RACES OF MAIZE IN CENTRAL AMERICA

E. J. Wellhausen
Alejandro Fuentes O.
Antonio Hernández Corzo

in collaboration with
Paul C. Mangelsdorf

NATIONAL ACADEMY OF SCIENCES—
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TABLE OF CONTENTS

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RACES OF MAIZE IN CENTRAL AMERICA

E. J. Wellhausen, Alejandro Fuentes O. and

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Paul C. Mangelsdorf [1]

INTRODUCTION

This monograph is concerned with the races of maize, their origin, characteristics and distribution in the countries that lie between Mexico and Colombia. The races of maize of Mexico have been described by Wellhausen *et al* (1952) and those of Colombia by Roberts *et al* (1957).

Since the diffusion of races of maize ignores national boundaries, and since much of the diffusion occurred in prehistoric times before there were such boundaries, it was to have been expected that among the races of maize encountered in Central America would be representatives of races previously found in Mexico and Colombia. It has, however, been surprising to find so few races in Central America which have not already been described from either Mexico or Colombia. That this is true has made the present task much simpler than it otherwise would have been. It has also made it possible for us to treat several aspects of the subject more briefly than we could have done had they not already been adequately considered in the earlier works. Consequently, the length of this monograph does not reflect accurately the diversity of maize of Central America, especially that of Guatemala, where more races are found in a smaller area than in any other country of this hemisphere.

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Since Guatemala is the center of diversity of the maize in Central America, and since the collections from that country are more complete than those from the remaining countries, we have, from necessity, devoted the greater part of this monograph to the maize of Guatemala.

The collections of maize upon which the majority of these studies are based were made under the joint auspices of the Rockefeller Foundation Agricultural Program in Mexico and the National Research Council of the United States. The former provided facilities and personnel, the latter (through a grant from the International Cooperation Administration) the funds to defray the costs of collecting and the publication of the English edition.

Other collections of Guatemalan maize, especially the collection made by Dr. F. W. McBryde in 1940–41, were also consulted in connection with the present studies.

METHODS OF CLASSIFICATION

The collections from the countries of Central America comprise 1231 entries, distributed among the different countries as follows:

Guatemala	1054
Honduras	30
El Salvador	40
Costa Rica	33
Nicaragua	49
Panamá	25

On the basis of the characteristics of the original ears (usually ten in each collection) an attempt was made to divide the collections into more or less distinct groups. Plants of representative collections were then grown in the field at Chapingo, Mexico. About one third of the Guatemalan collections and the majority of the collections from the remaining countries were studied in the field planting.

Employing the data from the ears of the original collections and from the plants grown in the field, and drawing upon our previous experience in classifying the maize of Mexico and

Colombia, we next assigned each collection to a "pure" race or classified it as a mixture in which the influence of one or more races was recognized. There were few collections which could not be assigned to one of these two groups.

The data presented in Tables 2 and 3 and in the descriptions are based upon typical collections. The collections used for this purpose are listed in Table 1.

TABLE 1. List of Collections Studied as Representative of each Race

Race	*Accession number of collection*
Nal-Tel Amarillo Tierra Baja	Guatemala 110, 111, 114, 150, 220, 281
Nal-Tel Blanco Tierra Baja	Guatemala 145, 280, 765
Nal-Tel Amarillo Tierra Alta	Guatemala 19, 835, 852, 908
Nal-Tel Blanco Tierra Alta	Guatemala 20, 161, 500
Nal-Tel Ocho	Guatemala 420, 458, 591, 647
Imbricado	Guatemala 493, 717, 720, 777, 922
Serrano	Guatemala 3, 14, 368, 413, 431, 471, 475, 492, 497, 505, 528, 543, 729, 755, 895, 909, 930, 940
San Marceño	Guatemala 8, 365, 407, 414, 420, 423, 427, 429, 433, 440, 447, 457, 458, 461, 465, 491, 496, 506, 517, 534, 564, 565, 647, 716, 724, 742, 748
Quicheño Early	Guatemala 19, 160, 162, 591, 744, 835, 852, 868, 908
Quicheño Late	Guatemala 40, 627, 739, 839, 863, 871, 877, 889, 894, 929, 934, 945
Quicheño Rojo	Guatemala 39
Quicheño Grueso	Guatemala 37, 891, 905, 924
Salpor	Guatemala 375, 403, 441, 476, 484
Salpor Tardío	Guatemala 412, 474, 485, 577
Negro de Chimaltenango	Guatemala 31, 369, 393, 590, 592, 646
Negro de Tierra Fría	Guatemala 386, 410, 480, 513, 522, 524, 536
Negro de Tierra Caliente	Guatemala 101, 146, 159, 256, 356, 358, 359, 603
Olotón	Guatemala 4, 27, 383, 391, 429, 477, 533, 539, 583, 626, 639, 650, 653, 655, 656, 672, 677, 680, 686, 696, 840, 880, 896, 932
Comiteco	Guatemala 23, 203, 241, 300, 367, 373, 418, 443, 464, 499, 507, 515, 529, 546, 568
Dzit-Bacal	Guatemala 127, 130, 131, 134, 291, 322
Tepecintle	Guatemala 65, 79, 597, 651, 806
Tuxpeño	Guatemala 456, 460

TABLE 2. Races of Maize of Guatemala, Compared in Characters of the Plants.

Races	Aver. Alt. (ft.)	Days to flowering	Height cm.	Leaves No.	Leaves Length cm.	Leaves Width cm.	Leaves Veins (No.)	Plant Color	Pubescence
Nal-Tel Amarillo Tierra Baja	2658	90	141	13.0	80	9.2	25.3	1.2	1.0
Nal-Tel Blanco Tierra Baja	3350	83	145	13.3	85	7.3	27.3	1.0	1.0
Nal-Tel Amarillo Tierra Alta	7412	103	281	16.0	100	11.1	26.5	2.2	2.1
Nal-Tel Blanco Tierra Alta	7700	93	233	15.0	108	10.3	26.3	1.0	2.1
Nal-Tel Ocho	7825	99	297	16.3	105	10.5	26.0	2.0	1.7
Imbricado	7650	100	311	15.6	115	10.6	25.2	1.4	2.1
Serrano	9060	83	253	14.0	94	11.4	26.4	2.3	2.1
San Marceño	7834	103	295	16.1	107	10.2	24.5	2.2	1.8
Quicheño (all collections)	6892	115	290	16.3	107	9.6	26.0	1.7	2.0
Quicheño, Early	6740	104	279	15.3	101	10.3	26.6	1.8	2.1
Quicheño, Late	7030	125	325	17.6	117	9.3	25.6	1.5	1.5
Quicheño, Rojo	6000	115	260	15.0	95	8.0	28.0	1.0	1.0
Quicheño, Grueso	7218	116	275	16.5	101	10.5	25.0	1.5	1.3
Negro de Chimaltenango	6985	121	298	17.2	105	10.9	27.3	1.8	2.1
Negro de Tierra Fría	8557	87	255	13.9	95	10.5	24.1	2.6	2.5
Negro de Tierra Caliente	2110	94	173	14.8	87	8.9	25.0	1.0	1.0
Salpor	7980	90	288	16.4	104	9.0	25.2	1.4	2.5
Salpor Tardío	8088	115	291	16.3	98	7.8	23.0	1.8	2.6
Olotón	5993	122	323	18.0	117	9.7	26.6	1.3	1.4
Comiteco	5606	119	306	18.3	115	9.9	28.0	1.5	1.3
Dzit-Bacal	2950	98	170	14.3	91	9.5	23.3	1.3	1.3
Tepecintle	720	117	170	16.4	86	10.1	27.2	1.6	1.2
Tuxpeño	350	125	205	18.5	113	12.5	32.0	1.5	1.0

TABLE 3. Races of Maize of Guatemala Compared in Characters of the Ears and Kernels.

	Ears					*Kernels*			
Race	*Length cm.*	*Diam. cm.*	*No. Rows*	*Diam. Peduncle mm.*	*Midcob color*	*Width mm.*	*Thick-ness mm.*	*Length mm.*	*Dent-ing*
Nal-Tel Amarillo Tierra Baja	11.2	3.4	11.7	10.2	1.5	8.3	4.1	9.4	1.4
Nal-Tel Blanco Tierra Baja	13.0	3.4	12.0	10.3	1.5	8.4	3.9	9.7	2.0
Nal-Tel Amarillo Tierra Alta	14.0	3.7	12.0	10.5	2.5	8.0	5.5	8.3	1.0
Nal-Tel Blanco Tierra Alta	13.0	3.4	12.0	12.7	1.7	7.8	4.7	8.5	1.3
Nal-Tel Ocho	15.0	4.1	11.0	14.6	4.2	10.2	4.8	11.4	1.8
Imbricado	16.2	4.8	14.4	14.3	2.2	8.6	4.6	13.0	1.6
Serrano	12.8	3.4	10.5	13.5	1.9	10.0	5.2	10.4	1.4
San Marceño	16.5	4.1	9.9	15.9	2.0	11.1	5.7	11.7	1.9
Quicheño (all collections)	13.8	3.6	12.5	11.2	1.8	8.7	6.8	7.2	1.3
Quicheño Early	13.5	3.6	13.0	11.3	1.8	8.2	4.9	9.1	1.0
Quicheño Late	14.0	3.6	12.3	11.1	2.0	8.4	5.8	8.9	1.2
Quicheño Rojo	13.1	3.4	Irreg.	7.1	1.0	7.0	4.8	6.8	2.0
Quicheño Grueso	12.0	7.1	14.0	7.7	1.0	8.0	6.0	8.0	1.0
Negro de Chimaltenango	15.8	3.9	10.3	12.5	1.9	9.9	5.2	10.3	1.1
Negro de Tierra Fría	14.1	4.1	10.3	14.3	1.1	10.1	5.2	11.4	1.2
Negro de Tierra Caliente	14.1	4.1	11.5	12.6	1.4	9.2	4.2	9.9	1.3
Salpor	19.7	5.7	13.0	23.5	1.2	11.8	5.9	13.1	1.2
Salpor Tardío	15.8	4.6	11.0	14.1	1.8	10 9	6.2	11.9	1.3
Olotón	21.1	4.5	12.6	16.0	1.6	9.7	5.5	10.6	1.5
Comiteco	20.1	4.9	13.1	18.4	1.7	10.2	5.1	11.5	1.7
Dzit-Bacal	17.2	3.8	9.2	9.1	1.7	10.2	4.3	10.8	2.2
Tepecintle	18.4	4.7	14.0	14.6	2.1	9.1	4.5	10.6	1.9
Tuxpeño	17.8	4.9	14.0	17.1	1.4	9.3	4.2	12.6	2.0

The data on the characteristics of the races of maize of Central America are by no means as extensive as those on the Mexican and Colombian races, partly because personnel for collecting data were not available, partly because some of the characteristics used in the earlier studies proved not to be discriminating in differentiating races. We have, however, made more extensive use of photographs to illustrate the variation found within races.

For detailed descriptions of the characters used in describing races of maize, the reader is referred to Wellhausen *et al* (1952) and Roberts *et al* (1957).

THE MAIZE OF GUATEMALA

GEOGRAPHICAL REGIONS

Guatemala is a small mountainous country with an area of approximately 108,000 square kilometers, or about 43,000 square miles, divided into 22 departments (Fig. 1). Although relatively small, it is the most populous country in Central America. One of its most outstanding geographical features is its rugged terrain, varying in elevation from sea level to more than 4200 meters (13,660 feet). Because of this tremendous range in elevation, there exists as much variation in climate in this small country as in all of Central America.

The geography of Guatemala has been studied and described by several authors (McBride and McBride, 1942; McBryde, 1947 and Higbee, 1947). According to these authors, the country is divided by two ranges of mountains of volcanic origin, trending from northwest to southeast. The first range rises more or less abruptly from the fairly level coastal plain at a point about 50 miles inland from the southwest coast. Its summit is not a well-defined crest but is rounded or flattened into a kind of tableland, dotted with numerous volcanic peaks of greatly different elevations. Farther inland, and almost parallel to the first, is an older, somewhat less prominent volcanic range which merges with the former in northwest Guatemala. Elevations are highest in the northwest where most of the land lies between 1500 and 3000 meters in elevation.

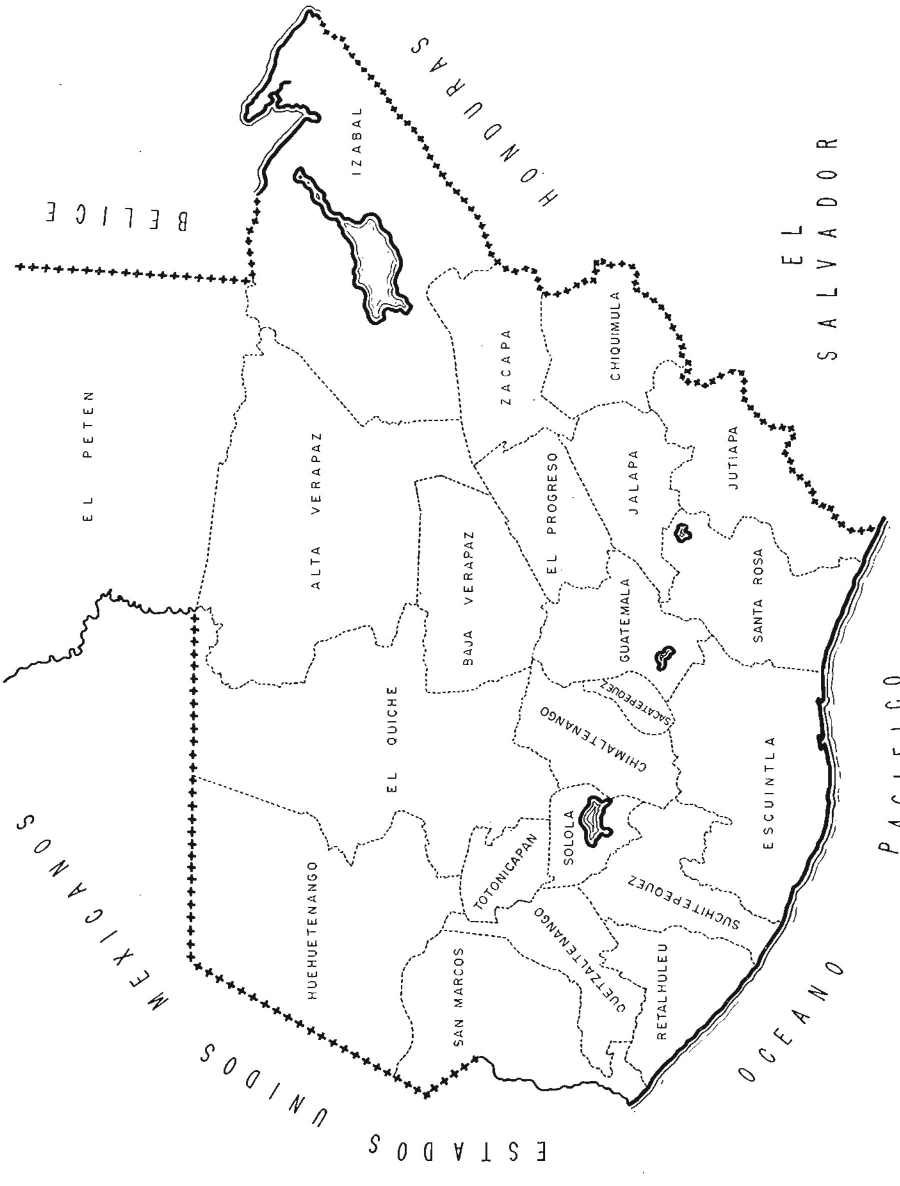


FIG. 1. Map showing the location of the Departments of Guatemala.

Ramifications of these two volcanic chains cover about half of the country, which is generally referred to as the highlands or "Los Altos" of Guatemala. The terrain is very rough with many peaks, small lakes, and deep ravines, often having sides so steep that adjacent villages are completely isolated from each other. The area consists primarily of a mountain and valley complex, with numerous small, high, fertile valleys more or less randomly dispersed among the mountains. Extensive table-lands are almost non-existent.

The southwestern slopes of this mountainous area are quite steep, with numerous parallel, small, short rivers dashing through often very deep gorges to the narrow plain below and into the Pacific (Fig. 1A). A few of the streams actually arise in the Central Highlands, passing through the western range of mountains at the bottoms of deep ravines.

The relief of the mountain slopes to the north and northeast of the Central Highlands is much more gradual, with innumerable ridges and terraces. The rivers here are less numerous and some are well developed, with many small tributaries. The great Motagua, for example, which runs in a northeasterly direction into the Gulf of Honduras, has a course of about 250 miles. The Usumacinta, with its headwaters in northern Guatemala, takes the drainage from this vast area through Mexico to the north and empties into the Gulf of Campeche.

This elevated, uneven terrain of the Central Highlands, together with the low, hot, humid, tropical plains in the north and south and the astonishing variation in rainfall (500 mm. to 5000 mm. = 20–195 inches), have provided many different climates and niches for the development of many different varieties of maize and other food crops in this extremely small area. In contrast to crops such as tropical fruits, coffee and chicle, which are limited in their adaptive range, maize is almost universally grown throughout the country.

The geography of Guatemala, as related to its agriculture, has been described adequately by Higbee (1947). He has divided the country into nine agricultural regions (Fig. 2), based principally on altitude and rainfall. A brief summary of the topog-

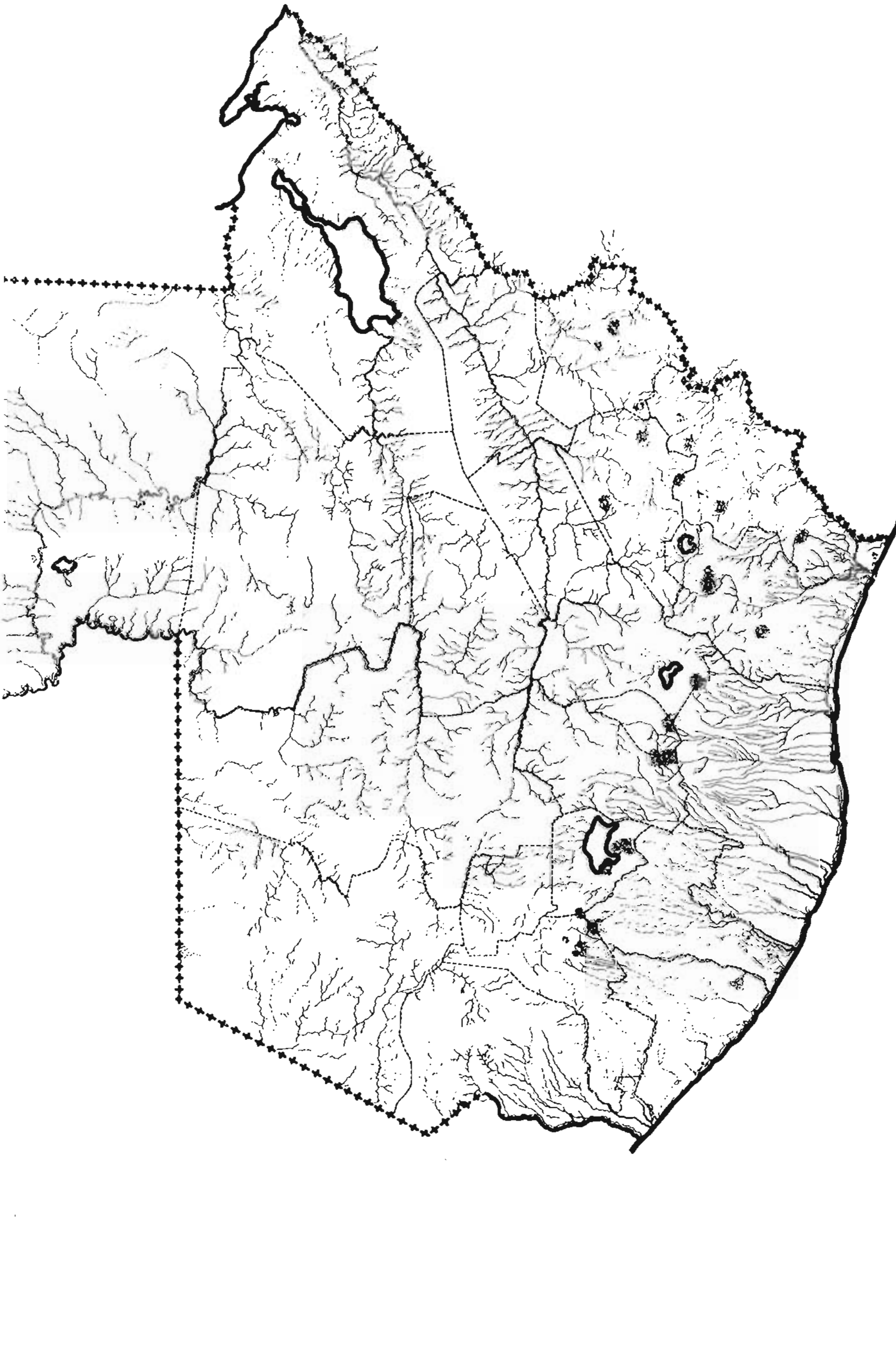


FIG. 1A. Map showing the principal rivers, lakes and peaks of Guatemala.

