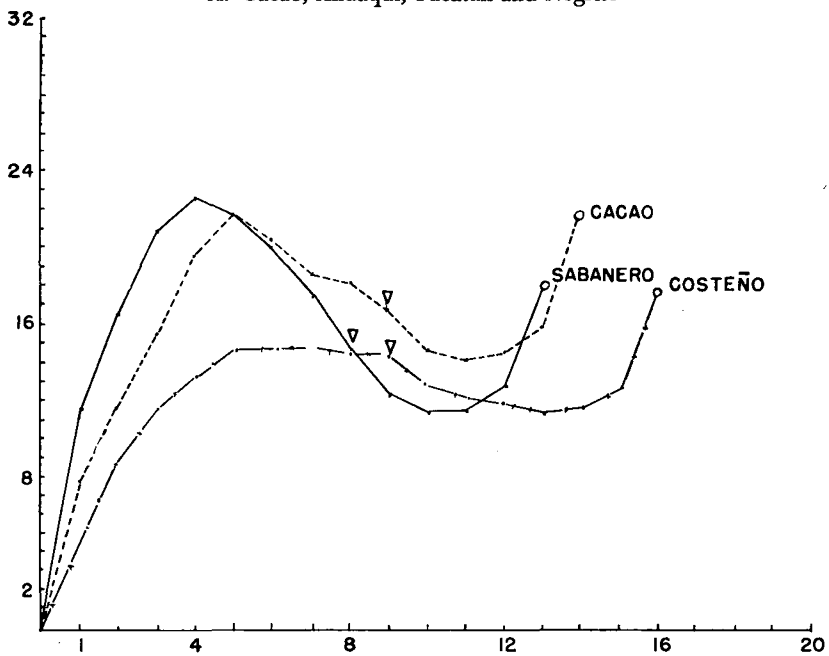
Note that the yellow and white seeded forms of Común are quite similar, also the yellow and white seeded forms of Costeño.

Vertical axis = Length of Internodes in centimeters
Horizontal axis = Number of nodes
▽ = Position of uppermost ear
○ = Tassel

FIG. 87. Internode Patterns



A. Cacao, Andaquí, Yucatán and Negrito

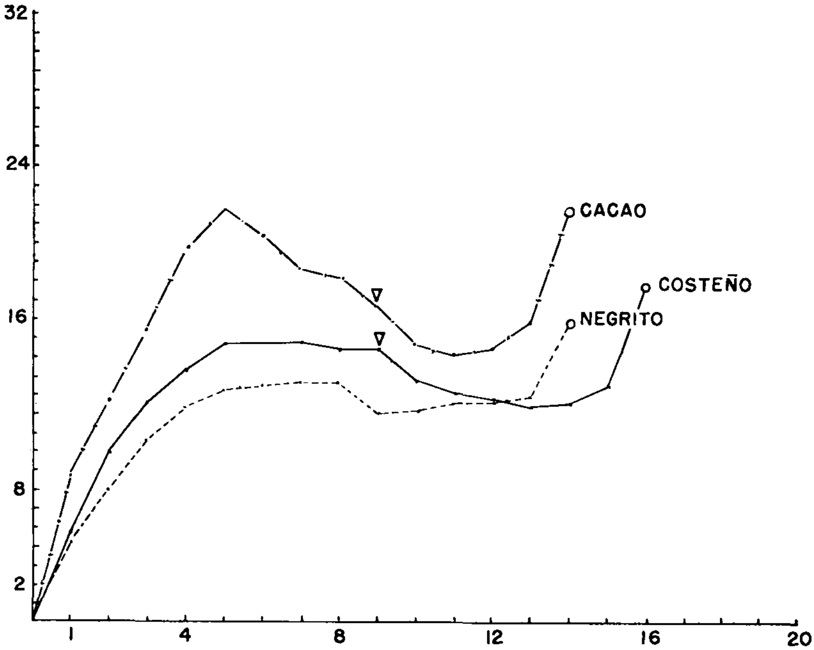


B. Cacao, Sabanero, Costeño

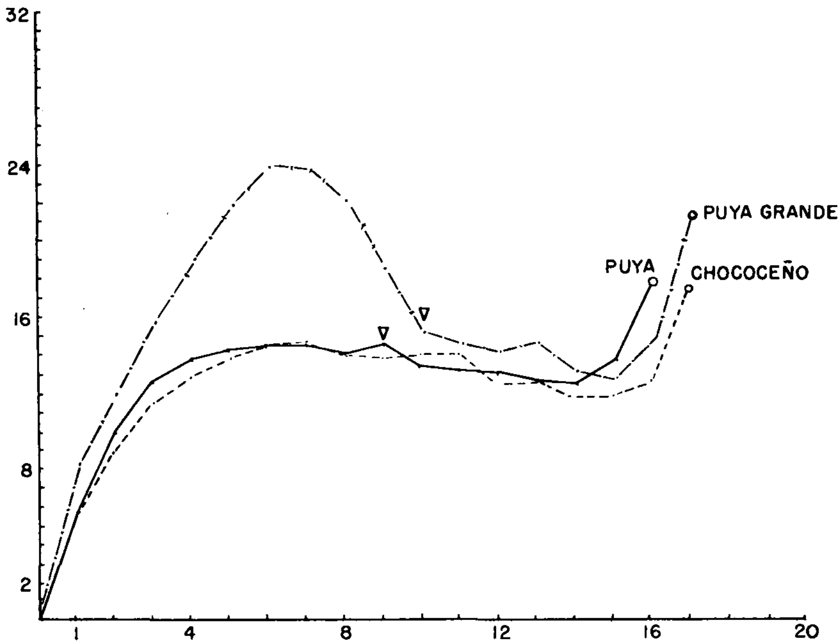
Note that the patterns of Andaquí and Yucatán, which are related races, are quite similar and that Cacao is intermediate in the early stages between Sabanero and Costeño, its putative parents.

Vertical axis = Length of Internodes in centimeters
Horizontal axis = Number of nodes
▽ = Position of uppermost ear
○ = Tassel

FIG. 88. Internode Patterns



A. Cacao, Costeño, Negrito



B. Puya, Puya Grande, Chococeño

Note that the internode pattern of Negrito is quite similar to that of Costeño to which it is closely related.

Vertical axis = Length of Internodes in centimeters
Horizontal axis = Number of nodes
▽ = Position of uppermost ear
○ = Tassel

FIG. 89. Internode Patterns

TABLE 1. Comparison of Cabuya with its Probable Progenitors, Sabanero and Clavo.