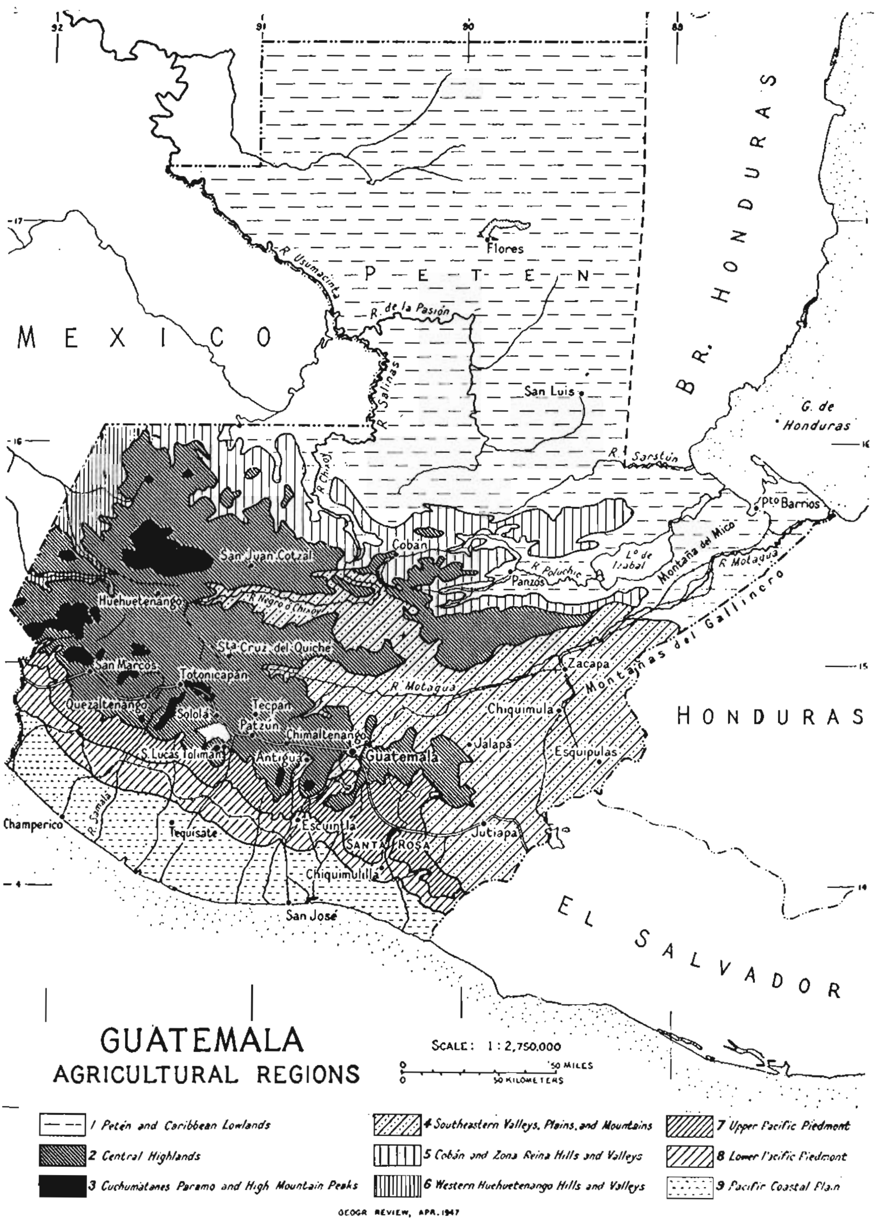


Fig. 2. Map showing the geographical regions of Guatemala. (Reproduced from Higbee, Geographical Rev., Apr. 1947).

raphy and climate of each of these regions as described by him is given below:

1. *Petén and Caribbean Lowlands.* This is the largest area with similar climate and topography in Guatemala. It comprises about 46 per cent of the total area of Guatemala (5,000,000 hectares) lying between sea level and 500 meters elevation in northern Guatemala. In ancient times, 320–633 A.D., this region was the heart of the Maya Old Empire, but today it is very sparsely populated.

The area now is completely forested, with a total annual rainfall of about 5 meters (195 inches). Average temperatures are high, 27°C. Its chief products, besides a little production of maize, abaca and bananas, are chicle gum and mahogany logs. Roads are underdeveloped. About the only means of land communication is by the winding trails made by the chicle gatherers.

2. *Central Highlands.* This area comprises about 18 per cent of the total area of Guatemala. Most of the agricultural land lies between 1500 and 3000 meters elevation. Its topography is the roughest of all areas, consisting mostly of rolling hills, steep mountain slopes and deep gorges. Interspersed among the hills, however, there are numerous small, fertile valleys and river plains.

Temperatures are cool, ranging from an average of about 17°C. in summer to 8°C. in winter. Average rainfall varies from 750 mm. to 1500 mm., with a five- or six-month dry season in winter.

Most of the maize in Guatemala is produced in this area. Maize here is generally planted on residual moisture from the previous rainy season before the current rains begin. Most of the varieties take from six to eleven months to mature because of the cool climate. Each 300-meter increase in altitude adds about two weeks to the growing season for maize in this area.

The population of this Central Highland region is predominantly Indian. The natives live chiefly on maize and, because of population pressure and relatively poor, exhausted land, have difficulty in supplying their needs.

3. *Cuchumatanes, Páramos and High Mountain Peaks.* This area comprises that part of the highlands above 3000 meters in elevation (about 1.3 per cent of all Guatemala) and is, in general,

above the upper limit for maize. There is some maize grown up to 3200 meters, but the potato is the main food crop in this area.

4. *Southeastern Valleys, Plains and Mountains.* This area grades downward from about 1500 meters elevation to 500 in the middle Motagua valley. It is almost as rough in topography as the Central Highlands. Average temperatures are high, 25°C. Average rainfall is from 500 to 1000 mm. annually, much less than in the areas described above, and all of it coming in a period of from 6 to 8 months. Good land is scarce and is found mainly on lake shores and river terraces. Most of the area is abandoned, cut-over brush, or grass range. Population pressures in this area are less than in the highlands. The main food crops are maize and beans, supplemented with such tropical fruits as mangoes, sapotes, bananas and citrus.

5. *The Cobán and Zona Reina Hills and Valleys.* This area constitutes about 5.7 per cent of the total area of Guatemala. It ranges about the same in elevation as the southern valleys (500–1500 meters), but is much more humid. In some parts, the weather is seldom dry except in March and April. The topography is hilly, soils are generally shallow and unproductive. Maize is the main food crop, produced primarily in a maize-brush rotation. Coffee is one of the main crops in the area now, although a marginal enterprise, and provides an additional source of income for the predominantly Indian population.

6. *Western Huehuetenango Hills and Valleys.* This area consists of about 1.4 per cent of the total area of the country. It ranges in elevation from 800–1500 meters, is very rough in topography and has a dense Indian population. As in the other areas, maize is the chief food crop and is grown mostly on the very steep hillsides. Good tillable soil is hard to find except along the river banks, and this is used mostly for the production of bananas, cassava and citrus fruits. This area is the least accessible of all the mountain areas in Guatemala.

7. *Upper Pacific Piedmont.* This area is one of the important agricultural regions of Guatemala, constituting about 2.3 per cent of the total area. It comprises a narrow strip along the western slopes between 500 to 1500 meters elevation from Mexico

almost to El Salvador. The land is steep, with many rivers and gorges.

This is the rich, coffee-producing area of Guatemala with fields of maize interspersed. Soils in general are good; average temperature is about 23°C.; rainfall is between 3 and 4 meters annually, becoming less from west to east, and generally falling between May and November.

8. *Lower Pacific Piedmont.* This is another very fertile, narrow strip of land at 100 to 500 meters elevation, extending from Mexico to El Salvador along the western slopes. Average temperatures are high, 27°C.; rainfall is abundant and in some parts as many as three crops of maize are produced each year. This region is less steep and better adapted to a system of mechanized agriculture than any of the others described above. Much of the land is still untilled because crop production here presents many more problems than in the highlands.

9. *Pacific Coastal Plain.* This is the narrow strip of land along the southern coast of Guatemala, about 150 miles long and 10 to 25 miles wide, varying in elevation from 0 to 100 meters. The climate is hotter and less humid than the Piedmont regions. Annual rainfall from May to December is about one meter. Some maize is grown here, but the region is largely undeveloped.

MAIZE CULTURE IN GUATEMALA

Maize has been a cultivated plant of considerable importance in Guatemala since ancient times. There is no doubt that the Maya Old Empire and its precursors developed primarily on the cultivation of this crop. It is most likely that agriculture in Guatemala had its beginning in the Central Highlands with the cultivation of maize several thousand years before the great Maya civilization that began to flourish in the lowlands of Petén about 320 A.D. (McBride and McBride, 1942; Morley, 1946.)

Most of the maize in Guatemala today is still grown in the highlands by the Maya Indians and the hand methods used are much the same as they were 3000 years ago. In the more level lowland areas, modern agricultural machinery is now beginning to replace the hand methods and tools so commonly used in the highlands.

Maize Culture in the Highlands. The ancient and modern methods of maize culture in Guatemala have been described in detail by Morley (1946) and by McBryde (1947) and in a similar area in Mexico by Emerson (1953). In brief, the system in ancient times involved primarily a maize-brush rotation. In preparing a piece of forest land for maize, the brush and trees were cut at the beginning of the dry season, allowed to dry and then cleared by burning. Maize was then planted for two or three successive years in the same plot, after which the site was again abandoned to grow in brush and trees, for a period of about ten to fifteen years. This system was not peculiar to Guatemala but became widespread throughout the tropics in heavily wooded areas with steep slopes and shallow soil, where a dry season is sufficiently long to permit burning of the cut brush and trees.

Although this system is still used to some extent in many places throughout the highlands, fields are now planted for a much longer period and abandoned only after yields become insignificant. In some areas, the fields are abandoned only for one or two years after four successive crops. Usually during this period, some of the fertility is replenished through a growth of wild legumes and weeds. Where manure is available and used, yields can be maintained at a reasonable level in the highlands, but manure is scarce. Little commercial fertilizer is being used, but where it is available and the Indians have learned how to apply it, yields have been very significantly increased. In most of the highland area, land pressure is so great that any location where there is some kind of soil and the field is not too steep to cling to is now used for planting maize.

Virtually the only tools used are the ax, machete, hoe and planting stick. The essential parts of these tools are now made of steel. In ancient times, the ax was made of stone, the hoe was a one-piece digging stick with a wide, pointed, wooden blade, and the planting stick of wood with a fire-hardened point. These are the only kinds of tools which can be effectively used on many steep slopes where maize is being cultivated and they are not likely to be replaced by modern machinery. However, on the more level land in San Marcos, Quetzaltenango and El Quiché, some machinery is now being used.

Recently cleared fields generally receive no further treatment after burning before maize is planted. Planting is done with a stick in rows about a meter apart. Seeds are dropped in hills, four or five seeds to a hill, about 60 centimeters apart. The maize is then left to grow without further tillage unless weeds become a serious problem, which is seldom the case on newly cleared land.

Where maize is planted successively in the same field, the land is sometimes tilled with a heavy hoe prior to planting. This is especially true where manure has been applied. Generally, however, the soil is not pre-tilled but furrowed out directly with the hoe at about one-meter intervals. These furrows are made on the contour in a very uniform pattern between the rows of the previous planting. The seed is then planted in the furrows in hills at about 60-centimeter intervals, with the end of the planting stick.

Hilling, the moving of soil around the base of the plants, begins after the maize is about half a meter high. The process is continued until, by the time the plants reach a meter and a half in height, mounds of soil up to 60 cm. in height are often built up around the plants. This practice reduces the need for any kind of tillage before planting and helps to hold up the plants. In many respects, it is quite an efficient system, because the tillage required for weed control is done in one or two operations, while the plants are growing.

Time of planting and length of vegetative period are chiefly a matter of elevation. The approximate planting and harvest dates at the different elevations in the highlands, as determined by McBryde (1947), are given below:

Elevation	*Average Planting Date*	*Average Major Harvest Period*
1500–2250	April 15—May 15 (after first rains)	December—January
2250–2500	March 15—30 (dry season on residual moisture)	November—December
2500–2750	February 15—28 (dry season on residual moisture)	January—February
2750–3100	February (dry season on residual moisture)	February

At elevations above 2250 meters, maize is planted in February or March—the higher the elevation, the earlier the planting date after danger of frost is past. Rains normally do not come before late April or May and maize planted prior to that time is usually planted on residual moisture from the previous rainy season, or that which may accumulate during the winter months from heavy dews or dense fogs. Because moisture is generally available at the higher elevations in the highlands, the Indians have developed late, higher-yielding varieties which tend to make use of the entire frost-free period. Some of the varieties, because of cool temperatures, develop slowly and require ten to eleven months to mature.

In regions with high rainfall, the maize stalks are broken over just below the ear as they begin to mature. This keeps the water out of the ears and also decreases the danger of lodging of the stalks from occasional strong winds while the ears are drying. After the stalks have been broken over, the fields are often left standing for two or three months. A few ears may be harvested from time to time to supply current needs, but the bulk of the grain is stored on the plant for as long as possible. The tight husks on the ears usually keep out insects, and birds find it difficult to perch on an ear hanging down, so losses from both insects and birds during this period are negligible.

Maize Culture in the Lowlands. Maize culture in the lowland tropical areas in general is much more difficult, due primarily to the rapid and excessive growth of weeds, more insects, and rapid loss of "soil tilth" and fertility, once the more natural vegetation is removed. Even today, about the only way to grow maize successfully in the lowland tropics with meager tools is in a maize-brush rotation.

Maize is grown with little difficulty for about two years in a field freshly cleared of brush and trees. After this period, however, weeds, especially annual grasses, take over very rapidly to a point where they can no longer be controlled with a machete-type of cultivation. Organic matter from the decaying roots of the previous vegetation is also rapidly decomposed, and any available nitrogen is quickly lost. The length of time a field can be kept in maize in the lowland tropics with good yields depends upon how long weeds, particularly the annual grasses, can be controlled and how long fertility can be maintained. Virtually the only way the Indian with his meager resources can cope with these two factors is through a rotation involving the growing of maize for two years and return to brush for ten to fifteen years. Once a field is abandoned to grass, it will eventually grow up in brush and trees, which will gradually crowd out all low-growing vegetation. When this point is reached, the field can again be cleared and used for maize for several years.

Raising maize in the tropical lowlands is still primarily an ax and machete culture. To change it will require a great deal of research, education and agricultural credit. The emphasis in Guatemala is now on the development of this large area of tropical lowlands which, properly managed, is capable of greatly increasing the country's food production.

The varieties of maize grown in the lowlands are generally of relatively early maturity. This is because the rainy season tends to be divided into two parts by a dry period in August. Consequently, in most areas two crops are produced and in some, if supplementary irrigation is available, as many as three.

Planting and harvest dates in the lowlands, as described by McBryde (1947), are shown below:

Altitude Meters	*Planting Date*	*Length of Vegetative Period*	*Harvest Period*
0–100	First—May	3–4 months	July–August
	Second—August	3–4 months	October–November
	Under irrigation, any time	3 months	
100–1350	First—March and April	4–5 months	July–August
	Second—September & October	5 months	February
	*Very early varieties	2–3 months	———
1350–1500	April	6–7 months	September

* Fast-growing early varieties may be planted at almost any time that moisture is available between 100-1350 meters elevation.

The Interchange of Maize between Highlands and Lowlands. There has been an interchange of maize between the highlands and lowlands in Guatemala since ancient times. Lowland maize.

although of minor importance in the total production of the country, has long served as an important supplement to the production of the highland Indians. According to McBryde (1947), the highland Indian, after a crop failure in the vicinity of his native habitat in ancient times, often traveled 50–60 miles to lowland areas to produce a supplementary crop of maize. Today, because of population pressures and depleted soils, he is forced even more to employ land at lower elevations, to supplement his often meager upland production.

An even greater exchange of maize between different climatic regions came about with the advent of cacao and coffee production. The migrant workers employed in the production of these crops often came from great distances and brought their maize with them. Those who remained near the cacao and coffee plantations for three months or more planted a field of maize in the vicinity and took some of the harvest with them as they returned to their homes in the highlands.

There is no doubt that the need for additional maize in the highlands brought about by adverse weather conditions or population pressures since pre-Columbian times, combined with the even greater interchange of highland and lowland maize by the migrant cacao and coffee workers in more recent times, has been a very important factor in the evolution of the many different varieties of corn which exist in Guatemala today.

During the earlier period of maize agriculture, the same variety was used for both upland and lowland production. But a continuation of the two types of production over a period of many centuries has resulted in the development of distinct varieties for the highlands and the lowlands. Usually several varieties are now maintained by the highland Indians for planting at different times of the year at the same elevation or at different elevations.

Maize Varieties and Uses. The highland Indians, so far as possible, keep their different varieties separated by color. Varieties are commonly referred to as "maíz amarillo" (yellow maize), "maíz blanco" (white) or "maíz negro" (dark purple) and these, in turn, may be classified as late or early, according to the length of time it takes to mature them. They are also sometimes kept separate according to texture and may be referred to as "maíz cristalino" (flinty) or "maís blando" (floury). The varieties of the highlands tend to be late and more flinty or floury, whereas those of the lowlands tend to be earlier in maturing and more dented.

In Guatemala, in contrast to Mexico, yellow maize is preferred and is the predominating color, with white a close second. Dark purple, red, calico or mixed colors are relatively infrequent. The yellow and white varieties are generally eaten in the form of tortillas or tamales. Although all kinds are sometimes eaten as green corn or "elotes", the purple or darker colored ones are generally preferred for this purpose. The purple or dark-colored varieties, according to McBryde (1947), are also preferred for other special purposes, such as fermented drinks.

Some varieties are considered to be better adapted to certain kinds of soil or fertility level than others. McBryde (1947) points out that some Indians believe that dark-colored maize yields more on poor soil than other types. Also in some areas, yellow maize is preferred for the best alluvial soil, whereas the white and purple maize is grown on the less fertile steep slopes. No doubt certain varieties, through long periods of natural selection under certain specific conditions of soil fertility, have become best adapted to those conditions.

Maize Storage. Keeping maize from one harvest to the next has always been a problem in the tropics. Usually the ears are left in the field hanging on the stalks as long as possible. In the highlands the husks are generally removed at the time of harvest and the ears are shelled, but in the lowlands maize is usually stored in the ear with the husks intact until used for tortillas or tamales. As a result of these procedures, most of the varieties over a long period of natural selection have developed excellent husk protection against birds, weevils and other stored-grain insects.

PREVIOUS STUDIES OF GUATEMALAN MAIZE VARIETIES

There have been no previous studies of the maize of Guatemala directed primarily at its classification, but a number of the races now recognized and described in this publication have been referred to or illustrated in various publications.

Sturtevant (1894) mentioned flint corn, *Zea mays indurata,* as occurring in both Honduras and Guatemala. Kuleshov (1930) referred to several types now recognized as races. Stadelman (1950) illustrated types now assigned to the races Tuxpeño, Olotón, Tehua and Quicheño Ramoso. The Guatemalan Tropical Flint of Anderson and Cutler (1942) is now recognized as a contaminated form of the race Nal-Tel, and their Guatemalan Big Grain is assigned to the race Olotón.

Mangelsdorf and Cameron (1942) made an intensive study of the characteristics of the Guatemalan maize collected by McBryde and concluded that Guatemala is a secondary center of origin of cultivated maize varieties. They postulated that the diversity of maize in Guatemala is the product of the introduction of varieties from South America followed by the hybridization of maize and Tripsacum. They made no attempt to classify the maize but their illustrations include examples of the races Quicheño Grueso, Serrano, Negro de Chimaltenango and Tepecintle. A subsequent re-study of the McBryde Collection reported later in this monograph shows that all of the thirteen races and several of the sub-races now recognized were included in the studies of Mangelsdorf and Cameron.

Anderson (1947) made the first extensive field studies of Guatemalan maize. He agreed with Mangelsdorf and Cameron (1942) that there is a center of maize diversity in northwestern Guatemala but suggested that this region might be a center of convergence rather than a center of origin. He found the intrafield variation of maize in Guatemala to be less than in any other area in which he had studied maize. Among the ears illustrated by Anderson are examples of the now-recognized races Serrano, San Marceño, Imbricado, Negro de Chimaltenango, Olotón and Comiteco. He also reported the occurrence of popcorn in Guatemala.

Studies on the comparative morphology of maize have included several Guatemalan races or have some bearing on the variation of maize in Guatemala. Lenz (1948), studying the comparative histology of the pistillate inflorescence, included the Mexican race Cacahuacintle, which is a counterpart of the Guatemalan race Salpor. Alava (1952), in similar studies of the staminate spikelets, concluded that the glumes of races of Central and North America have more and heavier veins, narrower margins, longer and narrower tips and stronger keels than prehistoric, oriental or South American varieties. All of these differences are in the direction of introgression from Tripsacum. Nickerson (1953), studying variation in cob morphology in archaeological and modern maize, included types which can now be assigned to the Guatemalan races Nal-Tel, Olotón and Salpor.

THE EVOLUTION OF MAIZE IN GUATEMALA

In their studies of the races of maize in Mexico, Wellhausen *et al* (1952) concluded that four principal factors were involved in the diversity of maize in that country: (1) The earliest maize comprised several races of popcorn which had become differentiated at various altitudes and under diverse environmental conditions. (2) Exotic races introduced from South America not only established themselves in the population of maize races but also hybridized with the ancient indigenous races to form new hybrid races. (3) Additional hybrid races came into existence through hybridization with teosinte. (4) Geographical and ecological isolation tended to preserve the races.

It is clear that these same four factors contribute to the diversity of maize in Guatemala. In addition, a fifth factor, a high proportion of Indians in the human population, is involved in the diversity of Guatemalan maize. This factor is probably also operating in Mexico but is not so clearly recognized there.

ANCIENT RACES AND GEOGRAPHICAL FEATURES

It will be shown later, under the description of races, that there are in Guatemala, as in Mexico, two distinct types of ancient, indigenous races. One of these, Imbricado, which is similar to the Mexican Palomero Toluqueño, has largely disappeared as a "pure" race but its distinctive characteristics are still to be found in several parts of Guatemala. The other type, a counterpart of the ancient indigenous Mexican race, Nal-Tel, is represented in Guatemala by five more or less distinct sub-races.

The greater diversification of Nal-Tel in Guatemala, as compared to Mexico, may suggest a greater antiquity of maize culture in the former. However, it can also be accounted for by Guatemala's geographical features, the custom of the Guatemalan Indian of growing maize at several altitudes, and of his keeping his varieties pure with respect to color. Thus, while Mexico has only one form of Nal-Tel, a yellow-seeded type adapted to the lowlands, Guatemala has three sub-races, yellow, white and red, in the highlands and two, yellow and white, in the lowlands.

The geography of Guatemala, especially that of the western part, being mountainous, furnishes numerous ecological niches in which races of maize, once adapted, tend to be preserved.

EXOTIC RACES AND HYBRIDIZATION

At some period in prehistoric times, there was an influx of races of maize into Guatemala from South America. When or how this occurred is a question which we, as botanists, are not qualified to answer and one which we are quite willing to leave to the anthropologists, who recognize that diffusion between South and Middle America in other cultural traits has occurred. Willey (1955) concludes that such diffusion was, first, from north to south, later from south to north. He considers it likely that there was direct sea trade between Peru or Ecuador and Middle America. The occurrence in Guatemala and Mexico of South American races of maize is consistent with this supposition.

Four races regarded as probably exotic—Quicheño, Salpor, Negro de Chimaltenango and Olotón—are recognized in Guatemala, and one additional race, Serrano, may belong in this category. Three of these same or similar races, Salpor, Cacahuacintle and Olotón, occur in Mexico. In addition, Mexico has two exotic races, Harinoso de Ocho and Maíz Dulce, which are not found in Guatemala. In the other countries of Central America, only one race of South American origin, Clavillo of Costa Rica, has been recognized. This race has not been collected in Guatemala but its influence on other races has been noted.

It is almost certain that it is the western part of Central America and Mexico to which the South American races were introduced. All of the exotic races of Guatemala are still largely confined to the western part of the country. All of the Mexican exotic races except Cacahuacintle occur in the western part of Mexico. The localities from which Clavillo was collected in Costa Rica are not known.

In Guatemala, as in Mexico, hybridization of the exotic races with the ancient indigenous races has been an important factor in creating new diversity. Of the thirteen races recognized in Guatemala, five, San Marceño, Comiteco, Dzit-Bacal, Tepecintle and Tuxpeño, and two sub-races, Negro de Tierra Fría and Negro de Tierra Caliente, are regarded as hybrid races.

HYBRIDIZATION WITH TRIPSACUM AND TEOSINTE

A part of the hybridization contributing to the diversification of maize in Guatemala may involve the closest relatives of maize and the only species with which maize has ever been hybridized, the two American Maydeae, Tripsacum and teosinte. Both of these species occur in Guatemala, and there is a distinct possibility that one or both have played a role in the evolution of maize in this region.

Teosinte a Hybrid of Maize and Tripsacum. Mangelsdorf and Reeves (1939) postulated that teosinte is a hybrid of maize and Tripsacum and that the subsequent hybridization of maize and teosinte has resulted in the development of new types of maize. The first hypothesis has not been proven. However, the fact that teosinte is intermediate between maize and Tripsacum in virtually all of its characteristics (cf. Reeves, 1953) suggests that teosinte is either a hybrid of maize and Tripsacum or a little-changed descendant of the common ancestor of both. The latter possibility seems remote.

A recent origin of teosinte is also suggested by the evidence from fossil pollen from Mexico. In the drill core studied by Barghoorn, Wolfe and Clisby (1954) teosinte pollen is found only in the upper levels, while both maize and Tripsacum pollen occur at deeper levels. Finally, recent studies of archaeological maize from New Mexico, northeastern Mexico and northwestern Mexico (Mangelsdorf and Smith, 1949; Mangelsdorf, MacNeish and Galinat, 1956; Mangelsdorf and Lister, 1956) indicate that the earliest maize is pure maize, showing no contamination with teosinte, while more recent prehistoric specimens include cobs which are identical in their characteristics with segregates from maize-teosinte hybrids.

All of these facts, although they obviously do not prove that teosinte originated as a hybrid of maize and Tripsacum, are consistent with the hypothesis.

If teosinte did originate as a hybrid of maize and Tripsacum, it may well have had its origin in Guatemala as Mangelsdorf and Cameron (1942) pointed out some years ago. Teosinte is widely distributed in Guatemala. Kempton and Popenoe (1937) reported seeing teosinte near Jutiapa, in the Department of Jutiapa, and along the shores of Lake Retana, in the adjoining Department of Jalapa. In this same general region it was reported by their informants to be growing near Moyuta and Papaturro. In northwestern Guatemala, these authors found teosinte as the dominant plant in the landscape at altitudes of 900 to 1350 meters on the road from Camoja to Río Huixta. A few plants were found near Nojoya above San Antonio Huixta. On the road to Jacaltenango, teosinte again was found to be the principal vegetation, and their informants assured them that it was just as common around Santa Ana and part way along the old road to Nenton. McBryde (cf. Mangelsdorf and Cameron, 1942) found teosinte growing in great abundance between Santiago Petatán and Santa Ana Huixta. Also, in Guatemala are found the most Tripsacoid (least maize-like) varieties of teosinte, both with respect to chromosome morphology and genetic characters (cf. Longley, 1937, 1941a, b: Rogers, 1950a, b, c).

Tripsacum, the putative parent of teosinte, also occurs widely in Guatemala. Of the seven species of Tripsacum described by Cutler and Anderson (1941), four, *T. lanceolatum, T. fasciculatum, T. pilosum* and *T. latifolium,* are found in Guatemala and are reported from fourteen different localities. Of the two additional species of Tripsacum described by Hernández and Randolph (1950) one, *T. maizar,* may occur in northwestern Guatemala, for Randolph (1955) reports seeing a broad-leaved Tripsacum which might have been either this species or *T. pilo-*

sum near Santa Ana and between San Antonio Huixta and Petatán.

The hypothesis of a hybrid origin of teosinte has been criticized by both Randolph (1952, 1955) and Weatherwax (1954, 1955) who regard it as highly implausible, contending that the cross of maize and Tripsacum which so far has been made only with the use of special techniques, such as shortening the silks of maize or employing embryo culture, is not likely ever to have occurred in nature.

The first objection, involving the artificial shortening of the styles, is not an insuperable one, since there are a number of situations in which the silks are naturally exposed to pollination for their entire lengths. These include: (1) plants of pod corn, both heterozygous and homozygous, (2) numerous other genetic tassel-seed types, (3) stunted plants with partially pistillate tassels, (4) tillers with partially or completely pistillate terminal inflorescences, (5) ears in which silks have emerged through holes in the husk covering produced by insect larvae.

Randolph (1952) has subjected the hypothesis to a direct test by crossing Guatemalan and Mexican races of maize with species of Tripsacum from Guatemala and Mexico. In extensive experiments he obtained only two hybrid seedlings and these only through embryo culture.

Negative evidence, however extensive, is seldom conclusive in problems of this nature, especially when there is other evidence in conflict with it. Mangelsdorf and Reeves (1939) found that hybrid seeds, sufficiently developed to be scored for aleurone color, were produced in all crosses of maize and *T. latifolium*, one of the species of Tripsacum which occurs in Guatemala. Randolph does not mention this species as one of those used as a pollen parent in his crossing experiments, and it seems apparent that it was not so used since it is not known to occur in Mexico, and since the only Guatemalan Tripsacum included in the experiments is said by Randolph to be "probably *T. lanceolatum*".

Another factor perhaps involved in Randolph's failure to obtain hybrids of maize and Tripsacum is the high incidence of the cross-sterility gene, *Ga*, in Central American and Mexican maize. Varieties of maize which are homozygous or heterozygous for this gene, while completely interfertile with other varieties carrying the gene, are highly cross-sterile with varieties which lack it. This gene probably served, in the wild, as an isolating mechanism and a barrier to hybridization between maize and its relatives. The hybridization of maize and Tripsacum probably could have occurred only in a variety of maize which had lost the *Ga* gene. Mangelsdorf (1953) has found that this gene has a high frequency in the maize of Central America and Mexico, 43 per cent of Guatemalan and 56 per cent of Mexican varieties tested having the gene.

In view of the several circumstances mentioned above, Randolph's experiments are neither as extensive with respect to numbers nor as conclusive with respect to results as they may at first glance appear to be. Nevertheless, it is possible that teosinte is not a hybrid of maize and Tripsacum, or if it is, it may be as Stebbins (1950) has suggested, not a recent but an ancient one. And if it is a hybrid, recent or ancient, it may not have originated in Guatemala.

The Introgression of Teosinte into Maize. Despite criticism and the lack of proof, the general hypothesis of the hybrid origin of teosinte is still useful, and regardless of its origin, there can be little doubt that teosinte has influenced the course of evolution of maize, especially in Guatemala and Mexico. Teosinte is constantly hybridizing with maize wherever the two are growing in pollinating proximity. The crossing is not as common as it is between two varieties of maize—there are isolating mechanisms and barriers to the free exchange of genes. Nevertheless, hybrids do occur and have been recognized not only by the natives, but by all students of the problem. Kempton and Popenoe (1937) did not see F_1 hybrids in the field but reported that the natives recognize that hybridization occurs and explain that the hybrid will become maize in three generations if seed from it is grown. These authors also found several hybrid spikes in a collection of seed sent to them from the region near San Antonio Huixta. Similar hybrid spikes were found in teosinte collected by F. W. McBryde near Santa Ana Huixta (Mangelsdorf, unpublished), and Randolph (1955) found 45 F_1 and 3 F_2 teosinte-maize hybrids near the villages of Nojoyá and San Antonio Huixta. There is no doubt that maize and teosinte are hybridizing in Guatemala today—there is no reason to doubt that such hybridization has been going on for centuries.

It is inevitable that the repeated introgression of teosinte into maize should have some effect upon the character of the maize which is subjected to such introgression. Among these effects are the introduction of chromosome knobs, increased resistance to certain diseases and to insect damage, and increased tolerance to excessive heat and moisture. There is a great diversity in chromosome-knob number in the maize of Guatemala. Mangelsdorf and Cameron (1942) found chromosome-knob numbers in Guatemalan maize ranging from one to sixteen, and these included all of the eighteen knob positions then known as well as three additional ones not previously reported. If the chromosome knobs of maize are derived from teosinte (and until a primitive maize having numerous chromosome knobs is discovered it is reasonable to assume that they are), then almost all Guatemalan maize except occasional plants at high altitudes has been contaminated by teosinte.

That teosinte introgression is capable of improving maize is demonstrated by the experiments of Reeves (1950) who developed a number of modified lines of two Texas inbreds by incorporating germplasm from two varieties of teosinte. The modified lines of one of these inbreds, 4R–3, did not improve the yields of hybrids in which the line was used, but some of the modified lines themselves proved to be more tolerant than the controls to artificial heat. The modified lines of the second inbred, 127C, produced a number of hybrids significantly superior in yield to the standard. The improvement was especially marked when the tester stock to which all of the strains were crossed was one not well adapted to the sub-tropical conditions of Texas. This suggests that teosinte introgression may impart to maize better adaptation to tropical and sub-tropical conditions.

This suggestion has received some support in the experiments of Wellhausen and Prywer (1954) who found that there is a positive correlation between productiveness and number of chromosome knobs at low altitudes and a negative correlation between these characteristics at higher altitudes. It is assumed that the number of chromosome knobs reflects to some extent the degree of teosinte introgression.

Also it is a fact that the races of maize of Guatemala and Mexico which are well adapted to the lowland tropics—races such as Tepecintle and Tuxpeño—do exhibit evidence of teosinte introgression in their tough stalks, lignified tissues of the rachis and glumes of the cob and relatively high chromosome-knob numbers.

We strongly suspect, although at this point we cannot prove, that the introgression of teosinte into maize and the subsequent development of races of maize well adapted to the lowland tropics may have opened the door to momentous new developments in the human cultures of Guatemala. For example, it is doubtful that the magnificent Mayan cities and temples of the Guatemalan lowlands could have been built and maintained by a people who did not already have an adequate and stable food supply provided by a race of maize well adapted to the tropical lowlands. To us this suggests that the Classic period of the Maya did not begin until after maize had become adapted to the lowland tropics through hybridization with teosinte. The finding, mentioned below, of a prehistoric cob of Tepecintle, a race which today has the highest chromosome-knob number of any race yet studied, at the late pre-Classic or early Classic is consistent with this suggestion.

THE ROLE OF THE INDIAN

Finally, the high proportion of Indians in Guatemala is undoubtedly a factor, if not in evolution, at least in the preservation of distinct races. Anderson (1947) found that among the pure-blooded non-Spanish-speaking Indians of Guatemala, rigid selection for type of seed ears is often practiced. He also found the ears from single fields to be quite uniform, showing less intra-field variability than samples from Mexico or any other area in which he had made collections. Indians are also prone to preserve unusual types such as the sub-races Grueso and Ramoso.

Guatemala has one of the most concentrated Indian populations of any country in the hemisphere. According to the 1950 census, 53.5 per cent of the Guatemalan population are "indígenas". In some departments the proportion exceeds 90 per cent.

There is a high correlation between the diversity of maize in Guatemala and the percentage of Indians in the population. In the nine departments in which the proportion of Indians is two-thirds or more are found all of the Guatemalan races of maize except Tuxpeño, which is probably a recent introduction from Mexico, and all of the sub-races except the two lowland forms of Nal-Tel.

This correlation between diversity of maize and percentage of Indians in the population may be in part a secondary one resulting from the fact that the proportion of Indians is generally highest in the more mountainous regions. The mountainous terrain may have preserved both the Indians and the diversity of maize. At least, there can be little doubt that the Guatemalan Indian, consciously, or through his preference for high altitudes, has played an important role in preserving races of maize which, under a more modern type of agriculture, would long since have disappeared.

That the Guatemalan Indian also played a conscious role in the creation of new races of maize is doubtful. Several students of maize, especially Kempton (1937) and Weatherwax (1942), have regarded cultivated maize as the product of the plant-breeding skill of the American Indian. There is little evidence, either from archaeological remains or from living races of maize, that the Indian was an accomplished plant breeder in the sense of visualizing a new type of maize and selecting toward it. He did, of course, play an important, indirect, role in the evolution of maize, through his migrations, in bringing races of maize into crossing proximity. When new races came into existence through such crossing, he played a second important role in preserving and perpetuating them and perhaps through rigid selection improving their uniformity to some extent. But the principal forces which have been involved in the evolution of maize under domestication are the same forces which operate in nature: mutation, random genetic drift, natural selection and hybridization. Man by his activities has accelerated some or all of these forces. There is little evidence at least in early stages of culture that he consciously added to them.

PREHISTORIC MAIZE IN GUATEMALA

Very few specimens of archaeological maize have so far been found in Guatemala.

The antiquity of maize in Guatemala certainly dates back to the origin of agriculture in the Western Highlands of Guatemala more than 3,000 years ago, but what kinds of maize were grown when agriculture began is difficult to determine, since very few archaeological specimens have so far been found. Dr. A. V. Kidder (1949), of the Carnegie Institution of Washington, described an archaeological piece of pottery which shows an ear of corn almost identical with those of the primitive race Nal-Tel in Mexico. A photograph of this specimen is included in *Races of Maize in Mexico* by Wellhausen *et al* (1952, Appendix).

Another specimen is in the form of a well-preserved cob from Uaxactún, one of the cities of the Maya Old Empire in Petén, Guatemala, referred to by Ricketson and Ricketson, 1937 (plate 68, fig. e). These authors state that . . . "this cob was found inside the rubble of the sub-structure of temple E–11 and does not differ noticeably from the corn characteristic of the region at the present time." It dates from the Middle America pre-Classic or Early Classic (1–400 A.D.).

This cob may be seen in the Museo Nacional de Arqueología y Etnología de Guatemala in Guatemala City. It has been described by Mangelsdorf as follows:

"This cob is almost intact with respect to length. (Fig. 3). Its present length is 9.5 cm. Its original length was probably 11–12 cm. The diameter is 26.0 mm., but since the cob is slightly eroded, the original diameter must have been slightly greater. It had ten rows of kernels. The shape is almost cylindrical with a slight taper at both ends. The base is slightly enlarged. The lower glumes are thick, strongly indurated and glabrous. The upper glumes are thick, probably originally fleshy, and almost glabrous. The rachillae are unusually long, up to 3.9 mm. in length by actual measurement. The cupule hairs are sparse. The rind of the rachis is thick and indurated.

"In all of its characteristics, this cob resembles closely the cobs of the living Guatemalan-Mexican race, Tepecintle, described by Wellhausen *et al* (1952). According to these authors, the ears of Tepecintle have an average length of 10.4 cm., and an average cob diameter of 32.8 mm. The row number varies from 10–14, with an average of 11.9. The shape is cylindrical with a slight taper at both ends. The lower glumes are indurated and glabrous, the upper glumes are fleshy and almost glabrous. The rachillae are unusually long, averaging 3.3 mm. in length. No other race of maize described by Wellhausen *et al* resembles so closely in its characteristics the archaeological specimen as does Tepecintle.

FIG. 3. A prehistoric cob from the Uaxactún site in Guatemala. This cob, which is estimated to be 1600-2000 years old, is a typical cob of the race Tepecintle. One-half natural size.*

"Tepecintle is postulated by Wellhausen *et al* to be the product of hybridization between a South American flour maize and teosinte. It is assumed to be the ancestor of a number of additional races, including Zapalote Chico, Zapalote Grande, Tuxpeño, Vandeño, Chalqueño, Celaya, Cónico Norteño and Bolita. If these assumptions are valid, and if the specimen is not a recent intrusion, but actually dates back to 1–400 A.D. as suggested, then this cob is highly significant in showing that the hybridization of maize and teosinte, which produced this race, occurred many centuries ago."

The corn which this cob represents may also be related to the variety moulded on the Zapotec funerary urn, dated at about 800–1000 A.D., a photograph of which is shown in the appendix of the publication by Wellhausen *et al,* 1952.

The only two archaeological specimens available from Guatemala are at least consistent with the hypothesis that one of the

* All of the photographs of cobs or ears of maize reproduced in this monograph are one-half natural size.

ancient indigenous races was Nal-Tel and that hybridization of maize and teosinte has been a factor in the evolution of maize in Guatemala.

EXISTING RACES OF MAIZE IN GUATEMALA

PRIMITIVE RACES

Sturtevant (1899) concluded that primitive maize is both a popcorn and a pod corn. Mangelsdorf and Reeves (1939) subsequently reached the same conclusion. The fact that primitive maize is a popcorn is now well established. Recent studies of archaeological maize (Mangelsdorf and Smith, 1949; Mangelsdorf, MacNeish and Galinat, 1956; Mangelsdorf and Lister, 1956) show that all early archaeological maize is small eared and small seeded. The second part of Sturtevant's conclusion—that primitive maize is also pod corn—has received only partial support from studies of archaeological maize. True pod corn, in which the kernels are completely enclosed in glumes, has not been found in the earliest archaeological maize. However, the glumes of early maize are more prominent than those of most varieties of modern maize, and it is still probable that primitive maize was a form of pod corn involving one of the alleles at the *Tu–tu* locus, plus a complex of modifying factors including an inhibitor which kept the glumes under control. Mangelsdorf (unpublished) has isolated from a popcorn variety an inhibitor of tunicate which reduces the effect of alleles at the tunicate locus by approximately half.

In the majority of countries where studies of races of maize have been made, or are now being made, one or more races of popcorn with various combinations of primitive characters have been found. This is true for Mexico, Colombia, Venezuela, Ecuador, Peru, Chile, Brazil and Argentina. At first glance the maize of Guatemala appears to present an exception to this general rule. No small-grained popcorn has yet been collected in Guatemala. Anderson (1947) has reported seeing popcorn balls in the market at Pargun, but he was unable to find ears with grain of the type in the same market. He later received by mail from this locality ears of a variety said to be popcorn with "phenomenally large kernels", which he found to be capable of popping.

Although the popcorns in pure form are unknown or rare in Guatemala, they must once have been common, for, modified by admixture with other races, they are still to be found throughout the country, and their influence upon other races is widespread.

These mixed popcorns and their influence represent two distinct types; one of these is similar to the races Palomero Toluqueño and Arrocillo Amarillo of Mexico, the other to the race Nal-Tel of Mexico. The latter appears to have been the original maize of Guatemala. Five more or less distinct types of Nal-Tel from a wide range of altitudes, described later in this publication as sub-races, are recognized in Guatemala, in contrast to Mexico where only one sub-race growing at low altitudes was found.

The descriptions of the sub-races of Nal-Tel and a complex called Imbricado, which represents relict characteristics of another race, follow.

NAL-TEL

This race, as already mentioned, appears to have been the original race of maize throughout Guatemala. It is seldom found in pure form today, but collections which show only slight admixture have been obtained from numerous localities. In addition, the influence of Nal-Tel upon other races can be seen not only throughout Guatemala but also in the maize of other countries of Central America all the way to Panamá. The occurrence of Nal-Tel in Mexico has been previously reported by Wellhausen *et al* (1952).

There is extensive archaeological evidence of the prehistoric existence of Nal-Tel not only in representations on ceramics but also in actual specimens. Zapotec funerary urns decorated with moulded representations of ears of Nal-Tel are illustrated by Wellhausen *et al* (1952, Fig. 2) and Caso and Bernal (1952, Fig. 1). The only known ceramic representation of a maize ear from Guatemala, described by Kidder (1949) is undoubtedly that of an ear of Nal-Tel (cf. Wellhausen *et al,* Plate I, Fig. D). The early archaeological maize of La Perra Cave in Tamaulipas, Mexico, described by Mangelsdorf, MacNeish and Galinat (1956) and dated at 4450 years, belongs to this race.

Another Mexican race, Chapalote, which is closely related to Nal-Tel, differing from it primarily in pericarp color, appears also to have been widely distributed in prehistoric times. Archaeological specimens of Chapalote, the earliest of which are probably quite ancient, have been excavated from caves in Chihuahua and Sonora in northwestern Mexico (Mangelsdorf and Lister, 1956). Well-preserved specimens of ears related to this race from Painted Cave in New Mexico have been described by Anderson (1947) and from Cottonwood Cave in Colorado by Hurst and Anderson (1949).

Probably also related to Nal-Tel and Chapalote is the primitive Colombian race, Pollo, recently described by Roberts *et al* (1957). Pollo in turn has affinities with the Peruvian popcorn, Confite Morocho, but since the exact nature of these is not yet clear, we shall for the present omit further consideration of this race.

The races of the Nal-Tel–Chapalote–Pollo complex have a number of characteristics in common. All are relatively early in maturity. All have a wide range of adaptation. The Nal-Tel of the lowlands of Yucatán and Campeche in Mexico produces fairly normal ears when grown at the high altitudes of Chapingo. The Pollo of Colombia found at altitudes of 2000 meters is not completely out of its element when grown at much lower altitudes. All of these races have relatively short plants with little or no pilosity or sheath color. The ears of all races are short and often bear staminate tips. Pericarp colors are common. Aleurone colors are rare.

In the past, anthropologists have sometimes postulated an "archaic" culture which, from a center of origin, spread far and wide in all directions. If there was also an archaic maize, the races of the Nal-Tel–Chapalote–Pollo complex would appear to meet the requirements of such a maize. Where this complex had its origin it is impossible to determine from the evidence at hand. The diversification of Nal-Tel into five sub-races in Guatemala may suggest a great antiquity of the race in this country. On the other hand, it may only show that ancient types are more likely to be preserved in countries in which the population has a high proportion of Indians who have been influenced but little by modern agricultural techniques. In any case, the Nal-Tel–Chapalote–Pollo complex represents an ancient gene population which has flowed into other races of maize and left its mark upon innumerable modern races. In no country are the results of this flow more apparent than in Guatemala.

In considering the detailed description of the five sub-races of Nal-Tel which follow, it should be remembered that the majority of the collections, particularly of the highlands, have suffered admixture with other races, usually with those which are later in maturity and taller.

Sub-race Amarillo Tierra Baja

Plants. Early, 90 days to first flowering at Chapingo; short, average height 141 cm., the shortest of any Guatemalan race; average number of leaves 13, average length 80 cm., average width 9.2 cm., average number of veins 25.3; little color or pilosity.

Ears (Fig. 4). Short, slender, average length 11.2 cm., average diameter 3.4 cm., tapering, slightly rounded at the butts, shank medium, average diameter 10.2 mm., but quite slender in some specimens; number of rows 10–14, average 11.7; grains small, average length 9.4 mm., average width 8.3 mm., average thickness 4.1 mm., usually dorsally flat, sometimes slightly rounded, seldom dented; endosperm flinty or semi-hard, yellow; pericarp color none or pale orange.