	Sabanero	*Cabuya*	*Clavo*
Plant Characters			
Height of Plant (cm.)	176.8	221.3	205.0
Height of Ear (cm.)	111.1	161.9	124.0
Stem Diameter, Minimum (mm.)	2.43	2.40	—
Stem Diameter, Maximum (mm.)	2.71	2.59	—
Length of Leaves (cm.)	72.5	77.5	101.3
Width of Leaves (cm.)	10.1	10.0	9.3
Venation Index	2.26	2.38	2.76
Number of Tillers	—	—	0.0
Tassel Characters			
Length of Tassel (cm.)	37.1	38.8	42.9
Length of Branching Space (cm.)	15.4	18.3	20.4
Per cent of Branching Space	41.5	47.2	47.6
Number of Branches	30.0	43.9	41.2
Per cent Secondary Branches	38.0	43.8	36.7
External Characters of the Ears			
Length (cm.)	14.0	16.0	20.0
Diameter (mm.)	44.3	36.7	32.2
Row Number	11.7	9.3	11.1
Angle of Tapering	5.44	4.05	3.27
Length of Peduncle (cm.)	15.3	15.3	6.9
Diameter of Peduncle (mm.)	13.2	13.6	11.3
Number of Husks	11.5	9.1	15.5
Characters of the Kernels			
Length (mm.)	11.34	10.35	10.47
Width (mm.)	10.59	10.79	8.32
Thickness (mm.)	6.11	6.36	5.15
Hardness	3.2	4.0	1.8
Denting	4.9	4.9	5.0
Internal Characters of the Ears			
Diameter of Cob (mm.)	25.0	17.8	18.0
Diameter of Rachis (mm.)	15.6	8.3	10.1
Length of Rachilla (mm.)	2.5	1.9	0.1
Cob/rachis Index	1.60	2.14	1.78
Glume/kernel Index	0.42	0.43	0.38
Rachilla/kernel Index	0.22	0.17	0.01
Physiological, Genetic and Cytological Characters			
Adaptation to Altitude Average (m.)	2,410	2,380	1,460
Number of Days to Silking	146.3	161.4 (B)	84.5
Rust Susceptibility	3.7	4.3	3.5
Helminthosporium Susceptibility	2.3	2.0	3.5
Pilosity (Intensity)	3.2	3.2	3.0
Pilosity (Frequency)	3.0	3.4	1.8
Plant Color	3.1	2.9	3.0
Lemma Color, Per cent	11.5	6.7	0.0
Glume Color, Per cent	43.5	44.4	27.6
Midcob Color, Per cent	61.8	77.8	82.8
Chromosome Knobs, Range	0–6	1–5	7–10
Chromosome Knobs, Average	1.5	2.2	8.6

TABLE 2. Comparison of Montaña with its Probable Progenitors, Sabanero and Pira Naranja.

	Sabanero	*Montaña*	*Pira Naranja*
Plant Characters			
Height of Plant (cm.)	176.8	225.0	254.5
Height of Ear (cm.)	111.1	162.2	188.0
Stem Diameter, Minimum (mm.)	2.43	2.98	—
Stem Diameter, Maximum (mm.)	2.71	3.30	—
Length of Leaves (cm.)	72.5	77.5	101.8
Width of Leaves (cm.)	10.1	11.4	10.0
Venation Index	2.26	2.14	2.82
Number of Tillers	—	—	0.4
Tassel Characters			
Length of Tassel (cm.)	37.1	40.4	41.0
Length of Branching Space (cm.)	15.4	21.2	17.8
Per cent of Branching Space	41.5	52.5	43.4
Number of Branches	30.0	50.1	58.2
Per cent Secondary Branches	38.0	41.5	35.4
External Characters of the Ears			
Length (cm.)	14.0	21.8	15.7
Diameter (mm.)	44.3	48.0	27.8
Row Number	11.7	13.2	14.7
Angle of Tapering	5.44	4.20	3.70
Length of Peduncle (cm.)	15.3	17.1	12.0
Diameter of Peduncle (mm.)	13.2	11.7	10.4
Number of Husks	11.5	11.6	16.0
Characters of the Kernels			
Length (mm.)	11.34	11.81	8.78
Width (mm.)	10.59	10.59	5.53
Thickness (mm.)	6.11	6.17	3.75
Hardness	3.2	1.9	1.4
Denting	4.9	4.3	5.0
Internal Characters of the Ears			
Diameter of Cob (mm.)	25.0	26.3	15.2
Diameter of Rachis (mm.)	15.6	14.8	8.1
Length of Rachilla (mm.)	2.5	4.3	1.1
Cob/rachis Index	1.60	1.78	1.88
Glume/kernel Index	0.42	0.49	0.41
Rachilla/kernel Index	0.22	0.36	0.12
Physiological, Genetic and Cytological Characters			
Adaptation to Altitude, Average (m.)	2,410	2,105	1,410
Number of Days to Silking	146.3	205.8	111.5
Rust Susceptibility	3.7	3.8	3.5
Helminthosporium Susceptibility	2.3	2.5	3.5
Pilosity (Intensity)	3.2	2.6	3.0
Pilosity (Frequency)	3.0	2.6	2.8
Plant Color	3.1	2.8	3.0
Lemma Color, Per cent	11.5	0.7	0.0
Glume Color, Per cent	43.5	55.7	16.7
Midcob Color, Per cent	61.8	83.1	100.0
Chromosome Knobs, Range	0–6	1–7	6–7
Chromosome Knobs, Average	1.5	5.2	7.0

TABLE 3. Comparison of Amagaceño with its Probable Progenitors, Montaña and Chococeño.

	Montaña	*Amagaceño*	*Chococeño*
Plant Characters			
Height of Plant (cm.)	225.0	225.6	200.0
Height of Ear (cm.)	162.2	150.1	148.6
Stem Diameter, Minimum (mm.)	2.98	2.56	1.88
Stem Diameter, Maximum (mm.)	3.30	2.90	1.93
Length of Leaves (cm.)	77.5	89.7	69.3
Width of Leaves (cm.)	11.4	10.2	8.0
Venation Index	2.14	2.79	3.18
Number of Tillers	—	0.4	1.9
Tassel Characters			
Length of Tassel (cm.)	40.4	42.9	30.2
Length of Branching Space (cm.)	21.2	21.1	15.3
Per cent of Branching Space	52.5	49.2	50.7
Number of Branches	50.1	44.3	41.5
Per cent Secondary Branches	41.5	36.4	33.3
External Characters of the Ears			
Length (cm.)	21.8	18.4	11.0
Diameter (mm.)	48.0	41.9	36.5
Row Number	13.2	12.6	17.2
Angle of Tapering	4.20	4.35	5.52
Length of Peduncle (cm.)	17.1	16.8	7.5
Diameter of Peduncle (mm.)	11.7	11.0	9.6
Number of Husks	11.6	10.8	16.5
Characters of the Kernels			
Length (mm.)	11.81	10.67	8.15
Width (mm.)	10.59	9.55	6.47
Thickness (mm.)	6.17	5.27	4.10
Hardness	1.9	1.8	2.0
Denting	4.3	4.6	5.0
Internal Characters of the Ears			
Diameter of Cob (mm.)	26.3	23.5	23.8
Diameter of Rachis (mm.)	14.8	15.0	15.6
Length of Rachilla (mm.)	4.3	2.3	2.0
Cob/rachis Index	1.78	1.57	1.53
Glume/kernel Index	0.49	0.39	0.50
Rachilla/kernel Index	0.36	0.22	0.19
Physiological, Genetic and Cytological Characters			
Adaptation to Altitude, Average (m.)	2,105	1,750	87
Number of Days to Silking	205.8	97.5	101.0
Rust Susceptibility	3.8	2.8	3.5
Helminthosporium Susceptibility	2.5	2.9	3.2
Pilosity (Intensity)	2.6	2.5	2.3
Pilosity (Frequency)	2.6	2.8	2.4
Plant Color	2.8	2.9	2.3
Lemma Color, Per cent	0.7	4.6	2.0
Glume Color, Per cent	55.7	56.3	75.0
Midcob Color, Per cent	83.1	85.5	100.0
Chromosome Knobs, Range	1–7	4–13	6–13
Chromosome Knobs, Average	5.2	7.4	8.7

TABLE 4. Comparison of Común with its Probable Progenitors, Amagaceño and Costeño.