Distribution (Fig. 6). Collected in the Departments of Chiquimula, Jutiapa and Baja Verapaz, at altitudes of 1500–3650 feet. Its influence on other maize has been noted also in Jalapa. Wellhausen *et al* (1952) found this sub-race to be common in Yucatán and Campeche in Mexico, at about 300–400 feet. The influence of this sub-race or something quite similar to it extends into the other countries of Central America as far south as Panamá.

Origin and Relationships. The lowland sub-races of Nal-Tel differ from their highland counterparts primarily in their earliness and adaptation to altitude. If we assume that both groups of sub-races stem from a common ancestor, the question arises whether this ancestor was a highland or a lowland race. Although the evidence now at hand does not furnish a conclusive answer to this question, it favors a highland rather than a lowland origin. The Colombian and Peruvian races, Pollo and Confite Morocho, to which Nal-Tel is related, are high altitude races. The Mexican race, Chapalote, also related to Nal-Tel, although

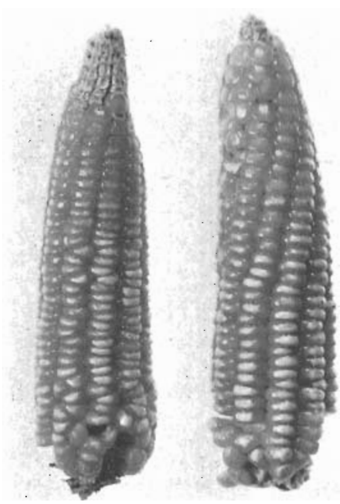


Fig. 4. Nal-Tel Amarillo Tierra Baja. (Guat. 150, Baja Verapaz, 2300 feet). The lowland yellow Nal-Tel has been collected at 1500-3650 feet. This is the Guatemalan counterpart of the yellow Nal-Tel of Yucatán and Campeche in Mexico.

now a lowland race, occurred at higher altitudes in prehistoric times. Finally, the distribution of other Guatemalan races indicates that the flow of maize races was from the higher to the lower altitudes—the more pure collections are usually found at higher altitudes. All of these facts combined do not prove the case for the highland origin of Nal-Tel. They are not much more than "straws in the wind", all pointing in one direction.

Sub-race Blanco Tierra Baja

Plants and Ears (Fig. 5). The characteristics of the plants and ears of this sub-race are so similar to those of the yellow-seeded sub-race that a detailed description is not needed. The data are set forth in Tables 2 and 3.

Distribution (Fig. 6). Collections of this sub-race come from the Departments of Jutiapa, Chiquimula and Baja Verapaz at altitudes of 3250–3500 feet.

Origin and Relationships. The white-seeded sub-race, like the yellow, has influenced the maize not only of Guatemala but also of the remaining countries of Central America. In addition, it was white Nal-Tel rather than yellow Nal-Tel, as Wellhausen *et al* concluded, which was the parent of the Mexican race, Dzit-Bacal.

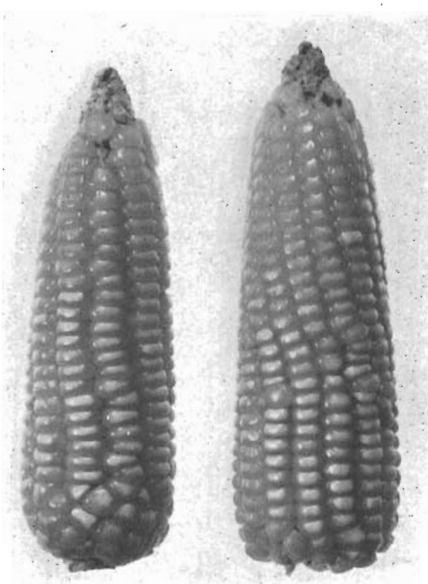


FIG. 5. Nal-Tel Blanco Tierra Baja. (Guat. 145, Baja Verapaz, 3300 ft.). This white lowland sub-race is probably the ancestor of Dzit-Bacal of Guatemala and Mexico and of Salvadoreño, the race most commonly grown in other parts of Central America.

Sub-race Amarillo Tierra Alta

There are only two collections of this race, one each from El Quiché and Totonicapan (Figs. 6, 7 and 8). The data on these plants and ears are set forth in Tables 2 and 3. Both the data and the photographs suggest that these collections represent an introgression of Quicheño into a race from higher altitudes with shorter earlier-maturing plants and smaller ears. Such a race would meet all of the specifications of a highland Nal-Tel. The two collections described here are the nearest approach to it now at hand.

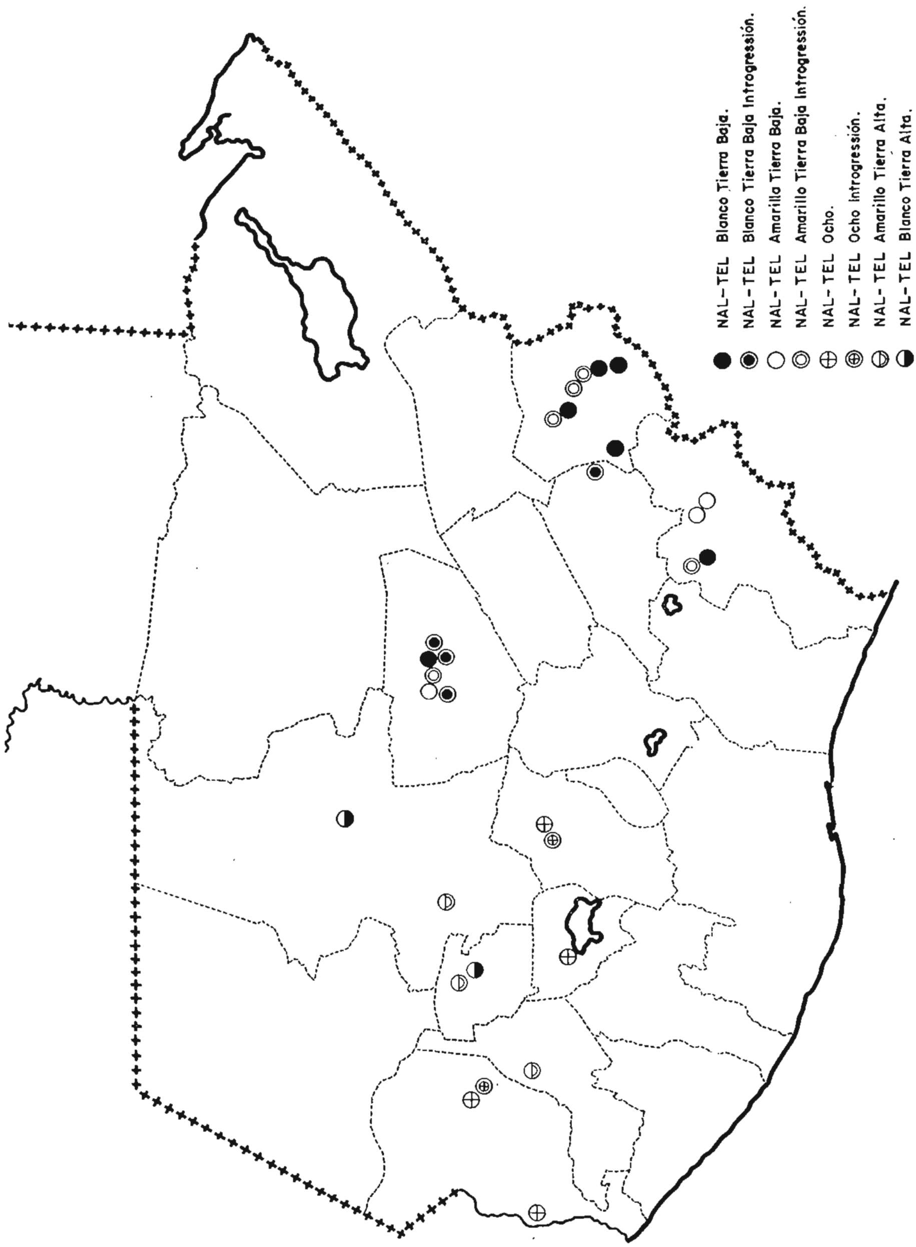


FIG. 6. The distribution of Nal-Tel and its sub-races in Guatemala.

Sub-race Blanco Tierra Alta

The three collections of this sub-race from the Departments of El Quiché, Totonicapan and Quetzaltenango (Figs. 6, 9–11), are similar to those of the yellow-seeded counterpart discussed above, except that the plants are earlier in maturity and the majority of the ears are more tapering in shape. The three collec-

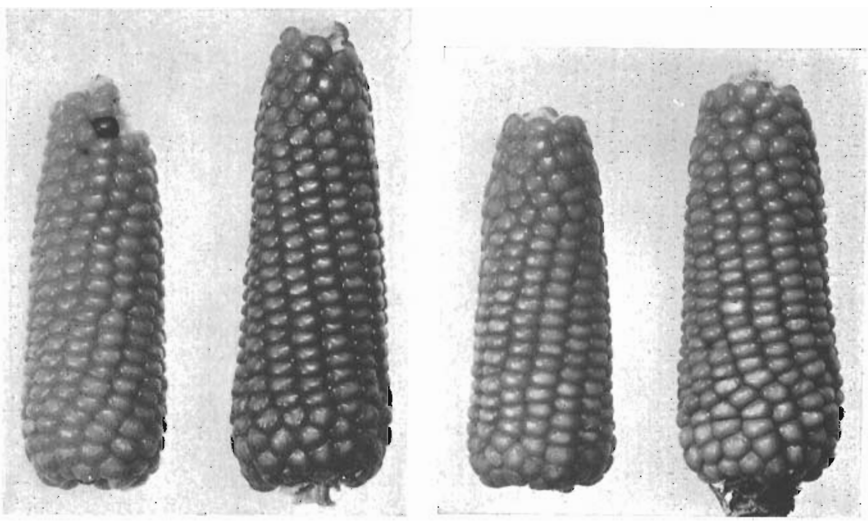


FIG. 7. Nal-Tel Amarillo Tierra Alta. (Guat. 908, Totonicapan, 7650 feet). A collection which shows slight introgression of Quicheño. One ear has the light red pericarp color often found in this race.
FIG. 8. Nat-Tel Amarillo Tierra Alta. (Guat. 835, El Quiche, 7500 feet). Like the ears of Fig. 7, these show slight introgression of Quicheño. One ear is quite similar to the ears of Nal-Tel illustrated by Wellhausen *et al* (1952, Fig. 16).

tions of Blanco show less admixture with other races than the two collections of Amarillo. One of the ears (Guat. 500, Fig. 9) has small vitreous kernels and would pass for a good popcorn.

Sub-race Ocho

Plants. Medium in maturity, average number of days to first flowering, 99, but two of the collections are earlier, flowering at 90 and 92 days respectively; height medium, average 297 cm., but two of the collections are much shorter, 270 and 265 cm.,

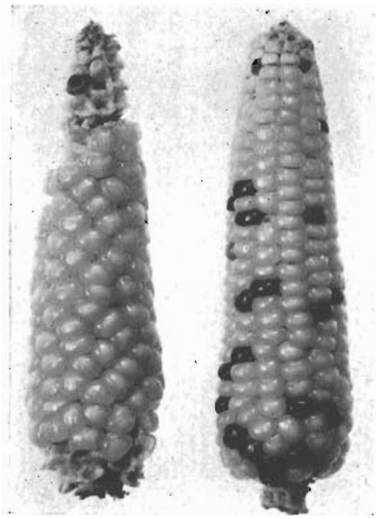
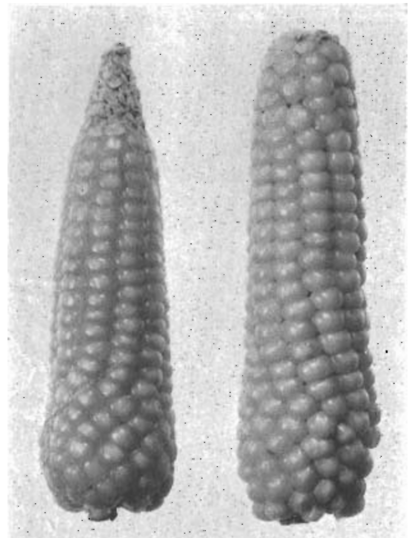



FIG. 9. Nal-Tel Blanco Tierra Alta. (Guat. 500, Totonicapan, 9100 feet). This collection is one of the nearest approaches to a true popcorn which has been found in Guatemala. The grains are small and vitreous. The ear on the right has been contaminated with a corn having aleurone color.

FIG. 10. Nal-Tel Blanco Tierra Alta. (Guat. 20, Quetzaltenango, 8000 feet). This sub-race, believed once to have been widely grown in Guatemala, has been collected at altitudes of 6000-9100 feet.

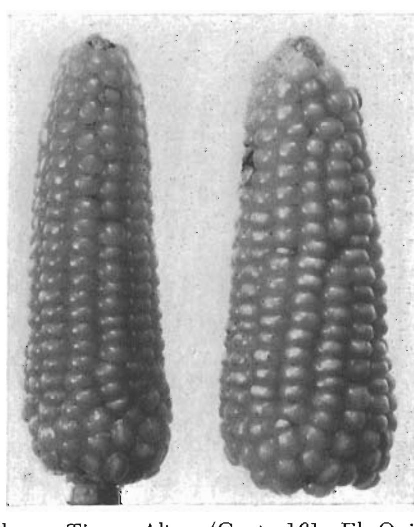


FIG. 11. Nal-Tel Blanco Tierra Alta. (Guat. 161, El Quiche, 6000 feet). At lower altitudes Nal-Tel shows the effects of increasing introgression from other races. Compare with Figs. 4 and 5.

respectively; average number of leaves 16.3, average length 105 cm., average width 10.5 cm., average number of veins 26; color and pilosity medium.

Ears (Figs. 12 and 13). Medium length, average 15 cm., but one collection has short ears, averaging 11.7 cm.; diameter medi-

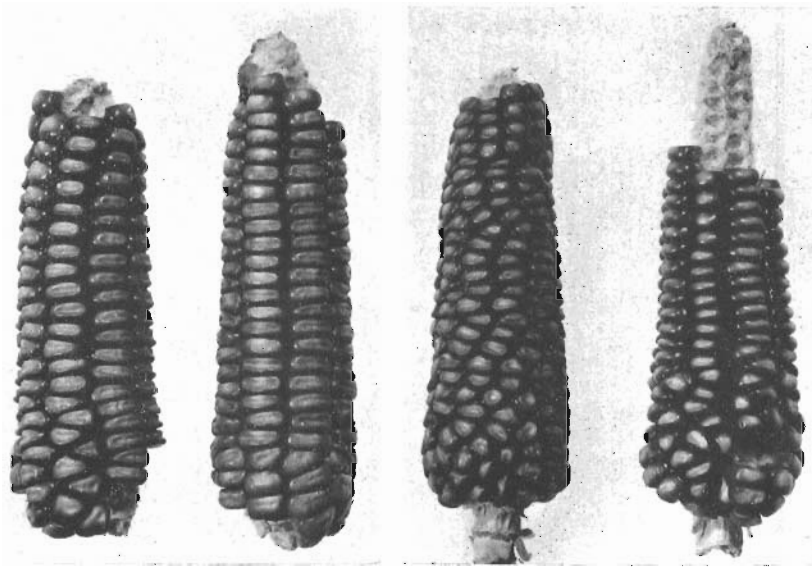


FIG. 12. Nal-Tel Ocho. (Guat. 420, Sacatepéquez, 7900 feet). This sub-race of the ancient indigenous race of Guatemala still retains the row number eight, which is common in early archaeological specimens from La Perra Cave in Mexico. Pale red pericarp color is also common. This collection has undergone admixture with the high-altitude race San Marceño.

FIG. 13. Nal-Tel Ocho. (Guat. 458, San Marcos, 8300 feet). This sub-race of Nal-Tel occurs at altitudes of 7100-8300 feet.

um, average 4.1 cm., one collection slender, average 3.5 cm., shape tapering; shank slender to medium, average 14.6 mm., average number of rows of all collections 11, but eight-rowed ears are common and are believed to represent the basic type, hence the name "Ocho"; grains of medium size, average width 10.2 mm., average thickness 4.8 mm., average length 11.4 mm.; grains usually dorsally flattened, often slightly dented; endosperm semi-hard to flinty, white or yellow; pericarp color light red or lacking; cobs white.

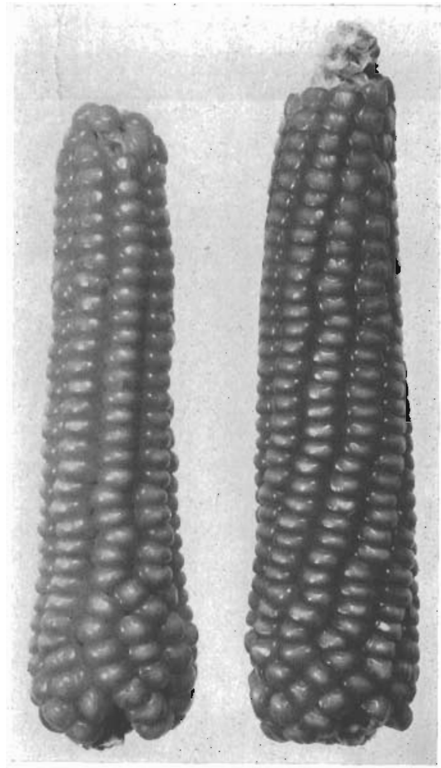
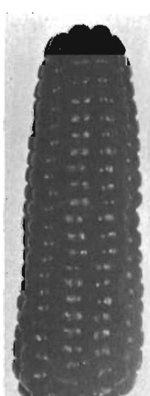


FIG. 14. The introgression of Quicheño into Nal-Tel Ocho. (Guat. 516 and 619, San Marcos 7900 feet and Chimaltenango 7100 feet). This introgression sometimes produces an eight-rowed flint (left) which in its general aspects is quite similar to the eight-rowed flint corns of New England and Canada. Whether the northern flint corns have originated in this manner has not been determined.



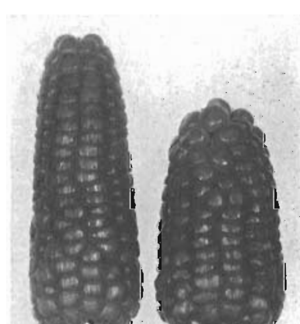


FIG. 15. Nal-Tel with purple aleurone. (McBryde Collection No. 51. Olintepeque, Quetzaltenango). This is the only collection of Nal-Tel with purple aleurone color.
FIG. 16. Nal-Tel modified by teosinte introgression. (McBryde Collection No. 33, San Pedro Jocopilas, El Quiché). These ears resemble Nal-Tel but plants grown from them were quite late in maturing and had a high (eleven) chromosome-knob number.

Distribution (Fig. 6). Nal-Tel Ocho has been collected from the Departments of San Marcos, Sololá and Chimaltenango at 7100–8300 feet. Introgression of this race occurs in the same departments.

Origin and Relationships. This is the only sub-race of Nal-Tel in which eight-rowed ears are common, but many eight-rowed cobs were found among the early archaeological specimens from La Perra Cave in Mexico described by Mangelsdorf *et al* (1956). Also the ears represented on the Zapotec funerary urn illustrated by Caso and Bernal (1952) are eight-rowed. Consequently, Nal-Tel Ocho may be no more than a sub-race, in which a primitive characteristic with respect to row number has persisted.

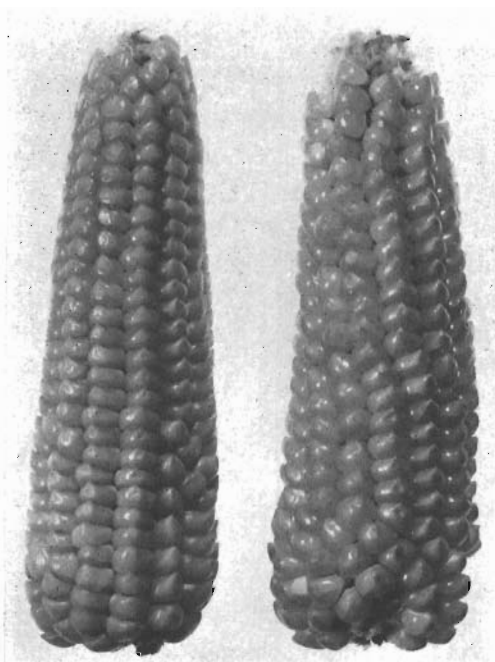
Nal-Tel Ocho is related in some manner to San Marceño which comes from the same region, is grown at the same altitudes and in which eight-rowed ears and pericarp colors are common. The introgression of Quicheño into Nal-Tel Ocho has produced eight-rowed flinty ears, which are scarcely distinguishable from the eight-rowed flint ears of New England and Canada (Fig. 14, left). Whether the two are actually related is a question requiring further study. It is a fact, however, that so far as ear characteristics are concerned, the Guatemalan specimens are almost exact counterparts of the small-eared flint corns of northern New England and Canada.

Ears of Nal-Tel with purple aleurone and with considerable teosinte introgression, from the McBryde Collection, are shown in Figs. 15 and 16, respectively. Since no data on the plants of these collections are available, it is not certain that they are related to Nal-Tel Ocho, although they are eight-rowed.

IMBRICADO

Plants. Medium maturity, 100 days to first flowering; tall, average height 311 cm.; average number of leaves 15.6, average length 115 cm., average width 10.6 cm., average number of veins 25.2; medium color, pilosity medium to strong.

Ears (Figs. 17 and 18). Medium to large, average length 16.2 cm., average diameter 4.8 cm.; tapering shank thick, average diameter 14.3 mm.; number of rows 12–16, average 14.4; grains



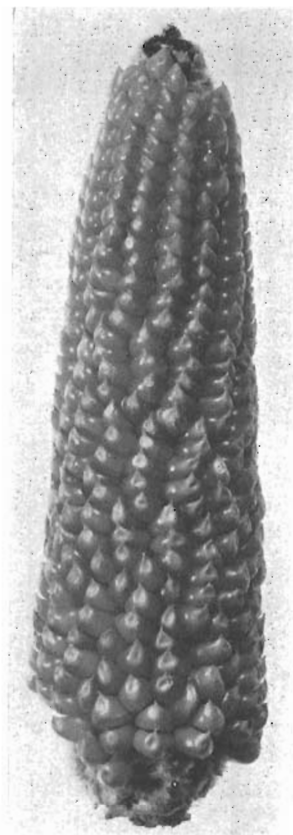


FIG. 17. Imbricado. (Guat. 922, Huehuetenango, 7400 feet). This is not a primitive race but a mixture showing the influence of a primitive race similar to the Mexican popcorn Palomero Toluqueño. Compare with Wellhausen *et al* (1952, Fig. 8) and with Roberts *et al* (1957, Fig. 28).