	Amagaceño	*Común*	*Costeño*
Plant Characters			
Height of Plant (cm.)	225.6	219.4	184.6
Height of Ear (cm.)	150.1	143.4	113.5
Stem Diameter, Minimum (mm.)	2.56	2.40	2.22
Stem Diameter, Maximum (mm.)	2.90	2.62	2.46
Length of Leaves (cm.)	89.7	90.4	96.2
Width of Leaves (cm.)	10.2	9.5	9.4
Venation Index	2.79	2.90	2.90
Number of Tillers	0.4	0.2	0.1
Tassel Characters			
Length of Tassel (cm.)	42.9	42.5	40.1
Length of Branching Space (cm.)	21.1	21.4	18.7
Per cent of Branching Space	49.2	50.4	46.6
Number of Branches	44.3	44.5	36.9
Per cent Secondary Branches	36.4	37.8	31.2
External Characters of the Ears			
Length (cm.)	18.4	18.2	15.5
Diameter (mm.)	41.9	48.2	47.2
Row Number	12.6	12.7	13.1
Angle of Tapering	4.35	4.09	3.62
Length of Peduncle (cm.)	16.8	10.6	8.5
Diameter of Peduncle (mm.)	11.0	11.1	8.2
Number of Husks	10.8	12.6	15.6
Characters of the Kernels			
Length (mm.)	10.67	11.73	11.28
Width (mm.)	9.55	10.61	9.88
Thickness (mm.)	5.27	4.90	4.42
Hardness	1.8	1.9	1.9
Denting	4.6	4.3	4.3
Internal Characters of the Ears			
Diameter of Cob (mm.)	23.5	33.7	29.7
Diameter of Rachis (mm.)	15.0	24.9	19.7
Length of Rachilla (mm.)	2.3	1.3	2.5
Cob/rachis Index	1.57	1.35	1.51
Glume/kernel Index	0.39	0.37	0.44
Rachilla/kernel Index	0.22	0.11	0.14
Physiological, Genetic and Cytological Characters			
Adaptation to Altitude, Average (m.)	1,750	1,040	221
Number of Days to Silking	97.5	86.8	84.9
Rust Susceptibility	2.8	3.4	4.1
Helminthosporium Susceptibility	2.9	3.3	3.7
Pilosity (Intensity)	2.5	2.5	2.4
Pilosity (Frequency)	2.8	2.7	2.5
Plant Color	2.9	2.8	2.4
Lemma Color, Per cent	4.6	7.5	8.4
Glume Color, Per cent	56.3	72.8	28.7
Midcob Color, Per cent	85.5	63.7	40.7
Chromosome Knobs, Range	4–13	6–13	7–13
Chromosome Knobs, Average	7.4	9.8	9.4

TABLE 5. Comparison of Yucatán with its Probable Progenitors, Común and Andaquí.

	Común	*Yucatán*	*Andaquí*
Plant Characters			
Height of Plant (cm.)	219.4	219.2	218.3
Height of Ear (cm.)	143.4	133.0	141.2
Stem Diameter, Minimum (mm.)	2.40	—	—
Stem Diameter, Maximum (mm.)	2.62	—	—
Length of Leaves (cm.)	90.4	96.0	99.4
Width of Leaves (cm.)	9.5	10.1	9.9
Venation Index	2.90	2.57	2.68
Number of Tillers	0.2	0.0	0.0
Tassel Characters			
Length of Tassel (cm.)	42.5	44.1	43.7
Length of Branching Space (cm.)	21.4	22.7	23.0
Per cent of Branching Space	50.4	51.5	52.6
Number of Branches	44.5	43.6	42.1
Per cent Secondary Branches	37.8	36.4	40.8
External Characters of the Ears			
Length (cm.)	18.2	17.5	15.0
Diameter (mm.)	48.2	45.6	36.2
Row Number	12.7	10.8	10.3
Angle of Tapering	4.09	3.59	4.32
Length of Peduncle (cm.)	10.6	11.5	13.2
Diameter of Peduncle (mm.)	11.1	14.3	12.4
Number of Husks	12.6	15.1	16.6
Characters of the Kernels			
Length (mm.)	11.73	12.01	9.61
Width (mm.)	10.61	11.29	9.64
Thickness (mm.)	4.90	4.24	4.61
Hardness	1.9	1.8	1.7
Denting	4.3	4.4	5.0
Internal Characters of the Ears			
Diameter of Cob (mm.)	33.7	29.0	22.0
Diameter of Rachis (mm.)	24.9	17.8	13.8
Length of Rachilla (mm.)	1.3	3.0	1.8
Cob/rachis Index	1.35	1.63	1.59
Glume/kernel Index	0.37	0.47	0.43
Rachilla/kernel Index	0.11	0.25	0.19
Physiological, Genetic and Cytological Characters			
Adaptation to Altitude, Average (m.)	1,040	585	610
Number of Days to Silking	86.8	87.1	81.1
Rust Susceptibility	3.4	4.0	3.5
Helminthosporium Susceptibility	3.3	4.1	3.8
Pilosity (Intensity)	2.5	2.9	2.8
Pilosity (Frequency)	2.7	1.5	1.7
Plant Color	2.8	3.2	3.1
Lemma Color, Per cent	7.5	—	—
Glume Color, Per cent	72.8	—	—
Midcob Color, Per cent	63.7	55.6	83.2
Chromosome Knobs, Range	6–13	9–12	8–12
Chromosome Knobs, Average	9.8	10.2	10.8

TABLE 6. Comparison of Cacao with its Probable Progenitors, Sabanero and Costeño.

	Sabanero	*Cacao*	*Costeño*
Plant Characters			
Height of Plant (cm.)	176.8	225.6	184.6
Height of Ear (cm.)	111.1	135.8	113.5
Stem Diameter, Minimum (mm.)	2.43	2.02	2.22
Stem Diameter, Maximum (mm.)	2.71	2.22	2.46
Length of Leaves (cm.)	72.5	82.4	96.2
Width of Leaves (cm.)	10.1	9.4	9.4
Venation Index	2.26	2.90	2.90
Number of Tillers	—	0.0	0.1
Tassel Characters			
Length of Tassel (cm.)	37.1	38.4	40.1
Length of Branching Space (cm.)	15.4	20.0	18.7
Per cent of Branching Space	41.5	52.0	46.6
Number of Branches	30.0	41.0	36.9
Per cent Secondary Branches	38.0	37.6	31.2
External Characters of the Ears			
Length (cm.)	14.0	15.0	15.5
Diameter (mm.)	44.3	45.6	47.2
Row Number	11.7	12.6	13.1
Angle of Tapering	5.44	4.87	3.62
Length of Peduncle (cm.)	15.3	9.8	8.5
Diameter of Peduncle (mm.)	13.2	8.8	8.2
Number of Husks	11.5	12.2	15.6
Characters of the Kernels			
Length (mm.)	11.34	11.53	11.28
Width (mm.)	10.59	10.16	9.88
Thickness (mm.)	6.11	5.27	4.42
Hardness	3.2	4.0	1.9
Denting	4.9	4.8	4.3
Internal Characters of the Ears			
Diameter of Cob (mm.)	25.0	28.0	29.7
Diameter of Rachis (mm.)	15.6	18.0	19.7
Length of Rachilla (mm.)	2.5	3.5	2.5
Cob/rachis Index	1.60	1.56	1.51
Glume/kernel Index	0.42	0.43	0.44
Rachilla/kernel Index	0.22	0.30	0.14
Physiological, Genetic and Cytological Characters			
Adaptation to Altitude, Average (m.)	2,410	1,530	221
Number of Days to Silking	146.3	86.2	84.9
Rust Susceptibility	3.7	3.2	4.1
Helminthosporium Susceptibility	2.3	3.1	3.7
Pilosity (Intensity)	3.2	2.1	2.4
Pilosity (Frequency)	3.0	2.4	2.5
Plant Color	3.1	2.5	2.4
Lemma Color, Per cent	11.5	18.4	8.4
Glume Color, Per cent	43.5	69.7	28.7
Midcob Color, Per cent	61.8	64.3	40.7
Chromosome Knobs, Range	0–6	5–14	7–13
Chromosome Knobs, Average	1.5	10.0	9.4