FIG. 18. Imbricado. (Guat. 777, Chimaltenango, 7750 feet). This ear shows the three principal characteristics which have been inherited from a primitive popcorn similar to Palomero Toluqueño; weak pericarp color, pointed imbricated kernels and a tendency for the members of a pair of spikelets to spread apart. Compare with Wellhausen *et al* (1952, Fig. 8) and with Roberts *et al* (1957, Fig. 26).

long and narrow, average width 8.6 mm., average thickness 4.6 mm., average length 13.0 mm., pointed and imbricated; endosperm flinty, white; pericarp color "dirty".

Distribution (Fig. 19). The five collections of Imbricado come from altitudes of 7400–7750 feet in Chimaltenango, Quetzaltenango and Huehuetenango.

Origin and Relationships. Imbricado is not itself a primitive race, indeed it is scarcely a race. It represents a complex of characteristics which are found in one of the ancient indigenous races of Mexico, Palomero Toluqueño. This complex includes pointed, imbricated kernels, pistillate spikelets in which the two members of a pair tend to spread apart, and a weak pericarp color best described as "dirty". (The Spanish equivalent "sucio" is used in several countries to describe this color.)

Races of popcorn similar to Palomero Toluqueño of Mexico (illustrated by Wellhausen *et al* 1952, Fig. 8) and possessing the characteristic features of this race have been collected in Peru, Chile and Brazil. The race itself is not included in our collections, but it must once have occurred in Guatemala, for its influence is seen in the collections described under the heading of Imbricado. Also, Ing. Alejandro Fuentes, who made the collections, informs us that smaller ears with smaller cobs and much more pointed grains than those collected exist in the Departments of Totonicapan and Quetzaltenango. Pointed, imbricated kernels and spreading spikelets are found in all five of our collections, weak pericarp color in all but one.

The Imbricado of Guatemala is related to the Colombian race of the same name (Roberts *et al,* 1957) only to the extent that it has the same combination of characteristics inherited from a common primitive ancestor. The remaining germplasm may be quite different.

EXOTIC AND DERIVED RACES

Some time after the primitive race Nal-Tel had become differentiated into various sub-races, there was an introduction from South America of more highly evolved races of maize. These not only became well established in the Guatemalan agricultural economy, but they also hybridized among themselves,

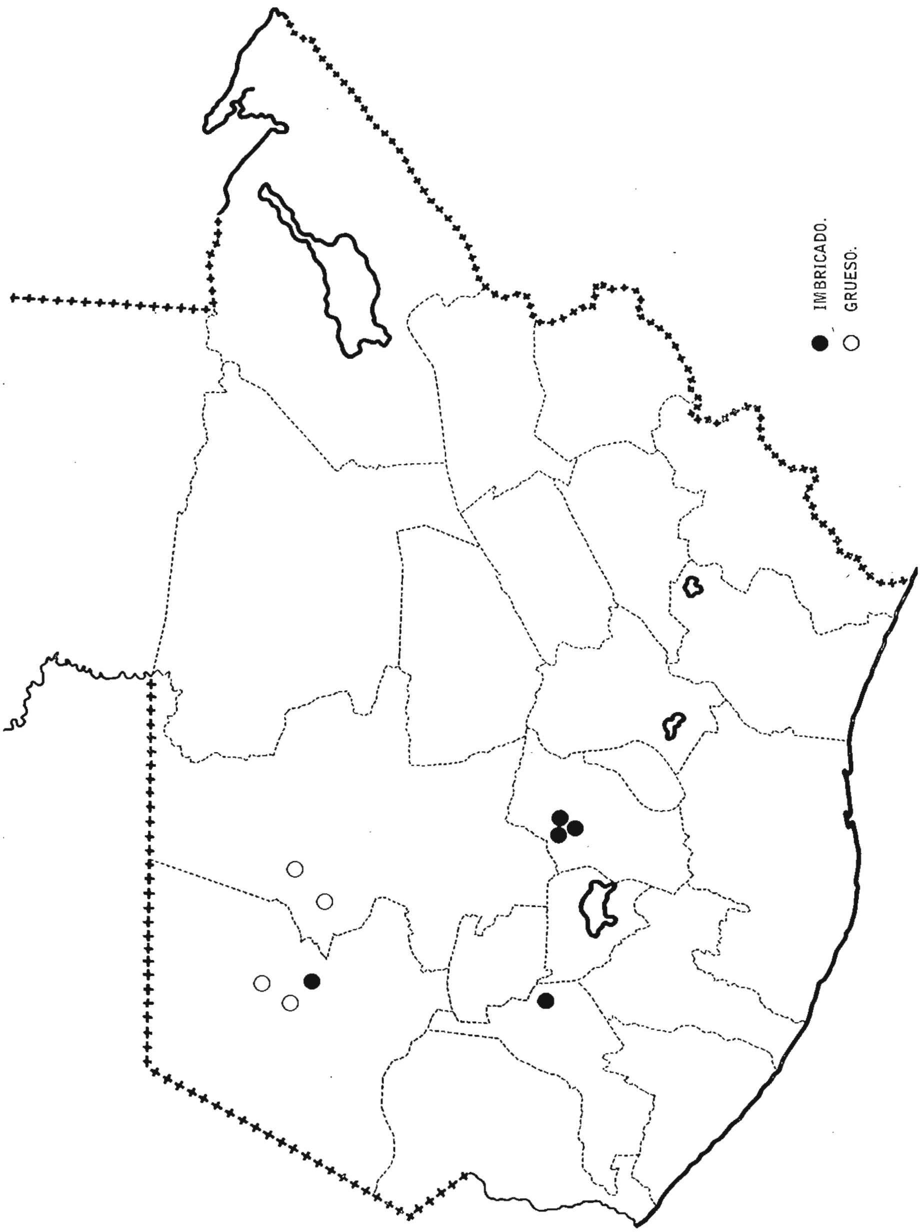


Fig. 19. The distribution of the races, Imbricado and Grueso, in Guatemala.

with other races, and with teosinte to form new hybrid races. Consequently, we have in Guatemala today two groups of races, one of which comprises those introduced from South America with little modification, the other comprising races originating in Guatemala.

To treat these two groups separately tends to obscure some of their relationships. For example, it separates the two sub-races of Negro de Chimaltenango from the parent race. For this reason we are considering the two groups together. The sequence in which they are described is, with several exceptions, their sequence with respect to the average altitude at which they are grown.

The descriptions of the races in this category follow.

SERRANO

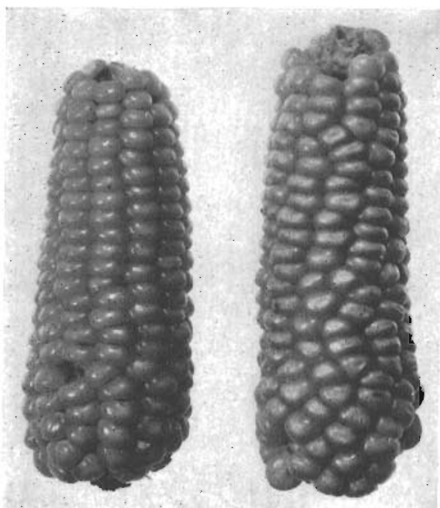
Plants. Earliest of the Guatemalan races, 83 days to first flowering at Chapingo; medium height, 253 cm.; average number of leaves 14, broad in relation to length, average length 94 cm., average width 11.4 cm., average number of veins 26.4; majority of plants colored, majority pubescent, some strongly so.

Ears (Figs. 20–23). Small, average length 12.8 cm., average diameter 3.4 cm.; shape cylindrical or slightly tapering, base often enlarged because of multiplication of rows, shank thick in relation to size of ear, average diameter 13.5 mm.; number of rows 8–14, average 10.5; grains small, average width 10 mm., thickness 5.2 mm., length 10.4 mm., usually dorsally rounded; endosperm texture flinty, color yellow or white.

Distribution (Fig. 24). Serrano is grown at higher average altitudes than any other race in Guatemala. The average altitude of the collections is 9060 feet and the range is 8100–10,000 feet. Typical collections come from the Departments of San Marcos, Huehuetenango, Totonicapan, Quetzaltenango and Sololá. The race has its highest frequency in San Marcos. Introgression into Serrano of other races (Figs. 25 and 26) is evident in the Departments mentioned above and also in El Quiché, Chimaltenango and Sacatepéquez.

Origin and Relationships. Serrano is related to the high-altitude

Colombian race Sabanero and may represent an ancient introduction into Guatemala from South America. Serrano has been modified by introgression from San Marceño and Nal-Tel, but its resemblance to the Colombian Sabanero, especially in plant color and pubescence, is still apparent.



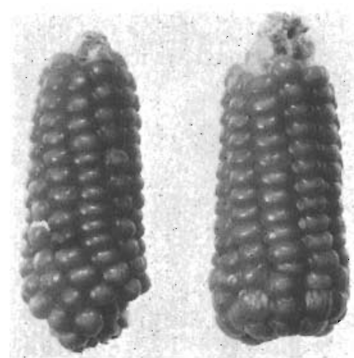


FIG. 20. Serrano. (Guat. 909, San Marcos, 10,000 feet). This high-altitude race may be an ancient introduction from South America. It resembles the Colombian race Sabanero. Compare with Roberts *et al* (1957, Fig. 29).

FIG. 21. Serrano. (Guat. 729, Sololá, 8750 feet). The ears of Serrano are usually small. These ears represent the minimum size in this race found in the Guatemalan collections. Compare with the Colombian Pollo (Roberts *et al* 1957, Fig. 3).

In Guatemala, Serrano has hybridized with Negro de Chimaltenango to form the sub-race Negro de Tierra Fría, which, except for its aleurone color, is quite similar to Serrano in its characteristics.

SAN MARCEÑO

Plants. Medium to late in maturity, average number of days to first flowering 103, but some collections requiring 125 days; medium to tall, average height 295 cm., but several collections exceeding 350 cm.; average number of leaves 16.1, average length

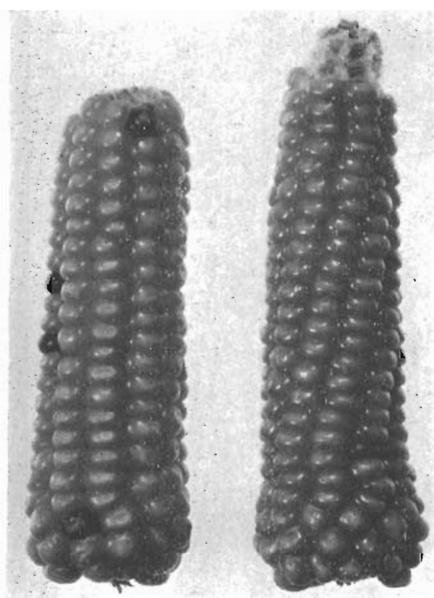


FIG. 22. Serrano. (Guat. 492, San Marcos, 8800 feet). The kernels of this race are usually flinty. The endosperm may be yellow or white. The former is more common.

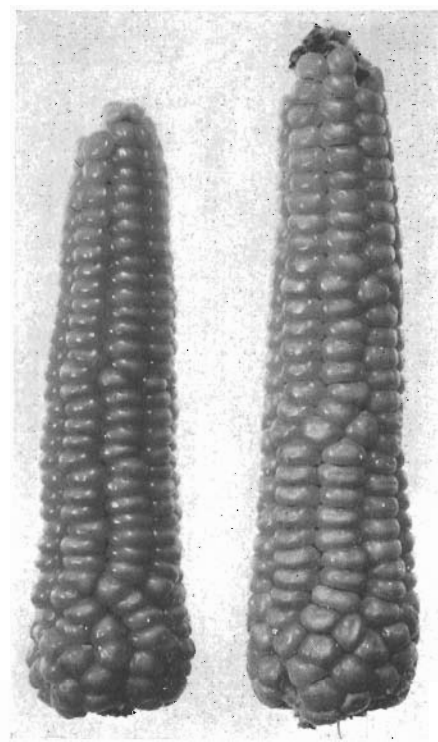


FIG. 23. Serrano. (Guat. 475, Quetzaltenango, 8800 feet). Many of the ears of Serrano have enlarged butts and irregular rows at the base. This is due to spikelet multiplication.

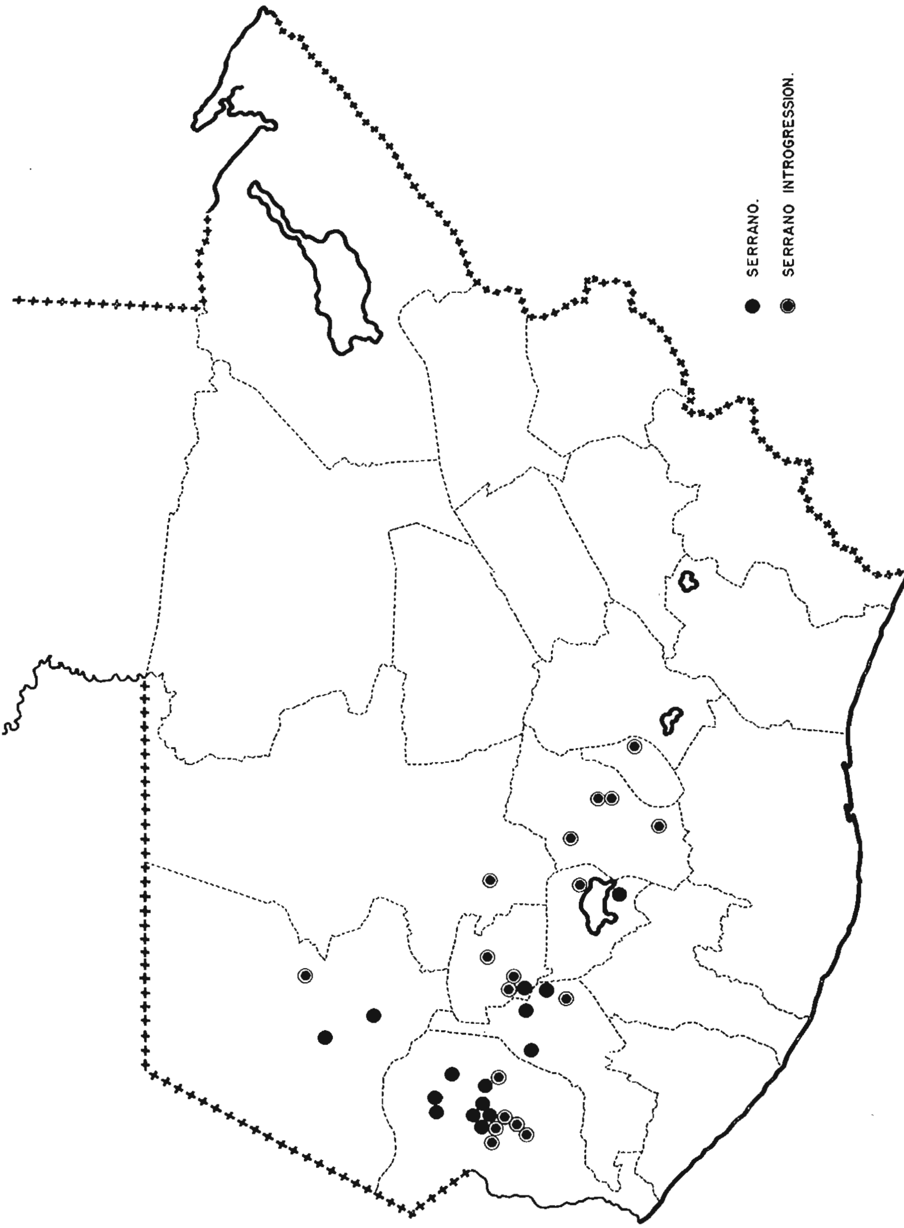


FIG. 24. The distribution of Serrano and Serrano introgression in Guatemala.

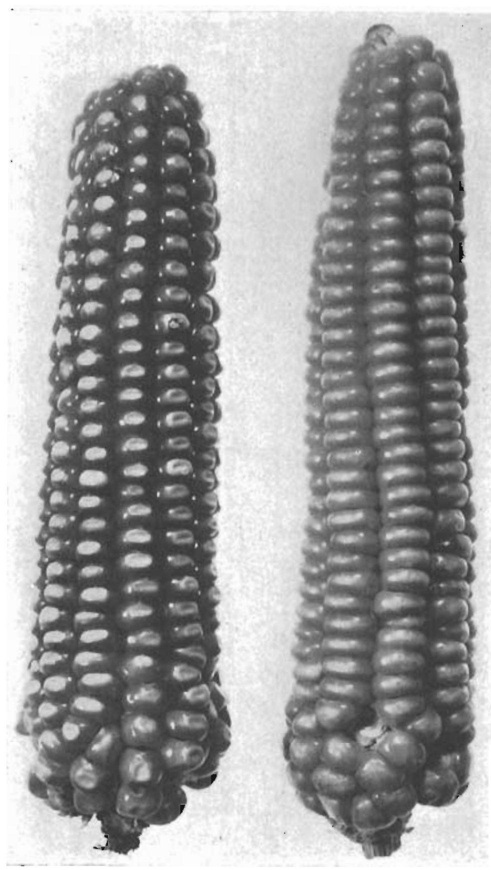


FIG. 25. Serrano modified by introgression from Olotón. (Guat. 946, Huehuetenango, 9500 feet). The range of these two races overlaps and many collections show the effects of admixture between them.

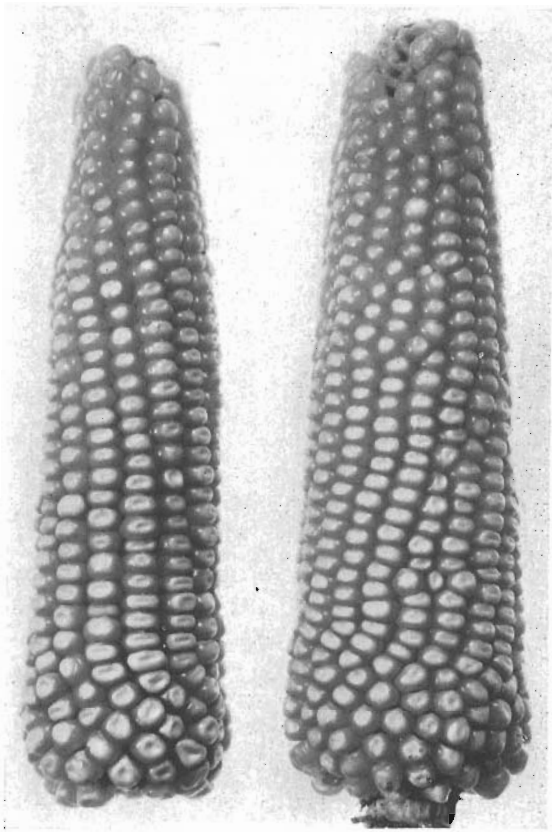


FIG. 26. Serrano modified by a race with fasciated ears, probably Salpor but possibly Grueso. (Guat. 479, Quetzaltenango, 7600 feet).

107 cm., average width 10.2 cm., average number of veins 24.5; strong plant color, medium pilosity.

Ears (Figs. 27–30). Medium size, average length 16.5 cm., average diameter 4.1 cm., tapering, usually with enlarged butt and multiplication of rows at the base; shank thick, average

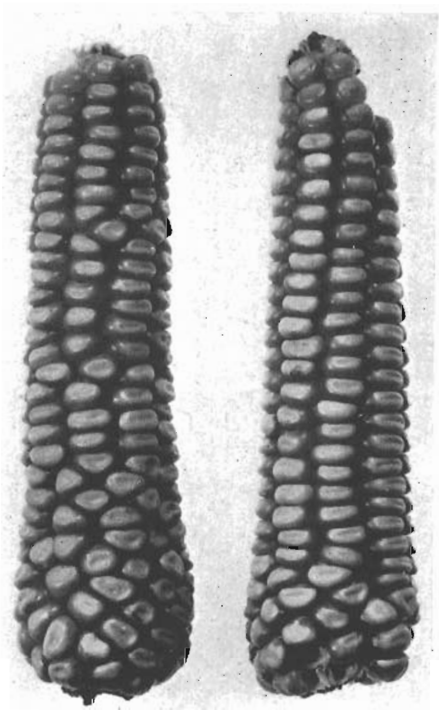


FIG. 27. San Marceño is the principal race at high altitudes in the Department of San Marcos, from which it receives its name. It is grown at altitudes of 7000-8800 feet. (Guat. 748, San Marcos, 8250 feet).

diameter 15.9 mm.; row number usually 8–10, average 9.9, the number usually larger at the butt; grains large, average length 11.7 mm., average width 11.1 mm., average thickness 5.7 mm., dorsally flattened, usually slightly dented; endosperm flinty, usually yellow, more rarely white; pericarp color common, various shades of light red; cob white, midcob color common.

Distribution (Fig. 31). San Marceño is most common in the Department of San Marcos, hence the name, but it also occurs in Huehuetenango, Quetzaltenango, Sololá and Chimaltenango.

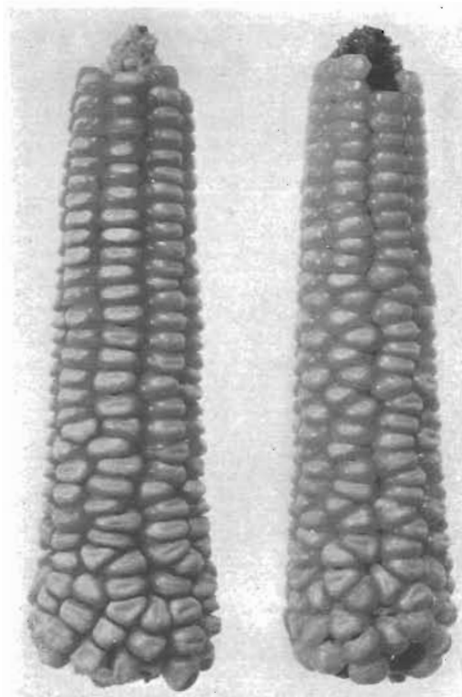


FIG. 28. San Marceño. (Guat. 365, Quetzaltenango, 8100 feet). This race appears to be a hybrid of Serrano and Nal-Tel Ocho. Many ears have the enlarged butts of the former and the row number of the latter.

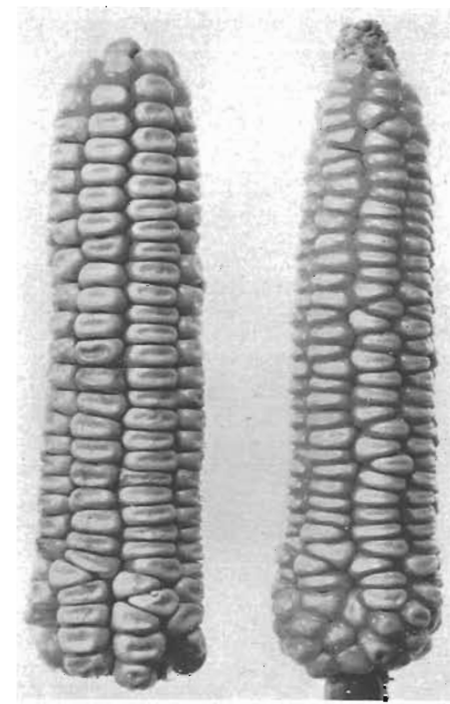


FIG. 29. San Marceño. (Guat. 742, San Marcos, 7650 feet). The majority of collections of this race are yellow, but white ears, illustrated here, also occur. Some ears show slight denting.