TABLE 7. Comparison of Puya with its Probable Progenitors, Clavo and Puya Grande.

	Clavo	*Puya*	*Puya Grande*
Plant Characters			
Height of Plant (cm.)	205.0	208.1	283.6
Height of Ear (cm.)	124.0	130.0	211.4
Stem Diameter, Minimum (mm.)	—	2.19	2.48
Stem Diameter, Maximum (mm.)	—	2.48	2.78
Length of Leaves (cm.)	101.3	93.5	100.7
Width of Leaves (cm.)	9.3	10.0	11.4
Venation Index	2.76	2.73	2.59
Number of Tillers	0.0	0.1	—
Tassel Characters			
Length of Tassel (cm.)	42.9	37.8	42.1
Length of Branching Space (cm.)	20.4	17.1	20.7
Per cent of Branching Space	47.6	45.3	49.0
Number of Branches	41.2	33.8	44.6
Per cent Secondary Branches	36.7	29.0	38.7
External Characters of the Ears			
Length (cm.)	20.0	17.2	18.7
Diameter (mm.)	32.2	37.9	39.4
Row Number	11.1	11.4	11.4
Angle of Tapering	3.27	2.36	3.62
Length of Peduncle (cm.)	6.9	9.2	15.5
Diameter of Peduncle (mm.)	11.3	8.1	10.0
Number of Husks	15.5	12.0	11.5
Characters of the Kernels			
Length (mm.)	10.47	11.30	11.54
Width (mm.)	8.32	9.04	9.51
Thickness (mm.)	5.15	4.18	4.35
Hardness	1.8	2.2	2.0
Denting	5.0	3.9	4.7
Internal Characters of the Ears			
Diameter of Cob (mm.)	18.0	18.9	25.4
Diameter of Rachis (mm.)	10.1	11.3	15.6
Length of Rachilla (mm.)	0.1	0.5	2.5
Cob/rachis Index	1.78	1.67	1.63
Glume/kernel Index	0.38	0.34	0.43
Rachilla/kernel Index	0.01	0.15	0.18
Physiological, Genetic and Cytological Characters			
Adaptation to Altitude, Average (m.)	1,460	215	937
Number of Days to Silking	84.5	85.0	—
Rust Susceptibility	3.5	4.1	—
Helminthosporium Susceptibility	3.5	2.9	—
Pilosity (Intensity)	3.0	2.5	—
Pilosity (Frequency)	1.8	2.7	—
Plant Color	3.0	2.5	—
Lemma Color, Per cent	0.0	30.1	5.2
Glume Color, Per cent	27.6	13.8	7.3
Midcob Color, Per cent	82.8	31.2	56.3
Chromosome Knobs, Range	7–10	8–10	8–10
Chromosome Knobs, Average	8.6	8.6	9.0

TABLE 8. Races of Maize of Colombia compared in Characters of the Plants.

Races	Height (cm.)		Stem Diameter (mm.)		Leaves					No. Tillers
					No. Above					
	Plants	*Ears*	*Minimum*	*Maximum*	Are No.	*Ear*	*Length*	*Width*	*Venation Index*	
A. Primitive										
Pollo	141.6	85.5	2.18	2.42	9.7	4.7	65.0	8.5	2.42	—
Pira	201.8	133.9	2.16	2.41	13.3	4.8	96.8	10.0	2.76	0.0
B. Races Probably Introduced										
Pira Naranja	254.5	188.0	2.79	3.00	18.2	6.2	101.8	10.0	2.82	0.4
Clavo	205.0	124.0	2.17	2.37	14.8	6.7	101.3	9.3	2.76	0.0
Güirua	217.3	159.0	2.50	2.67	12.5	4.6	92.3	10.0	2.65	0.0
Cariaco	143.1	84.5	2.01	2.26	13.8	5.2	76.1	8.8	2.89	0.1
Andaquí	218.3	141.2	2.26	2.47	13.6	5.7	99.4	9.9	2.68	0.0
Imbricado	192.4	131.2	2.54	2.82	10.9	4.3	73.6	9.5	2.40	—
Sabanero	176.8	111.1	2.43	2.71	11.4	4.6	72.5	10.1	2.26	0.0
C. Colombian Hybrid Races										
Cabuya	221.3	161.9	2.40	2.59	13.6	5.5	77.5	10.0	2.38	0.0
Montaña	225.0	162.2	2.98	3.30	14.9	5.5	77.5	11.4	2.14	0.0
Capio	202.0	141.0	3.00	3.37	13.4	5.8	96.7	11.8	2.44	0.0
Amagaceño	225.6	150.1	2.56	2.90	15.9	5.5	89.7	10.2	2.79	0.4
Común	219.4	143.4	2.40	2.62	14.2	5.6	90.4	9.5	2.90	0.2
Yucatán	219.2	133.0	2.45	2.66	14.4	5.8	96.0	10.1	2.57	0.0
Cacao	225.6	135.8	2.02	2.22	13.4	5.4	82.4	9.4	2.90	0.0
Costeño	184.6	113.5	2.22	2.46	13.2	5.6	96.2	9.4	2.90	0.1
Negrito	145.2	90.2	1.72	1.91	12.8	5.0	69.6	8.3	3.07	0.0
Puya	208.1	130.0	2.19	2.48	15.2	5.7	93.5	10.0	2.73	0.1
Puya Grande	283.6	211.4	2.48	2.78	15.9	5.8	100.7	11.4	2.59	—
Chococeño	200.0	148.6	1.88	1.93	15.8	4.7	69.3	8.0	3.18	1.9

TABLE 9. Races of Maize of Colombia compared in Characters of the Tassels.

	Length (cm.)		*Branching Space*		*Branches*			
Races	*Tassel*	*Peduncle*	*Length (cm.)*	*Per cent*	*No.*	*% Secondary*	*% Tertiary*	*Condensation Index*
A. Primitive								
Pollo	30.7	15.4	14.8	48.2	35.2	44.3	8.0	1.03
Pira	38.8	18.5	19.0	49.0	50.6	38.7	4.2	1.04
B. Races Probably Introduced								
Pira Naranja	41.0	15.2	17.8	43.4	58.2	35.4	3.6	1.04
Clavo	42.9	19.5	20.4	47.6	41.2	36.7	3.0	1.09
Güirua	42.7	19.5	19.9	46.7	43.6	41.5	4.3	1.18
Cariaco	36.4	13.9	18.2	50.0	46.1	34.4	2.8	1.08
Andaquí	43.7	20.9	23.0	52.6	42.1	40.8	6.2	1.10
Imbricado	37.8	20.6	16.9	44.7	41.2	35.0	1.9	1.06
Sabanero	37.1	21.8	15.4	41.5	30.0	38.0	4.3	1.04
C. Colombian Hybrid Races								
Cabuya	38.8	21.3	18.3	47.2	43.9	43.8	6.4	1.04
Montaña	40.4	17.9	21.2	52.5	50.1	41.5	6.0	1.08
Capio	—	19.4	19.6	—	42.0	50.7	7.9	1.03
Amagaceño	42.9	20.3	21.1	49.2	44.3	36.4	3.6	1.02
Común	42.5	20.6	21.4	50.4	44.5	37.8	4.3	1.04
Yucatán	44.1	20.4	22.7	51.5	43.6	36.4	3.9	1.03
Cacao	38.4	21.4	20.0	52.0	41.0	37.6	3.4	1.03
Costeño	40.1	17.7	18.7	46.6	36.9	31.2	2.2	1.07
Negrito	33.8	15.5	14.7	43.5	28.1	26.0	1.4	1.09
Puya	37.8	17.6	17.1	45.3	33.8	29.0	2.1	1.06
Puya Grande	42.1	21.1	20.7	49.0	44.6	38.7	6.0	1.03
Chococeño	30.2	17.0	15.3	50.7	41.5	33.3	2.9	1.05

TABLE 10. Races of Maize of Colombia compared in External Characters of the Ears and Kernels.

Races	Length cm.	Diam. cm.	Row No.	Angle of Tapering Degrees	Peduncles Diam. mm.	Peduncles Length cm.	No. Husks	Characters of the Kernels Length mm.	Width mm.	Thickness mm.	Hardness	Denting
A. Primitive												
Pollo	8.8	29.3	10.0	5.65	8.7	11.3	11.3	8.54	7.94	4.96	1.6	5.0
Pira	11.2	25.6	11.0	3.12	8.7	9.9	13.1	8.96	6.49	3.58	1.2	5.0
B. Races Probably Introduced												
Pira Naranja	15.7	27.8	14.7	3.70	10.4	12.0	16.0	8.78	5.53	3.75	1.4	5.0
Clavo	20.0	32.2	11.1	3.27	11.3	6.9	15.5	10.47	8.32	5.15	1.8	5.0
Güirua	16.2	43.0	12.2	4.39	13.2	13.3	12.7	10.44	7.97	4.88	2.4	4.8
Cariaco	11.9	47.7	15.8	4.72	9.4	8.3	16.0	10.77	8.80	4.73	4.5	4.4
Andaquí	15.0	36.2	10.3	4.32	12.4	13.2	16.6	9.61	9.64	4.61	1.7	5.0
Imbricado	11.0	38.65	14.3	5.73	11.7	10.0	8.2	10.64	7.23	5.26	1.3	5.0
Sabanero	14.0	44.3	11.7	5.44	13.2	15.3	11.5	11.34	10.59	6.11	3.2	4.9
C. Colombian Hybrid Races												
Cabuya	16.0	36.7	9.3	4.05	13.6	15.3	9.1	10.35	10.79	6.36	4.0	4.9
Montaña	21.8	48.0	13.2	4.20	11.7	17.1	11.6	11.81	10.59	6.17	1.9	4.3
Capio	19.8	50.5	13.0	4.53	14.3	18.4	15.0	12.08	11.38	7.01	4.4	4.6
Amagaceño	18.4	41.9	12.6	4.35	11.0	16.8	10.8	10.67	9.55	5.27	1.8	4.6
Común	18.2	48.2	12.7	4.09	11.1	10.6	12.6	11.73	10.61	4.90	1.9	4.3
Yucatán	17.5	45.6	10.8	3.59	14.3	11.5	15.1	12.01	11.29	4.24	1.8	4.4
Cacao	15.0	45.6	12.6	4.87	8.8	9.8	12.2	11.53	10.16	5.27	4.0	4.8
Costeño	15.5	47.2	13.1	3.62	8.2	8.5	15.6	11.28	9.88	4.42	1.9	4.3
Negrito	13.1	42.5	14.4	3.76	8.0	6.9	10.5	11.38	8.40	4.27	3.3	4.2
Puya	17.2	37.9	11.4	2.36	8.1	9.2	12.0	11.30	9.04	4.18	2.2	3.9
Puya Grande	18.7	39.4	11.4	3.62	10.0	15.5	11.5	11.54	9.51	4.35	2.0	4.7
Chococeño	11.0	36.5	17.2	5.52	9.6	7.5	16.5	8.15	6.47	4.10	2.0	5.0

TABLE 11. Races of Maize of Colombia compared in Internal Characters of the Ears.

Races	Diameter (mm.)			Length	Indices			Pubescence			Induration	
	Ear	Cob	Rachis	Rachilla	Cob/ rachis	Glume/ kernel	Rachilla/ kernel	Cupule	Lower Glume	Upper Glume	Lower Glume	Rachis
A. Primitive												
Pollo	29.3	14.3	8.1	1.4	1.77	0.36	0.16	1.8	0.9	1.0	2.4	3.0
Pira	25.6	11.2	5.5	0.5	2.04	0.31	0.06	1.6	0.8	0.4	1.6	2.5
B. Races Probably Introduced												
Pira Naranja	27.8	15.2	8.1	1.1	1.88	0.41	0.12	2.7	1.2	0.3	1.0	2.0
Clavo	32.2	18.0	10.1	0.1	1.78	0.38	0.01	2.3	1.1	0.3	1.9	3.0
Güirua	34.1	21.5	10.9	2.3	1.97	0.55	0.24	1.2	1.2	0.5	1.0	2.0
Cariaco	47.7	28.8	18.1	3.7	1.59	0.50	0.34	1.8	1.6	2.1	3.1	3.2
Andaquí	36.2	22.0	13.8	1.8	1.59	0.43	0.19	2.1	1.5	2.0	2.6	2.8
Imbricado	38.6	22.7	13.9	1.9	1.63	0.77	0.17	1.9	0.1	0.3	3.1	3.1
Sabanero	44.3	25.0	15.6	2.5	1.60	0.42	0.22	1.6	0.8	0.8	2.2	2.4
C. Colombian Hybrid Races												
Cabuya	36.7	17.8	8.3	1.9	2.14	0.43	0.17	1.3	1.8	1.4	1.7	2.3
Montaña	48.0	26.3	14.8	4.3	1.78	0.49	0.36	2.2	0.2	0.8	2.5	2.8
Capio	50.5	29.0	16.8	5.1	1.73	0.51	0.42	1.9	1.2	1.8	2.8	3.0
Amagaceño	41.9	23.5	15.0	2.3	1.57	0.39	0.22	1.6	0.2	0.3	3.5	3.5
Común	48.2	33.7	24.9	1.3	1.35	0.37	0.11	1.9	1.3	1.1	3.3	3.5
Yucatán	45.6	29.0	17.8	3.0	1.63	0.47	0.25	2.0	1.8	2.2	3.5	3.5
Cacao	45.6	28.0	18.0	3.5	1.56	0.43	0.30	1.6	0.8	0.8	2.9	2.8
Costeño	47.2	29.7	19.7	2.5	1.51	0.44	0.14	2.2	1.4	1.3	3.0	3.0
Negrito	42.5	24.0	16.7	1.5	1.44	0.32	0.13	2.2	1.4	1.9	2.9	2.6
Puya	37.9	18.9	11.3	0.5	1.67	0.34	0.15	1.8	1.2	0.8	2.2	3.1
Puya Grande	39.4	25.4	15.6	2.5	1.63	0.43	0.18	1.7	0.8	0.8	3.0	2.8
Chococeño	36.5	23.8	15.6	2.0	1.53	0.50	0.19	2.3	1.2	1.4	2.4	2.3