The average altitude of the collections is 7834 feet and the range in altitude 7000–8800 feet. The distribution follows closely a range of volcanic peaks extending southeastward from San Marcos to Salvador. The race is unknown outside of Guatemala.

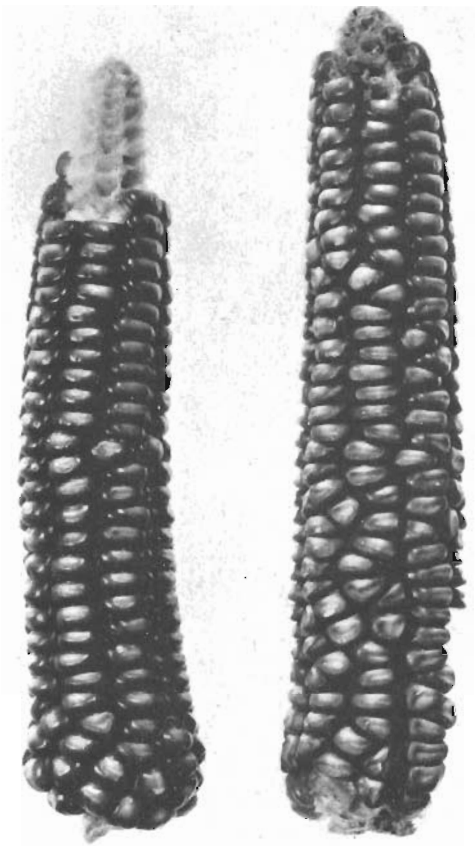


FIG. 30. San Marceño. (Guat. 440, San Marcos, 7850 feet). Red pericarp associated with white cobs, illustrated in this photograph, is common in this race.

Origin and Relationships. San Marceño is probably a hybrid of Nal-Tel Ocho and Serrano. It resembles Nal-Tel Ocho in the majority of its characteristics but has obviously undergone introgression from one or more other races. Since Serrano has approximately the same geographical distribution as San Marceño, and since the ranges of altitude of the two races overlap, it seems probable that the introgression has come from Serrano.

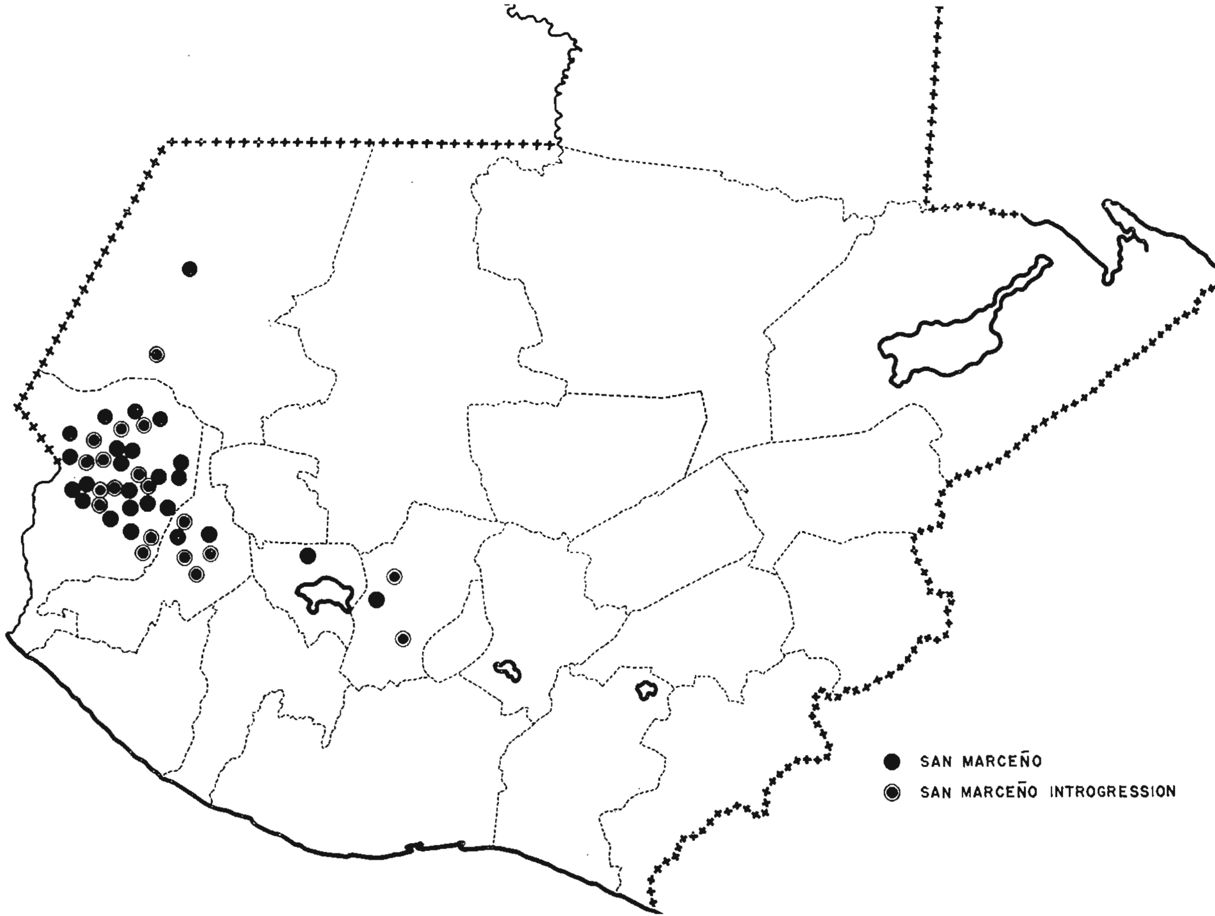


FIG. 31. The distribution of San Marceño and San Marceño introgression in Guatemala.

The influence of San Marceño, including pericarp color, is evident in two Guatemalan races, Serrano and Olotón.

QUICHEÑO

Plants. Medium to late, 115 days to first flowering; tall, average height 290 cm.; average number of leaves 16.3, average length, 107 cm., average width 9.6 cm., number of veins 26; color medium, pubescence strong.

Ears (Figs. 32 and 33). Small, average length 13.8 cm., average diameter 3.6 cm.; slightly tapering or almost cylindrical, butts rounded, both butts and tips well filled; shank slender, average diameter 11.2 mm., number of rows 12–14, average 12.5, often twisted; grains large in relation to size of ear, average length 7.2 mm., average width 8.7 mm., average thickness 6.8 mm., dorsally rounded; endosperm yellow, flinty.

Distribution (Fig. 34). This race in relatively pure form is found in the Departments of El Quiché and Huehuetenango, at altitudes of 6000–7700 feet. Its introgression into other races occurs commonly in the additional Departments of Totonicapan, Sololá, Suchitepéquez, Chimaltenango, and Sacatepéquez, at altitudes of 5500–8000 feet, and to a lesser degree in several additional departments (Figs. 35–38).

Origin and Relationships. Quicheño has the general aspects of the maize of the Andean region of South America. Its ears show some resemblance to those of the Peruvian race Confite Morocho. Quicheño probably represents an ancient introduction into Guatemala from South America. In Guatemala it has given rise to the sub-races Grueso and Ramoso.

Since varieties of Quicheño vary considerably in maturity, it has seemed advisable to average separately in Tables 2 and 3 the data for early and late varieties. The early varieties are generally found at lower altitudes than the late varieties and have shorter plants. They may be the product of introgression from Nal-Tel.

Sub-race Rojo

The only evidence for the existence of this sub-race is a single collection from El Quiché at 6000 feet (Fig. 39) and the intro-

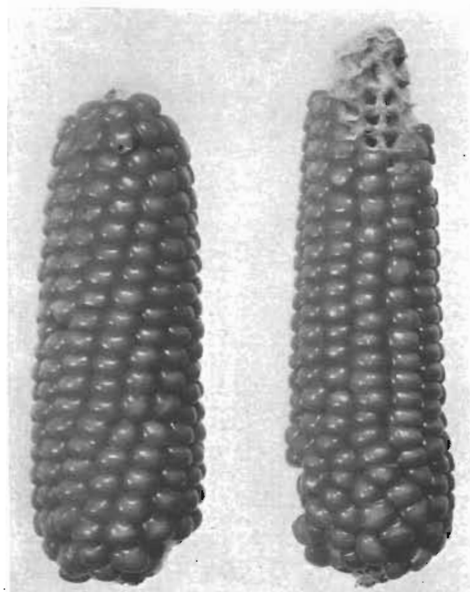


FIG. 32. Quicheño. (Guat. 839, El Quiché, 6550 feet). This race, which occurs most commonly in the Department of El Quiché after which it is named, is believed to represent an ancient introduction from South America. A race similar to it, Confite Morocho, is found in Peru.

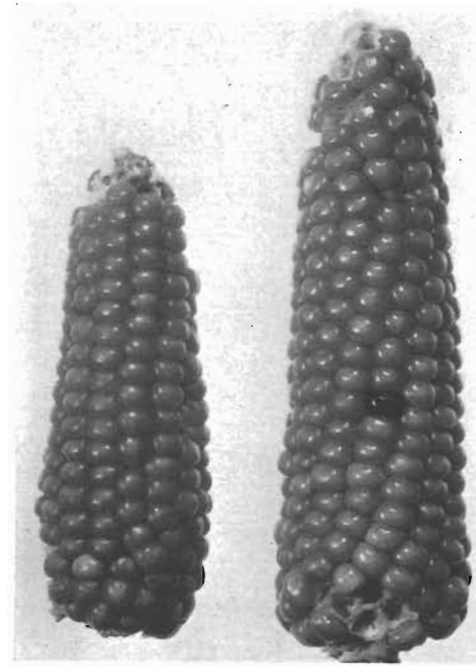


FIG. 33. Quicheño. (Guat. 894, Huehuetenango, 7700 feet). Conspicuous characteristics of this race are the rounded butts and tips and the large, almost round, flinty kernels. The endosperm color is usually yellow, more rarely white.

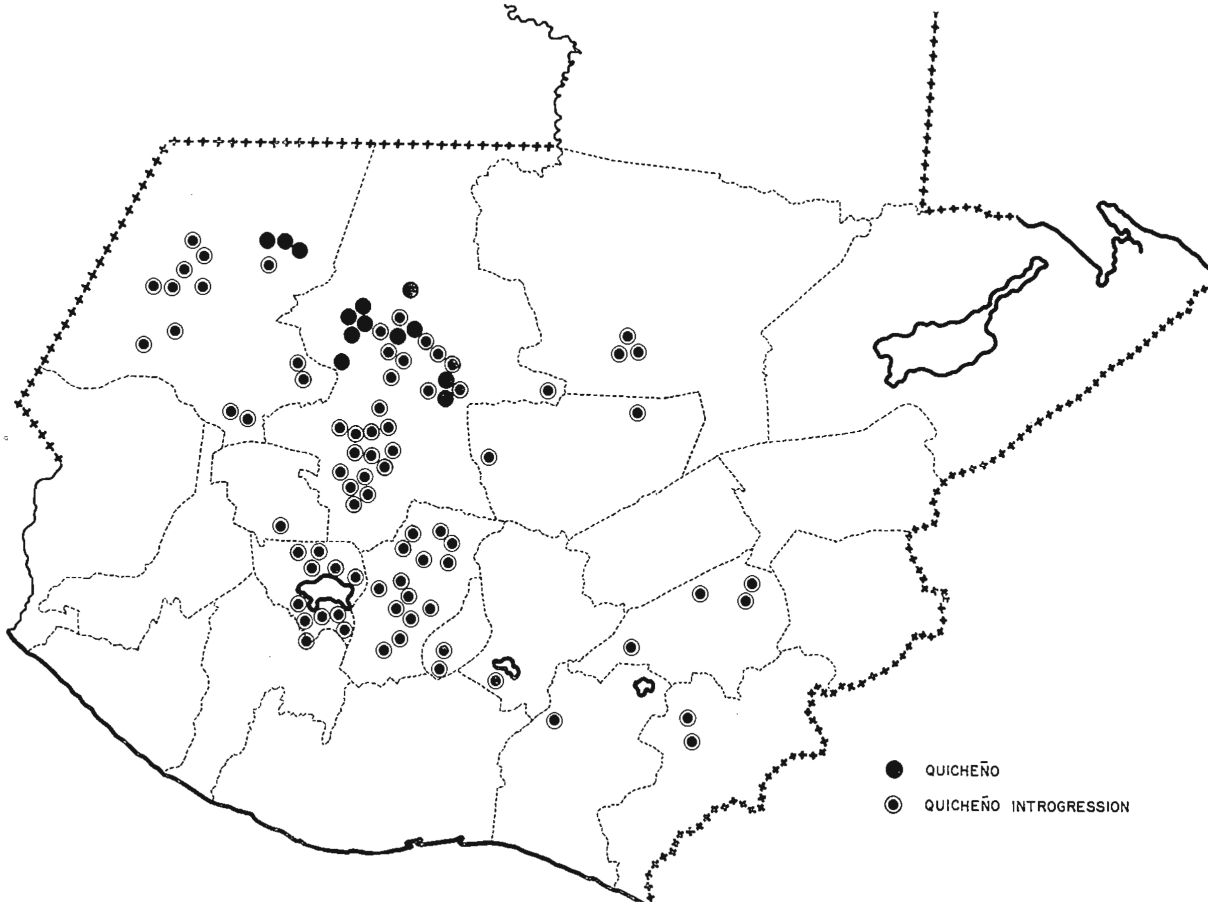


Fig. 34. The distribution of Quicheño and Quicheño introgression in Guatemala.

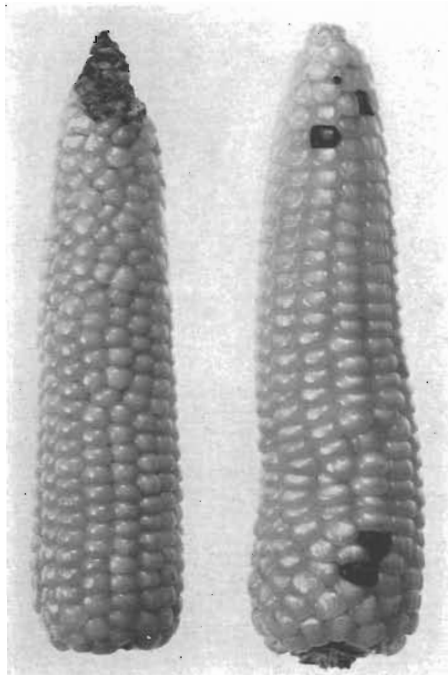


FIG. 35. Quicheño modified by introgression from Nal-Tel. (Guat. 164, Suchitepéquez, 5750 feet). The introgression of Quicheño into other races occurs at altitudes of 5500-8000 feet.

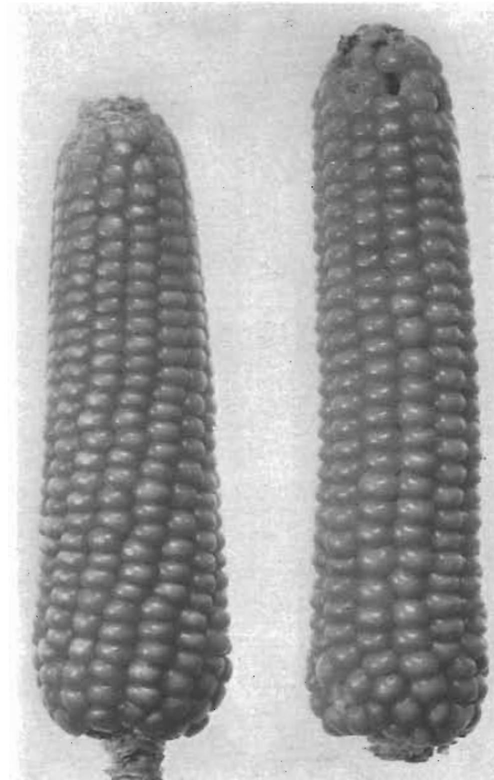


FIG. 36. Quicheño. (Guat. 863, El Quiché, 6000 feet). At lower altitudes Quicheño is modified by introgression from other races. These ears have retained the principal characteristics of the race but are larger than average.

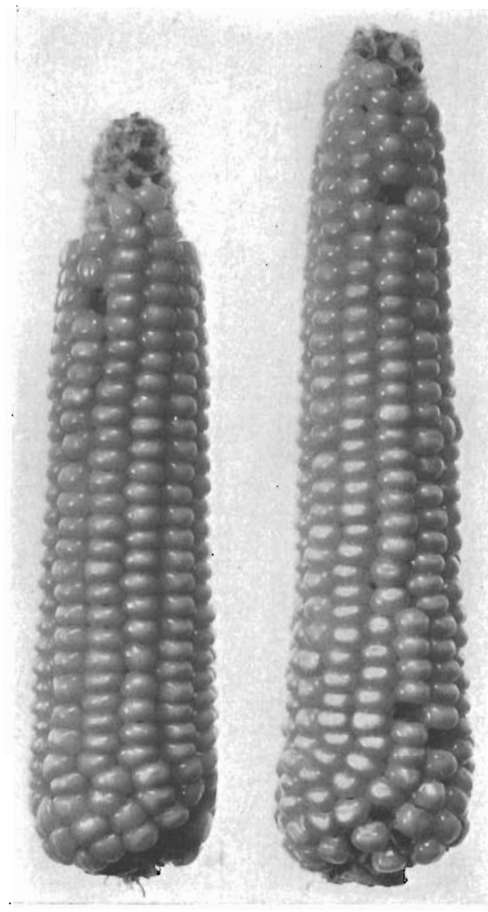


FIG. 37. Quicheño modified by introgression from Olotón (Guat. 892, El Quiché, 6900 feet). Admixture with Olotón tends to increase the length of the ears of Quicheño.

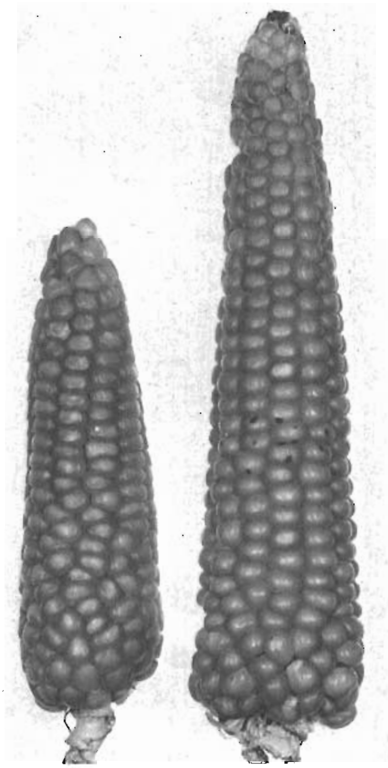


FIG. 38. Quicheño modified by teosinte introgression (McBryde Collection Nos. 36 and 91, San Pedro Jocopilas, El Quiché and Huehuetenango, Huehue.). Associated with Quicheño is a type with strongly tapering ears, slightly flattened kernels and a higher average (eight) chromosome-knob number. This type is thought to represent the product of the introgression of teosinte into Quicheño.

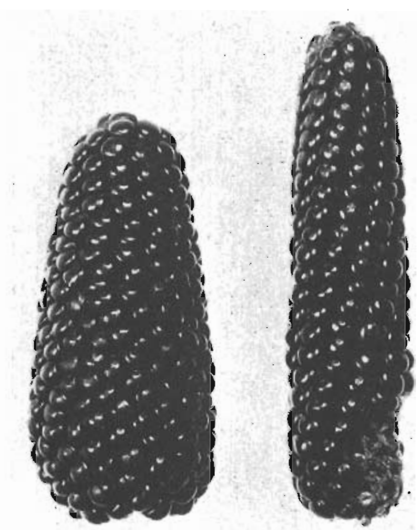


FIG. 39. Quicheño Rojo. (Guat. 39, El Quiché, 6900 feet). These ears, which are definitely related to Quicheño, may represent a relict primitive form of this race. They resemble some of the prehistoric ears of Peru. They also illustrate how normal and fasciated ears occur in the same race.

gression of its principal characteristics, red pericarp and red cob, into three collections from Quetzaltenango and Huehuetenango (Fig. 40). The data on ears and plants from the single collection are too few to merit detailed discussion, although they are included in Tables 2 and 3, which show that in the majority

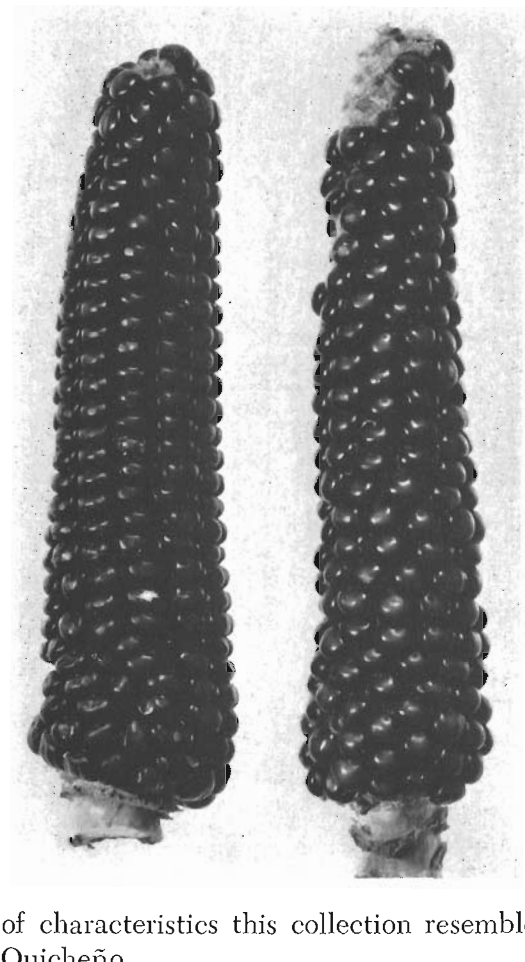


FIG. 40. Quicheño Rojo modified by the introgression of Olotón. (Guat. 8, Huehuetenango, 7500 feet). The red pericarp and red cob of Quicheño Rojo are found in several mixed collections, one of which is illustrated here.

of characteristics this collection resembles the early varieties of Quicheño.

The collection is of interest because the two ears illustrated in Figure 39 are similar to the prehistoric corn of Peru in their deep red pericarp color, slender shanks, well-filled butts and tips and isodiometric kernels. It has already been suggested that Quicheño in Guatemala is a South American introduction. The resemblance of these primitive ears of Quicheño to prehistoric Peruvian maize supports the suggestion.

One of the ears of Quicheño Rojo (Fig. 39) is fasciated. This ear shows that the tendency to fasciation exists in Quicheño and

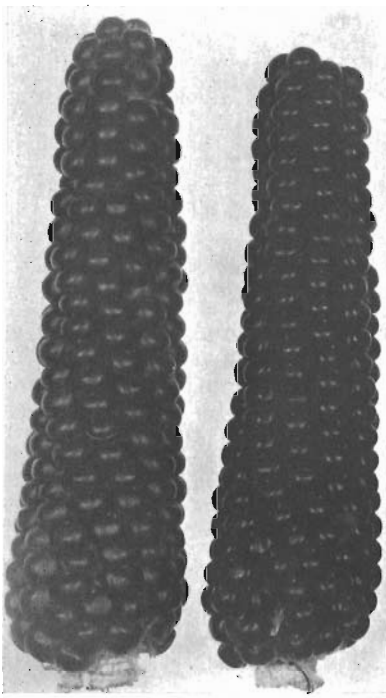


FIG. 41. Quicheño with purple aleurone (left) and with red pericarp (right). (McBryde Collection Nos. 45 and 46, San Juan Ixcoy, Huehuetenango). Plants grown from these ears had chromosome-knob numbers of four and five respectively.

supports the conclusion discussed later that the race Grueso, the ears of which are strongly fasciated, is related to Quicheño.

An ear of Quicheño Rojo also occurs in the McBryde Collection (Fig. 41).

Sub-race Grueso

Plants. Medium to late in maturity, average number of days to first flowering 116; medium height, average 275 cm.; average number of leaves 16.5, average length 101 cm., average width 10.5 cm., number of veins 25; plant color medium, pubescence slight.

Ears (Figs. 42 and 43). Short, thick, slightly tapering, fasciated, shank thick; rows of grain irregular, difficult to count, probably 14–16; grains large, round; endosperm flinty, white or yellow.

Distribution (Fig. 19). There are only four collections of this race, two from El Quiché and two from Huehuetenango.

Origin and Relationships. Grueso appears to be nothing more than a fasciated form of Quicheño. It is grown in the same area

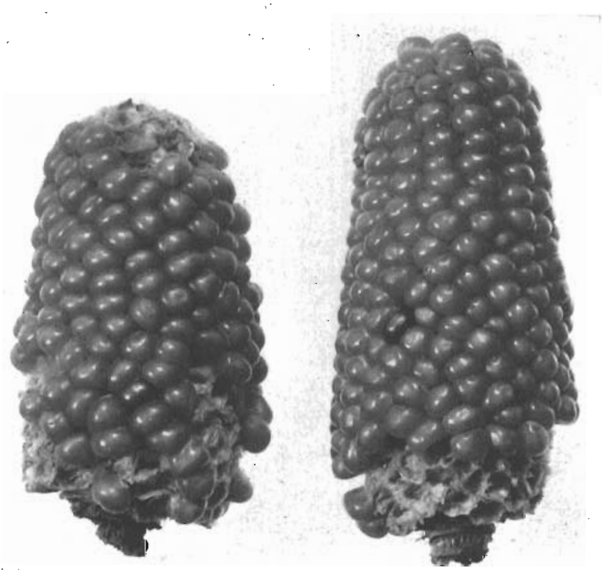


FIG. 42. Quicheño Grueso. (Guat. 905, Huehuetenango, 7350 feet). Except for its fasciated ears, this race is quite similar to Quicheño in its characteristics. Fasciation also occurs in Quicheño Rojo.

at approximately the same altitudes, and except for the fasciation it is quite similar to Quicheño in the characteristics of its plants, ears and kernels.

Fasciation is not uncommon in maize and is found in both archaeological specimens and living varieties. It may take various forms, affecting the base of the ear, or the tip of the ear or the entire ear. Little is known about the inheritance of fasciation, but there is some indication that a fairly simple genetic change may in some cases virtually double the row number.

Grueso is not common in Guatemala and appears to have had little influence upon other races. Since there is no obvious advantage in the fasciated ears, Grueso, like Ramoso and the branched maize of Mexico, is probably grown either as a curiosity or because of supposed magical or other properties.

Sub-race Ramoso

In the Departments of Quetzaltenango and Huehuetenango is found a sub-race of Quicheño which differs from the race primarily in the fact that the ears are branched (Fig. 44).

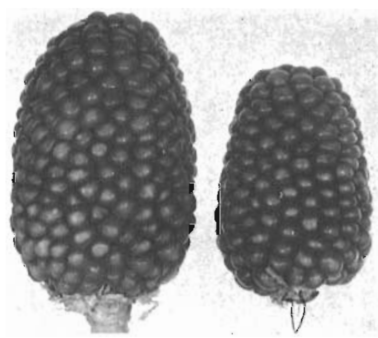


FIG. 43. Quicheño Grueso, probably modified by teosinte introgression. (McBryde Collection No. 34, San Pedro Jocopilas, El Quiché). These ears are smaller than ordinary Grueso and plants grown from them were late in maturity and had a high (nine) chromosome-knob number.

The type of branching characteristic of this sub-race appears to be one manifestation of the fasciation found in Grueso, another sub-race of Quicheño. This is well illustrated in Figure 45, which shows the transition from fasciation to branching in a collection of the race of Quicheño.

Branched ears of various types have appeared in many varieties of maize throughout the world and have always attracted the attention and curiosity of maize growers. Weatherwax (1954) states that some types of branched ears were given a prominent place as fertility symbols in the agricultural festivities of ancient Peru, and that pottery specimens of branched ears are said to have been used in ancient religious ceremonies in Guatemala.

It is quite likely that this branched sub-race of Quicheño is preserved in Guatemala because of its symbolic or religious significance. The fact that its average chromosome-knob number, 4.3, is lower than that of the race, 5.0, may suggest that special efforts are made to keep this type free of contamination with other races.

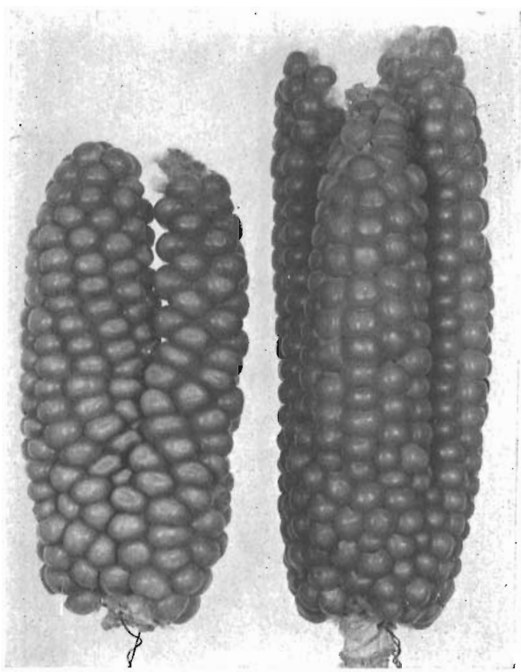


FIG. 44. Quicheño Ramoso (McBryde Collection Nos. 26 and 47, San Juan Ostuncalco, Quetzaltenango and San Juan Ixcoy, Huehuetenango). The branched ears of this sub-race of Quicheño have a slightly lower average chromosome-knob number than the race. This suggests that special efforts are made to keep this type free from contamination.

NEGRO DE CHIMALTENANGO

Plants. Late in maturity, average number of days to first flowering 121; tall, average height 298 cm.; average number of leaves 17.2, average length 105 cm., average width 10.9 cm., average number of veins 27.3; medium to strong color, medium to strong pubescence.

Ears (Figs. 46 and 47). Medium to long, slender, tapering,

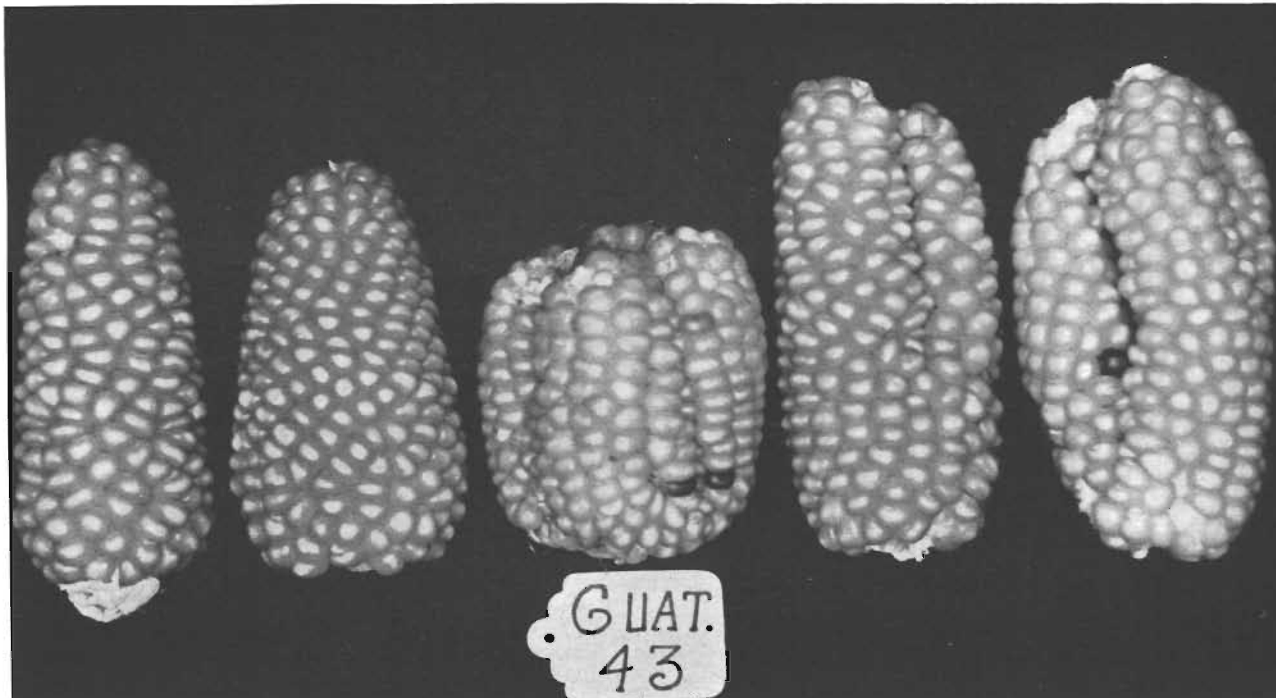


FIG. 45. The transition from fasciation to branching in Quicheño. The ears of this collection suggest that fasciation and branching are closely related phenomena. The type of branching illustrated here appears to be the product of extreme fasciation.

average length 15.8 cm., average diameter 3.9 cm.; shank medium, average diameter 12.5 mm., number of rows 10–12, average 10.3; grains of medium size, dorsally rounded, average width

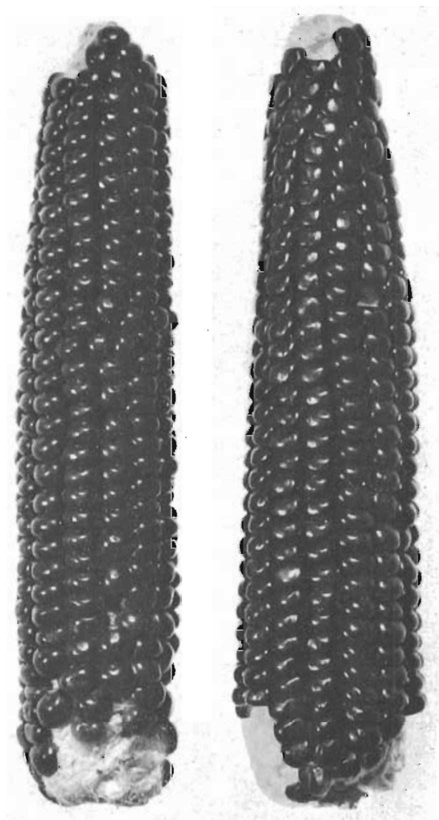


FIG. 46. Negro de Chimaltenango. (Guat. 590, Chimaltenango, 7100 feet). This race, as the name suggests, is most common in Chimaltenango. In its slender, tapering ears, deep blue aleurone color and floury endosperm, it resembles closely the Colombian race Güirua (cf. Fig. 15, Roberts *et al*, 1957), and it probably represents an ancient introduction from South America.

9.9 mm., average thickness 5.2 mm., average length 10.3 mm.; endosperm white, floury; aleurone black; midcob color common, glumes long and indurated.

Distribution (Fig. 48). This race, as its name suggests, is most common in Chimaltenango, but it has also been collected in the adjoining Departments of El Quiché, Sololá and Guatemala at altitudes of 6000–7425 feet. Its introgression into other races of maize is discussed under its two sub-races.

Origin and Relationships. Negro de Chimaltenango is almost identical in the size and shape of its ears to the Colombian race Güirua. In Colombia the race has been collected only in the

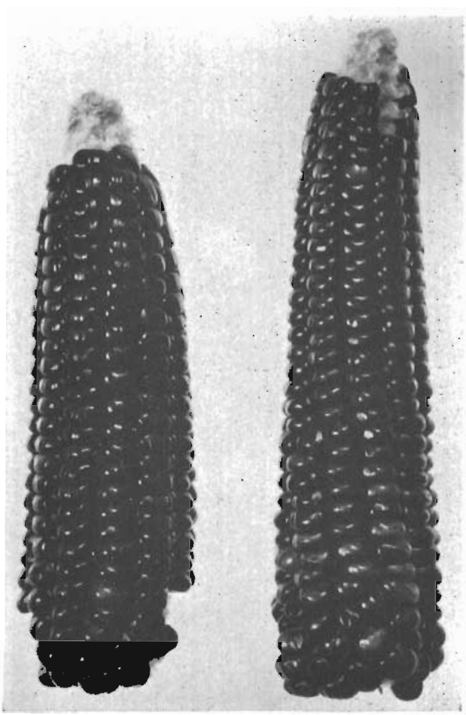


FIG. 47. Negro de Chimaltenango. (Guat. 646, Chimaltenango, 7200 feet). The ears of this collection have been slightly modified by the introgression of Serrano.

Department of Magdalena at altitudes similar to those at which it occurs in Guatemala. How a race of maize from high altitudes in northeastern Colombia could have diffused to high altitudes in western Guatemala is a mystery. It may be that the Colombian race was once more widely distributed than it now is, occurring also in the southern part of Colombia where at least two of the Colombian races now found in Guatemala, Serrano and Olotón, occur.

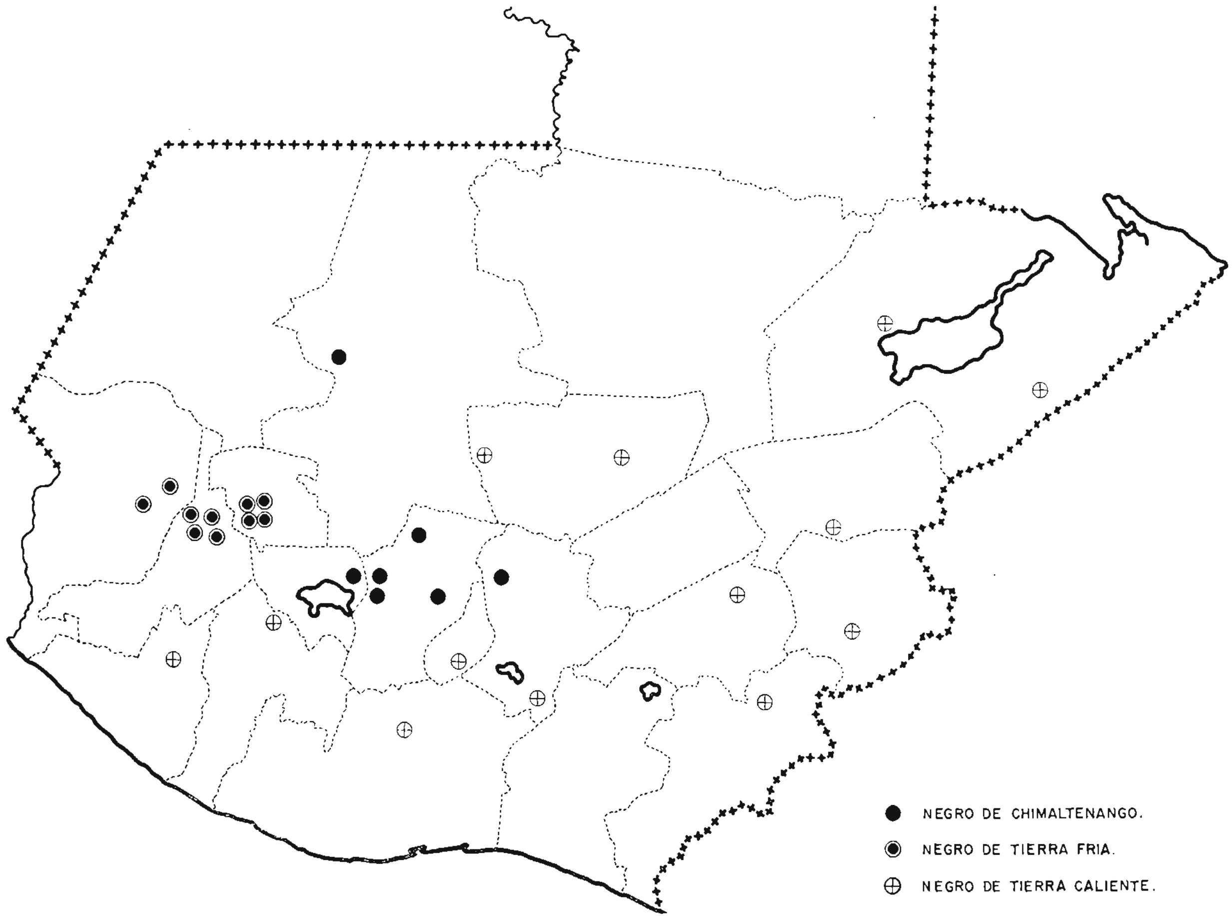


FIG. 48. The distribution of Negro de Chimaltenango and its sub-races in Guatemala.

Both the Colombian and Guatemalan forms of this race have relatively long glumes, probably due to an allele at the *Tu* locus, but in the Colombian form the glumes are soft, while in the Guatemalan form they are strongly indurated. The difference may be due to contamination with teosinte, which is common in Guatemala.

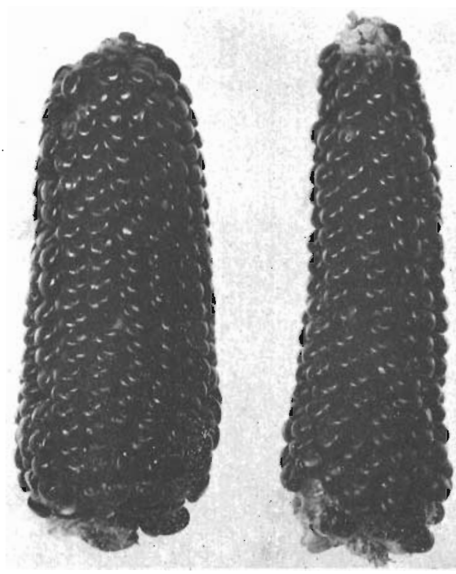


FIG. 49. Negro de Tierra Fría. (Guat. 513, Totonicapan, 9100 feet). The introgression of Negro de Chimaltenango into Serrano has produced a sub-race with ears similar to those of Serrano but having the purple aleurone and floury endosperm of the original Negro.

Sub-race Negro de Tierra Fría

Plants. Early, average number of days to first flowering, 87; medium height, average 255 cm., average number of leaves 13.9, average length 95 cm., average width 10.5 cm., average number of veins 24.1; plant color and pubescence strong.

Ears (Fig. 49). Small, average length 14.1 cm., average diameter 4.1 cm.; tapering, with enlarged butts accompanied by multiplication of rows; average shank diameter 14.3 mm., number of rows 8–12, average 10.3; grains medium in size, dorsally rounded, average width 10.1 mm., average thickness 5.2 mm., average length 11.4 mm.; endosperm white, floury, aleurone black.

Distribution (Fig. 48). Collected only in small area in San Marcos, Quetzaltenango and Totonicapan at altitudes of 7600–9000 feet.

Origin and Relationships. Negro de Tierra Fría could almost equally well be called a sub-race of Serrano, since in the characteristics of its plants and ears it is similar to this race. In those characteristics in which it differs from Serrano, it approaches Negro de Chimaltenango, and some collections of this sub-race include a few ears which are quite similar to the basic race. For these reasons, Negro de Tierra Fría is regarded as the product of the hybridization of Negro de Chimaltenango and Serrano, with repeated back-crossing to Serrano. It has had no obvious influence upon other races.

Sub-race Negro de Tierra Caliente

Plants. Early, average number of days to first flowering at Chapingo 94, but for the majority of collections less than 90; short, average height 173 cm.; average number of leaves 14.8, average length 87 cm., average width of leaves 8.9 cm., average number of veins 25; little color or pubescence.

Ears (Figs. 50–53). Medium size, average length 14.1 cm.; average diameter 4.1 cm.; slightly tapering, with rounded butts and barren tips; shank diameter medium, average 12.6 mm., row number 10–14, average 11.5; grains medium size, average width 9.2 mm., average thickness 4.2 mm., average length 9.9 mm., dorsally rounded or slightly flattened and dented; endosperm white, floury to semi-flinty; aleurone purple, segregating red.

Distribution (Fig. 48). This sub-race is found at altitudes of 128–3500 feet in the Departments of Retalhuleu, Suchitepéquez, Escuintla, Sacatapéquez, Guatemala, Baja Verapaz, Jalapa, Jutiapa, Chiquimula, Zacapa and Izabal.