TABLE 12. Races of Maize of Colombia compared in Physiological, Genetic and Cytological Characters.

Races	Adap. to altitude	Maturity	Rust	Helminthosporium	Pilosity		Color in Plants and Ears							Chromosome knobs		
								Percentages of Ears with color in:								
					Intensity	Frequency	Plant score	Lemmas	Glumes	Mid-Cob	Pith	Aleurone	Pericarp	No. Plants studied	Range	Average
A. Primitive																
Pollo	1865	142.9	4.1	2.1	1.8	1.5	1.8	4.5	40.7	76.9	18.1	13.6	19.7	6	3–5	4.0
Pira	1100	89.7	4.0	4.0	2.8	3.3	2.3	1.3	9.2	35.6	9.2	5.0	0.0	5	6–10	8.4
B. Races Probably Introduced																
Pira Naranja	1410	111.5	3.5	3.5	3.0	2.8	3.0	0.0	16.7	100.0	27.8	4.2	0.0	2	6–7	7.0
Clavo	1460	84.5	3.5	3.5	3.0	1.8	3.0	0.0	27.6	82.8	38.0	0.0	0.0	4	7–10	8.6
Güirua	1861	83.9	3.4	3.5	3.2	2.0	3.1	19.8	25.0	39.5	0.0	100.0	17.2	—	—	—
Cariaco	244	84.6	3.8	3.9	2.1	2.2	2.4	41.4	38.0	48.6	18.1	4.2	45.8	3	5–6	5.3
Andaquí	610	81.1	3.5	3.8	2.8	1.7	3.1	1.5	39.0	83.2	6.2	0.0	8.0	6	8–12	10.8
Imbricado	2310	147.0	3.2	1.8	4.0	3.5	3.8	36.0	72.0	92.0	44.0	0.0	75.7	4	1–5	2.8
Sabanero	2410	146.3	3.7	2.3	3.2	3.0	3.1	11.5	43.5	61.8	14.7	6.2	14.9	35	0–6	1.5
C. Colombian Hybrid Races																
Cabuya	2380	161.4	4.3	2.0	3.2	3.4	2.9	6.7	44.4	77.8	8.9	31.1	2.2	4	1–5	2.2
Montaña	2105	205.8	3.8	2.5	2.6	2.6	2.8	0.7	55.7	83.1	9.2	0.0	6.8	5	1–7	5.2
Capio	2370	199.8	3.9	3.0	2.6	2.9	3.5	18.7	54.5	72.8	24.2	2.3	26.6	2	6–7	6.2
Amagaceño	1750	97.5	2.8	2.9	2.5	2.8	2.9	4.6	56.3	85.5	9.0	4.5	5.1	8	4–13	7.4
Común	1040	86.8	3.4	3.3	2.5	2.7	2.8	7.5	72.8	63.7	8.5	1.8	7.0	20	6–13	9.8
Yucatán	585	87.1	4.0	4.1	2.9	1.5	3.2	11.0	20.0	55.6	2.4	0.0	12.0	5	9–12	10.2
Cacao	1530	86.2	3.2	3.1	2.1	2.4	2.5	18.4	69.7	64.3	7.9	55.5	15.6	6	5–14	10.0
Costeño	221	84.9	4.1	3.7	2.4	2.5	2.4	8.4	28.7	40.7	4.5	3.5	10.5	17	7–13	9.4
Negrito	79	82.3	4.2	4.0	2.5	2.8	2.3	10.7	28.6	53.6	0.0	100.0	0.0	2	8–9	8.5
Puya	215	85.0	4.1	3.9	2.5	2.7	2.5	30.1	13.8	31.2	0.6	4.2	2.8	5	8–10	8.6
Puya Grande	937	—	—	—	—	—	—	5.2	7.3	56.3	2.1	0.0	12.7	4	8–10	9.0
Chococeño	87	101.0	3.5	3.2	2.3	2.4	2.3	2.0	75.0	100.0	2.9	10.5	4.4	16	6–13	8.7

TABLE 13. List of Collections Studied as Representative of Each Race of Colombian Maize.

Race of Maize	*Accession Number of Collection*
A. Primitive Races	
1. Pollo	Boy. 384, 444, 450, 452, 453, 455, 456, 457, 466; Cun. 366, 423, 424, 443, 445, 465.
2. Pira	Boy. 445, 462, 473, 474; Cun. 301, 327, 375, 421, 449, 452, 470, 480, 483, 486, 488, 515, 520, 521; Hui. 374; Mag. 403; Meta. 320, 902; Sas. 356, 374, 375, 379, 380, 384, 385, 389, 390; Tol. 351, 368, 379, 390, 400, 405; Val. 361.
B. Races Probably Introduced	
3. Pira Naranja	Nar. 363, 369, 471, 521, 532, 536, 537; Val. 429.
4. Clavo	Cal. 370, 374; Chocó 311; Nar. 329; San. 314; Tol. 358.
5. Güirua	Mag. 443, 447, 450, 464, 466, 469.
6. Maíz Dulce	Nar. 430.
7. Maíz Harinoso Dentado	Nar. 326.
8. Cariaco	Ant. 401; Atl. 318; Bol. 301, 349; Cor. 302, 332, 334, 338; 340, 342; Cun. 473; Cho. 338; Mag. 399, 408, 434; San. 302; Tol. 307, 312.
9. Andaquí	Caq. 307, 320, 321, 324, 325, 327, 329, 330, 333, 334, 336; Put. 329.
10. Imbricado	Boy. 406; Cun. 372; Nar. 389, 390.
11. Sabanero	Ant. 333A; Boy. 305, 306, 308, 309, 313B, 315, 317, 320, 323, 324, 326, 331, 332, 335, 339, 340, 342, 344, 352, 354, 356B, 357, 358, 360, 361, 362, 364, 365, 367, 368, 369, 370, 371, 372, 373, 374, 375, 377, 378, 379, 381, 383, 390, 393, 395, 398, 399, 400, 401, 402, 403, 407A, 408, 409, 411, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 426A, 432, 439, 443, 447, 458, 459, 460; Cau. 308; Cun. 307, 308, 309, 310, 317, 318, 320, 323, 336, 339, 349, 353, 357, 358A, 358B, 359, 360, 361, 362, 364, 365, 367, 369, 370, 371, 373, 374, 377, 378, 379B, 381, 382, 384, 385, 386, 387, 388, 389, 391, 392, 394, 395, 396, 397, 398, 400, 402, 403, 404, 406, 408, 409, 410, 411, 412, 413, 414, 415, 417, 418, 419, 420, 422, 425,

TABLE 13. List of Collections Studied as Representative of Each Race of Colombian Maize.—Continued

Race of Maize	*Accession Number of Collection*
	426, 427, 428, 429, 430, 431, 432, 433, 444, 489, 494, 495, 513, 535, 541; Hui. 305; Nar. 304, 305, 314, 318, 319, 320, 335, 342, 343, 365, 388, 405, 406, 410, 415, 416, 423, 425, 428, 429, 434, 435, 438; Put. 301, 302, 307; San. 303, 306, 308, 324, 326, 327, 329, 333; Sas. 303, 365, 368, 369, 373; Val. 303, 306.
C. Colombian Hybrid Races	
12. Cabuya	Cun. 312, 313, 314, 316; San. 301, 304, 316, 317.
13. Montaña	Ant. 307, 320, 339, 346, 349, 350, 351, 353, 355, 356, 357, 360, 361, 362, 418, 419, 420; Nar. 374, 426, 437, 493, 494, 509, 520, 534.
14. Capio	Ant. 318, 348, 354; Nar. 315.
15. Amagaceño	Ant. 322, 340, 344, 367, 392; Cal. 368; Cau. 307, 310, 336, 341, 342, 358, 375, 376, 380, 381, 382, 384, 385, 414, 421; Cun. 324, 329, 330, 517; Cho. 317; Hui. 317; 319; Nar. 317, 355, 358, 359, 367, 371, 378, 401, 418, 512, 542; Put. 303; San. 313, 323; Tol. 359, 384; Val. 350, 408.
16. Común	Ant. 303, 308, 316, 321, 325, 326, 328, 330, 331, 335, 336, 342, 368, 372, 373, 374, 375, 377; Cal. 302, 303, 307, 309, 312, 315, 316, 317, 319, 321, 322, 323, 326, 327, 329, 330, 331, 333, 334, 336, 337, 339, 340, 341, 346, 352, 353, 354, 355, 356, 358, 359, 361, 362; Cau. 301, 311, 314, 315, 316, 319, 320, 322, 324, 325, 326, 327, 343, 344, 345, 346, 352, 353, 355, 356, 362, 363, 366, 367; Caq. 306, 328; Cun. 439; Hui, 301, 302, 303, 308, 309, 311, 313, 315, 318, 322, 323, 328, 337, 341, 347, 361, 367, 369, 378; Mag. 336, 377; Nar. 366, 370, 380; Sas. 314; Tol. 303, 310, 339, 341, 345, 402, 414; Val. 302, 308, 310, 312, 315, 316, 320, 321, 322, 326, 327, 330, 332, 335, 356, 357, 358, 366, 368, 372, 374, 375, 378, 379, 380, 381, 385, 388, 390, 391, 392, 394, 397, 399, 401, 402, 405, 407, 409, 411, 412, 413, 414, 416, 418.
17. Yucatán	Cun. 475, 476, 478, 534; Tol. 370, 377, 378, 389, 399, 408.

TABLE 13. List of Collections Studied as Representative of Each Race of Colombian Maize.—Continued

Race of Maize	Accession Number of Collection
18. Cacao	Boy. 314, 318, 345, 346, 431, 437, 446, 454; Cun. 451; Hui. 304; San. 321; Sas. 301, 304, 315, 317, 318, 319, 323, 324, 326, 327, 328, 329, 330, 331, 332, 335, 337, 338, 340, 341, 342, 345, 346, 347, 348, 351, 354, 355, 358, 359, 364.
19. Costeño	Ant. 309, 323, 324, 378, 379, 380, 381, 382, 383, 384, 385, 387, 388, 389, 390, 391, 393; Atl. 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 312, 313, 314, 315, 316, 317, 320, 323, 324, 325, 326, 327, 328, 329; Boy. 310; Bol. 305, 311, 313, 314, 316, 322, 323, 324, 326, 327, 328, 329, 330, 331, 332, 334, 336, 337, 339, 340, 341, 342, 343, 345, 347, 348, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 364, 370, 371, 372, 374, 375, 377, 378, 379, 380, 381; Cal. 310, 369, 377; Cor. 304, 305, 306, 308, 309, 310, 311, 312, 313, 314, 316, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 333, 335, 336, 339, 341, 343, 344, 345; Cun. 348, 487, 519; Mag. 302, 307, 309, 311, 312, 313, 316, 335, 337, 340, 343, 344, 345, 347, 348, 349, 350, 351, 352, 354, 356, 359, 360, 361, 363, 366, 367, 368, 369, 370, 371, 372, 386, 391, 394, 395, 397, 400, 406; Meta. 303, 305, 314, 319; Sas. 308, 313, 350; Tol. 306, 320, 347, 352, 353, 360, 361, 363, 365, 393, 395, 401.
20. Negrito	Atl. 321; Cho. 339; Gua. 306; Mag. 321, 392.
21. Puya	Ant. 363; Ara. 301; Gua. 302, 304, 305, 307, 308; Mag. 303, 318, 322, 332, 355, 374, 375, 376, 390; San. 305, 345, 349, 350, 351; Sas. 311.
22. Puya Grande	San. 315, 319, 320, 332, 335, 336, 340, 341, 347.
23. Chococeño	Ant. 399; Cau. 388, 389, 390, 392, 393, 394, 395, 396, 397, 399, 400, 401, 402, 403, 404, 405, 406, 407, 409, 410, 411, 412, 427, 428, 429, 430, 431, 432, 433; Cho. 301, 302, 303, 304, 306, 307, 308, 309, 310, 312, 314, 316, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 340, 343, 344, 345, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 360, 361, 362, 363,

TABLE 13. List of Collections Studied as Representative of Each Race of Colombian Maize.—Continued

Race of Maize	*Accession Number of Collection*
	364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 389, 390, 392, 393, 394, 395, 400; Nar. 301, 302, 392, 397, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 467, 468, 469, 484, 490, 495, 496, 499, 504, 514, 530, 544; Val. 304, 359, 360, 362, 420, 421, 423, 424, 425. 426, 427.

TABLE 14. Number of Collections of Each Race which were studied for Various Characters.

Race	*Plants*	*Ears*			*Pubescence Rust, etc.*	*Chromosome knobs*
		External	*Internal*	*Color*		
Pollo	5	11	1	15	13	6
Pira	9	6	2	5	3	5
Clavo	2	2	1	2	2	4
Güirua	7	7	3	7	7	—
Cariaco	4	11	1	6	4	3
Andaquí	6	12	2	—	6	6
Imbricado	2	3	1	2	2	4
Sabanero	36	184	2	189	177	35
Pira Naranja	4	2	1	2	4	2
Montaña	7	13	1	14	17	5
Capio	2	4	1	4	4	2
Amagaceño	8	44	1	32	23	8
Común	20	200	1	135	101	20
Yucatán	8	9	2	—	8	5
Cacao	5	43	1	40	10	6
Costeño	28	130	4	155	91	17
Negrito	4	4	1	4	3	2
Puya	11	19	2	16	8	5
Puya Grande	4	11	4	9	—	4
Chococeño	14	38	2	27	12	16
Cabuya	4	8	1	4	5	4

TABLE 15. List of Institutions and Individuals to whom Maize Seed has been sent from the Collection Center in Medellín, Colombia.

Name	*Institution*	*Place*
H. Rosado	Instituto Interamericano de Ciencias Agrícolas	Turrialba, Costa Rica
Carlos A. Krug	Servicio Nacional Ciencias Agronomicas	Campinas, Sao Paulo, Brasil
Americo Groszman	Servicio Nacional Ciencias Agronomicas	Rio de Janeiro, Brasil
F. G. Brieger	Escola Superior de Agricultura "Luiz de Queiroz"	Piracicaba, Sao Paulo, Brasil
Narciso M. Cross	Departamento Meteorologia	Santiago de las Vegas, Cuba
Ricardo Cardenosa B.	University of Minnesota	Minneapolis, Minn.
H. C. Thorpe	East African Agriculture and Forestry Research Organization	D.P.O. Njoro, Kenya Colony, Africa.
Edward E. Christensen	Christensen Plant Co.	Padada, Santa Cruz, Davao, Philippines
Mario Gutierrez J.	Instituto Interamericano de Ciencias Agrícolas	Turrialba, Costa Rica
H. K. Hayes	College of Agriculture University of Philippines	Los Baños, Luzon, Philippines
J. G. Hunter	Institute of Inter-American Affairs	San Jose, Costa Rica
Glauco P. Viegas	Instituto Agronomico	Campinas, Sao Paulo, Brasil
R. P. Bartholomew	Technical Cooperation Administration	Divisa, Panamá
Luigi Bozzi	Administrazione Educiaria Italiana	Mogadiscio, Somalia
H. H. Storey	East African Agricultural Research Organization	Kikuyu, Kenya, Africa
John R. Laughnan	University of Illinois	Urbana, Ill.
O. H. Pearson	Eastern States Farmers Exchange	Springfield, Mass.
Walton C. Galinat	Wisconsin University	Madison 6, Wisconsin
Milton Rocha	Instituto Agronomico do Sul	Pelotas, Rio Grande do Sul, Brasil
Ezequiel Espinosa S.	Ministerio Agricultura y Comercio	Divisa, Panamá
Arthur F. Swanson	Institute of Inter-American Affairs	Lima, Peru
H. E. Rothe	Department of Agriculture	Peoria 5, Ill.
P. C. Mangelsdorf	Harvard University	Cambridge, Mass.
J. B. Paxson	Harvard University	Cambridge, Mass.
Sherill Chase	De Kalb Hybrid Corn Co.	Sycamore, Ill.
Earl S. Horner	University of Florida	Gainesville, Fla.
Sterling Wortman	Rockefeller Foundation	Mexico D.F., Mexico
R. Brodier	Ministerio de Agricultura, Cria	Valencia, Venezuela
James S. Brooks	Oklahoma A & M College	Stillwater, Okla.
R. L. Jackson	Technical Cooperation Administration	Jakarta, Indonesia

TABLE 15. List of Institutions and Individuals to whom Maize Seed has been sent from the Collection Center in Medellín, Colombia.—Continued

Name	Institution	Place
Lawrence Swildens	S. A. Timber Export Co.	Georgetown, British Guiana, S.A.
Santiago Bocanegra	Estacion Experimental Agrícola	La Molina, Lima, Peru
John Lonnquist	University of Nebraska	Lincoln, Nebraska
Alexander Grobman	Escuela Natl. de Agricultura	La Molina, Lima, Peru
E. V. Walter	Cereal and Forage Insect Investigations, U.S.D.A.	Lafayette, Indiana
J. R. Galarraga	Servicio Cooperativo Inter-Americano de Agricultura	Quito, Ecuador
Jose J. Eljuri	———	Cuenca, Ecuador
R. H. Painter	Kansas State College	Manhattan, Kansas
Boshi Sen	Vivekananda Laboratory	Almora, Uttar Pradesh, India
V. M. Chavan	Deputy Director of Agriculture, Bombay State	Poona 5, India
Dioscoro L. Umali	College of Agriculture University of Philippines	College, Laguna, Philippines
A. J. Mangelsdorf	Hawaiian Sugar Planters Experiment Station	Honolulu 14, Hawaii
F. D. Clement	Trans-United Seed Co.	149 Rue Saint Honoré, Paris, France
S. M. Sikka	Indian Agricultural Research Institute	New Delhi, India
Loring M. Jones	De Kalb Hybrid Corn Co.	De Kalb, Ill.
D. F. Jones	Connecticut Agricultural Experiment Station	New Haven, Conn.
Alfredo Carvallo	Ministerio de Agricultura	San Jose, Costa Rica
Rameshwar Singh	Sabour Agricultural College	Sabour, Bihar, India
D. L. Smith	Rockefeller Foundation	Mexico D.F., Mexico
Ernesto Paterniani	Escola Superior de Agricultura "Luiz de Queiroz"	Piracicaba, Sao Paulo, Brasil
Walter Kugler	Estacion Experimental de Pergamino	Pergamino, Buenos Aires, Argentina
A. Rattray	Agricultural Experiment Station	Salisbury, Southern Rhodesia, Africa
Robert D. Osler	Rockefeller Foundation	Mexico D.F., Mexico
G. H. Stringfield	Ohio Agricultural Experiment Station	Wooster, Ohio
L. F. Randolph	Cornell University	Ithaca, N. Y.
I. D. Clement	Atkins Garden and Research Laboratory	Cienfuegos, Cuba
Nevin S. Scrimshaw	Nutrition Institute of Central America. I.N.C.A.P.	Guatemala City, Guatemala
Mario P. Mezzacapa	Escola Superior de Agricultura "Luiz de Queiroz"	Piracicaba, Sao Paulo, Brasil
Glenn M. Smith	Purdue University	Lafayette, Indiana
Coel W. Mills	Servicio Cooperativo Inter-Americano de Agricultura	Quito, Ecuador
Jorge Soria	Servicio Cooperativo Inter-Americano de Agricultura	Pichilingue, Ecuador
Ralph S. Matlock	Oklahoma A & M College	Stillwater, Okla.

TABLE 15. List of Institutions and Individuals to whom Maize Seed has been sent from the Collection Center in Medellín, Colombia.—Continued

Name	*Institution*	*Place*
William Paddock	Servicio Cooperativo	La Aurora, Guatemala
D. L. Richardson	Purdue University	Lafayette, Indiana
H. L. Everett	International Cooperation Administration	Los Baños, Philippines
William L. Brown	Pioneer Hybrid Corn Co. Department of Plant Breeding	Johnston, Iowa
Pedro Obregon	Ministerio de Agricultura y Cria	Maracay, Venezuela

NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL

The National Academy of Sciences—National Research Council is a private, nonprofit organization of scientists, dedicated to the furtherance of science and to its use for the general welfare.

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Receiving funds from both public and private sources, by contribution, grant, or contract, the Academy and its Research Council thus work to stimulate research and its applications, to survey the broad possibilities of science, to promote effective utilization of the scientific and technical resources of the country, to serve the Government, and to further the general interests of science.