Origin and Relationships. This sub-race is obviously the product of introgression of Negro de Chimaltenango into lowland races. Selection for purity of aleurone color has tended to retain other characteristics of the original race, including ear shape, floury endosperm and dorsally rounded kernels. The aleurone color of the lowland Negro is, however, by no means as deep as that of the original race, probably because of a quite different complex of modifier genes. Also, some of the kernels are red

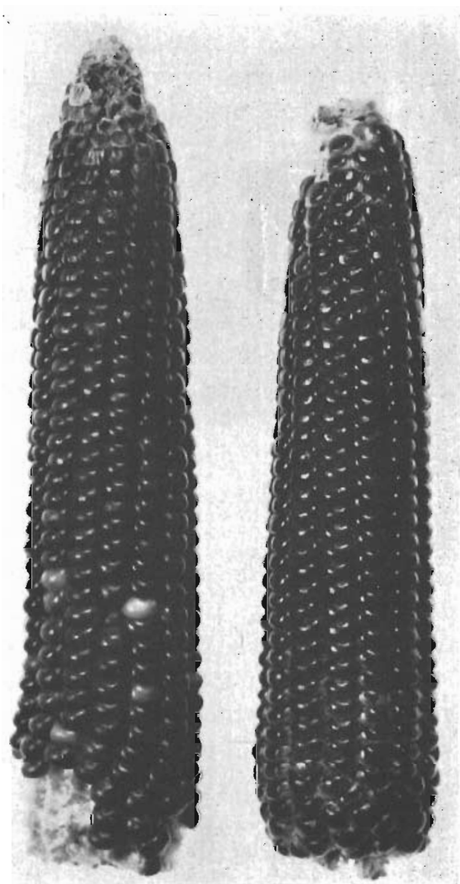


FIG. 50. Negro de Tierra Caliente. (Guat. 635, Jalapa, 5450 feet). As Negro de Chimaltenango was moved to lower altitudes it became modified by admixture with other races. These ears show a slight influence of Olotón.

rather than blue because of the loss of the *Pr* gene. Nevertheless, the relationship of the sub-race to the original is obvious and the distribution map for the sub-race (Fig. 48) furnishes an excellent illustration of the manner in which the genes of a well-defined race are diffused through hybridization over a wide area.

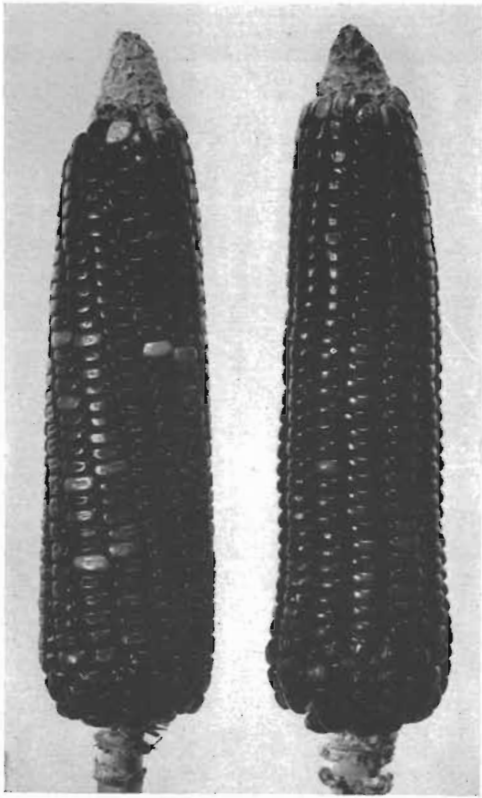


FIG. 51. Negro de Tierra Caliente. (Guat. 159, Suchitepéquez, 3500 feet). Admixture of Negro de Chimaltenango with low altitude races has produced ears with barren tips and a somewhat diluted aleurone color. This collection shows the influence of Tepecintle.

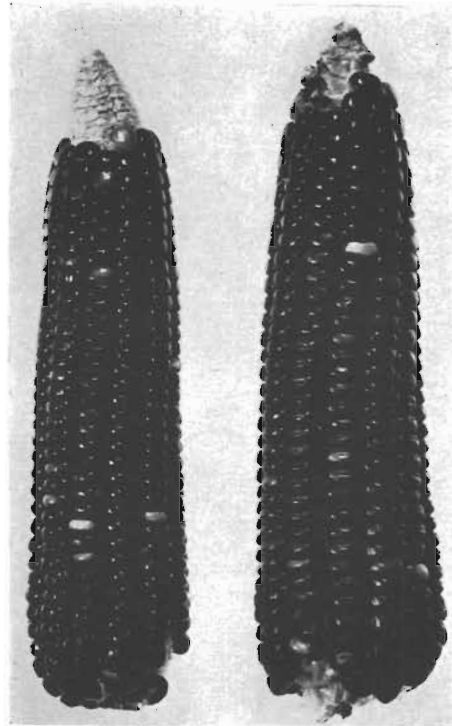


FIG. 52. Negro de Tierra Caliente. (Guat. 358, Retalhuleu, 1000 feet). At still lower altitudes the ears of this sub-race tend to become smaller probably because of introgression from Nal-Tel.

SALPOR

Plants. Early in maturity, 90 days to first flowering at Chapingo; medium to tall, average height 288 cm.; average number of leaves 16.4, average length 104 cm., average width 9.0 cm., average number of veins 25.2; medium plant color, strong pubescence.

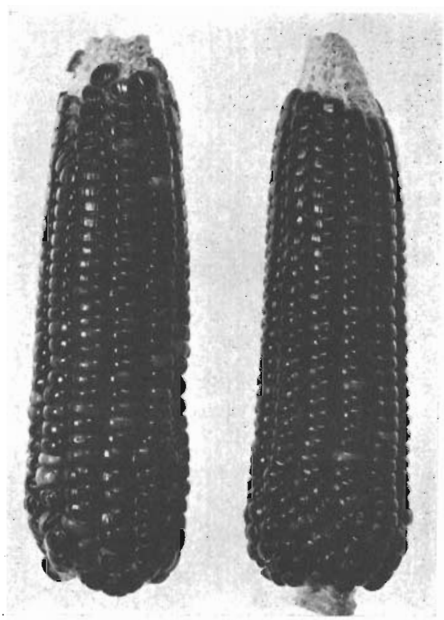


FIG. 53. Negro de Tierra Caliente. (Guat. 356, Escuintla, 350 feet). At altitudes approaching sea level the ears of this sub-race are quite short, because of the strong introgression of Nal-Tel. The race Negro de Chimaltenango and its sub-races illustrate how a combination of characteristics, in this case floury endosperm and aleurone color, can diffuse into other races over a wide range of altitudes.

Ears (Fig. 54). Large, thick, fasciated, average length 19.7 cm.; average diameter 5.7 cm., the largest diameter of any Guatemalan race except the strongly fasciated Quicheño Grueso; tapering, the base of the ear often enlarged because of multiplication of rows; shank thick, average diameter 23.5 mm., the largest of any Guatemalan race; number of rows at middle of ear 12–14; grains large, round, thick, average width 11.8 mm., average thickness 5.9 mm., average length 13.1 mm.; endosperm white, floury.

Distribution (Fig. 55). Salpor has been collected from one department, Quetzaltenango, at altitudes of 7600–9200 feet. Its

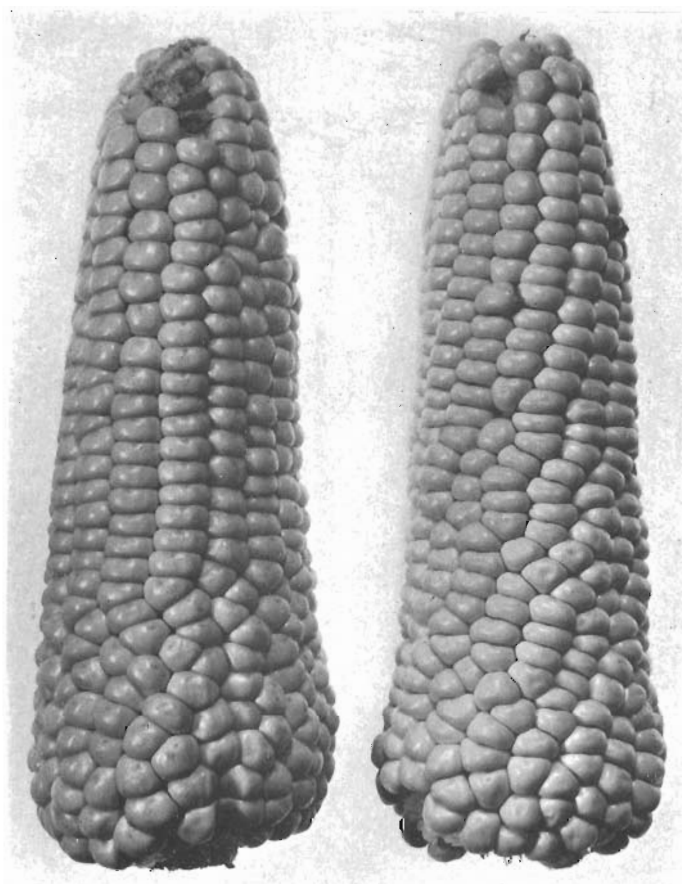


FIG. 54. Salpor. (Guat. 484, Quetzaltenango, 7600 feet). In its fasciated ears and floury endosperm this race resembles the Colombian race, Capio. Compare with Fig. 46 of Roberts *et al* (1957).

influence is seen on maize in an adjoining department, Totonicapan.

Origin and Relationships. The origin of Salpor is not clear. Its ears resemble those of the Colombian race, Capio, which has fasciated ears and floury grains (cf. Roberts *et al,* 1957, Fig. 46),

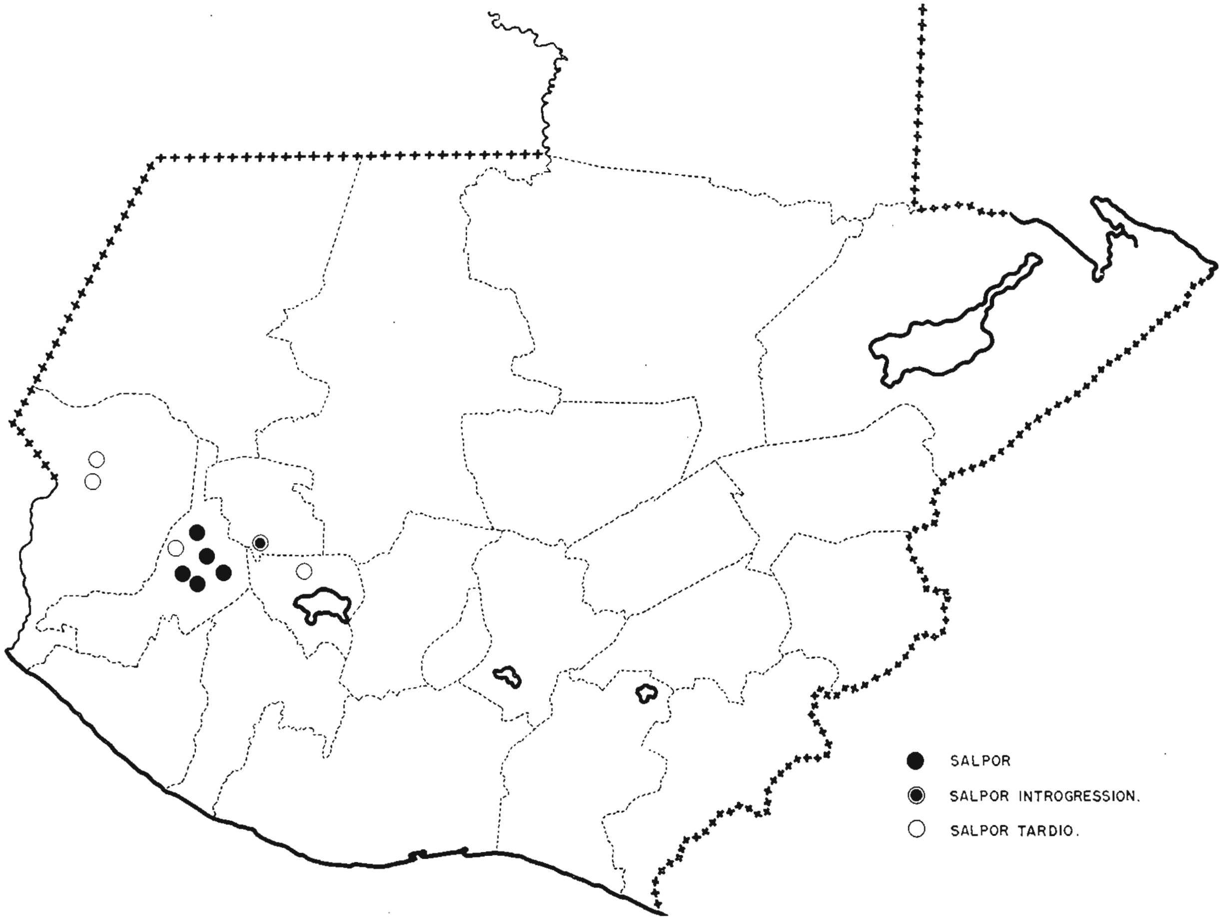


FIG. 55. The distribution of Salpor, Salpor introgression and Salpor Tardío in Guatemala.

but its plants are quite different. Capio is related to the Colombian Montaña and the Guatemalan–Mexican Olotón, both of which have tall, late plants. Salpor is among the earliest of the Guatemalan races and in its general plant characteristics shows more resemblance to Serrano than to Olotón. It may be an early form of the Colombian Capio or Capio which has undergone introgression with Serrano. Its range overlaps that of Serrano both geographically and in altitude.

Salpor is also related in some way to Salpor Tardío and to Cacahuacintle of Mexico (cf. Wellhausen *et al*, 1952, Fig. 18). All have the same strongly pilose leaf sheaths and white, floury endosperm.

SALPOR TARDÍO

Plants. Medium to late in maturity, average number of days to first flowering, 115; medium to tall, average height 291 cm.; average number of leaves 16.3, average length 98 cm., average width 7.8 cm., average number of veins 23; plant color and pubescence strong.

Ears (Fig. 56). Medium size, average length 15.8 cm., average diameter 4.6 cm.; shape nearly cylindrical, rounded at base and tip, well filled; average shank diameter 14.1 mm.; number of rows 8–14, average 11; grains medium to large, dorsally rounded, average width 10.9 mm., average thickness 6.2 mm., average length 11.9 mm.; endosperm white, floury.

Distribution (Fig. 55). Four collections of this race were made in the Departments of San Marcos, Quetzaltenango and Sololá, at altitudes of 7700–8800 feet.

Origin and Relationships. Salpor Tardío is obviously related to Salpor. It is grown in the same region and at the same altitudes as Salpor and except for its lateness in maturity and lack of fasciation it is quite similar to Salpor in its characteristics. Which of these two races is the original and which other race has influenced one of them to bring about the present differences cannot be determined from the data now available.

Salpor Tardío is also related to Cacahuacintle of Mexico (cf. Wellhausen *et al*, 1952, Fig. 18), but the exact nature of the relationship is not clear.

OLOTÓN

Plants. Late in maturity, 122 days to first flowering at Chapingo; tall, average height 323 cm.; average number of leaves 18, average length 117 cm., average width 9.7 cm., average number of veins 26.6; plant color none to strong; pubescence none to medium.

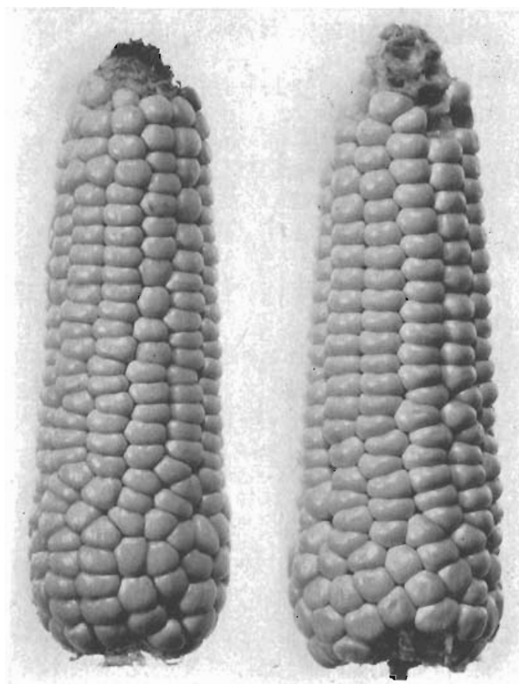


FIG. 56. Salpor Tardío. (Guat. 485, San Marcos, 7850 feet). This Guatemalan race of flour corn is related in some way to the race Salpor. It also resembles the Colombian race, Sabanero Harinoso, and the Mexican race, Cacahuacintle.

Ears (Figs. 57–60). The longest of any Guatemalan race, average 21.1 cm., but reaching a maximum length of 35–40 cm., average diameter 4.5 cm.; strongly tapering, often with enlarged butts due to multiplication of rows; peduncle thick, average diameter 16.0 mm., part of the peduncle often remaining attached to the ear when harvested; grains large, thick, average width 9.7 mm., average thickness 5.5 mm., average length 10.6

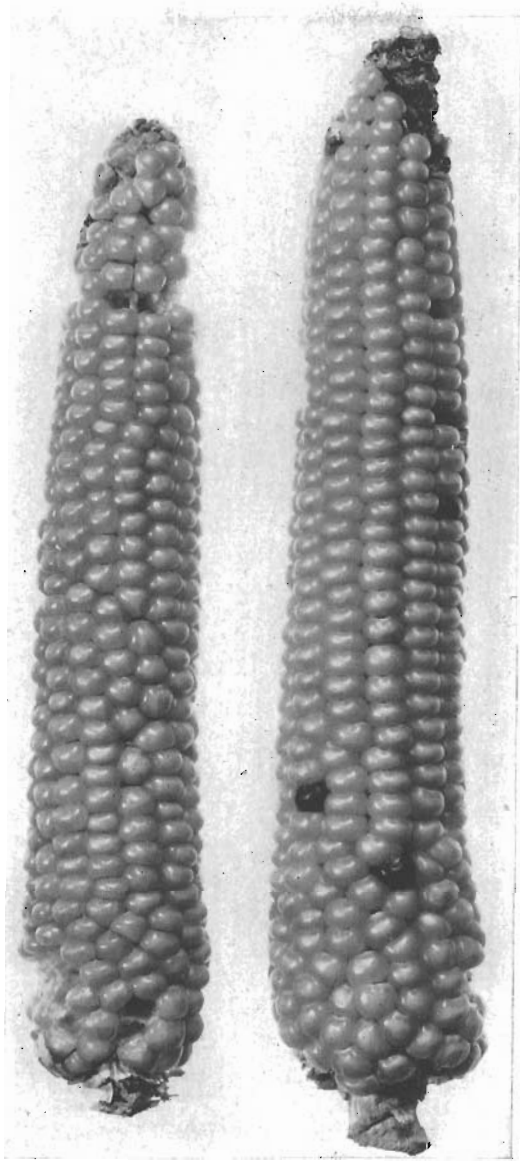


Fig. 57. Olotón. (Guat. 902, Huehuetenango, 7500 feet). This race is the Guatemalan counterpart of the Colombian race, Montaña (cf. Roberts *et al*, 1957, Fig. 41). Since Montaña had its origin in southern Colombia, Olotón is almost certainly an introduction into Guatemala from South America.

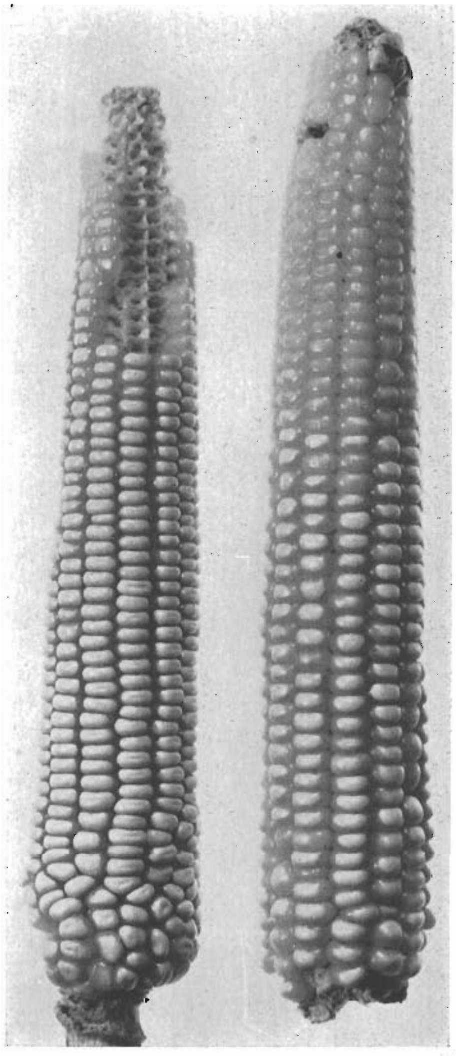


FIG. 58. Olotón. (Guat. 477, Guatemala, 6000 feet). Some collections of Olotón approach the giant Mexican race Jala in size and shape of the ears. (See Fig. 65, Wellhausen *et al*, 1952). Olotón is almost certainly one of the ancestors of Jala.

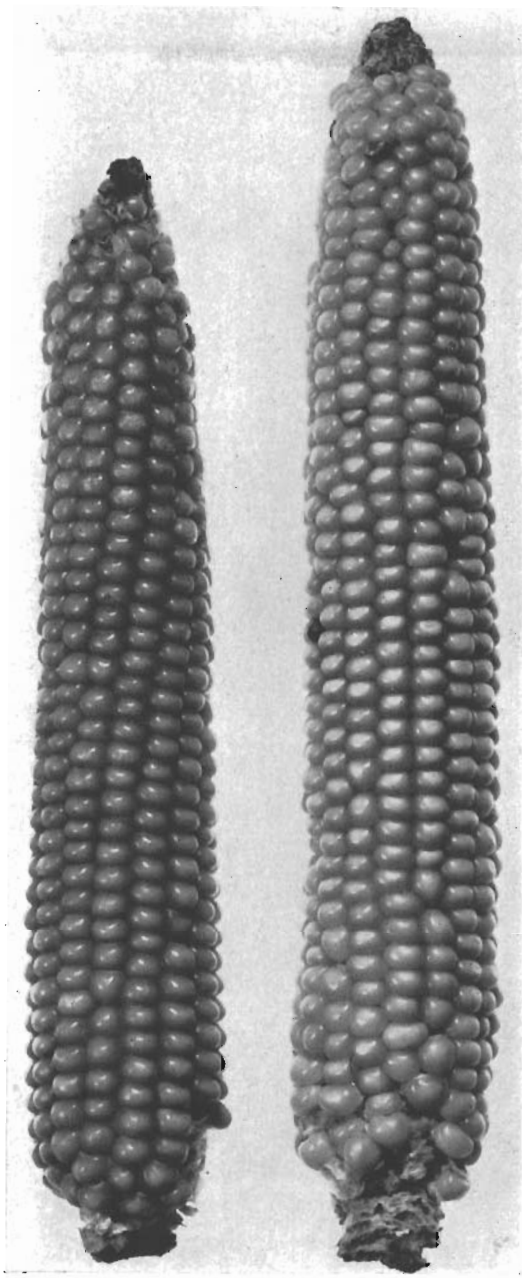


Fig. 59. Olotón. (Guat. 680, Baja Verapaz, 5350 feet). No other race in Guatemala is so widely distributed at intermediate altitudes as Olotón. It is grown at altitudes of 4000-8100 feet.

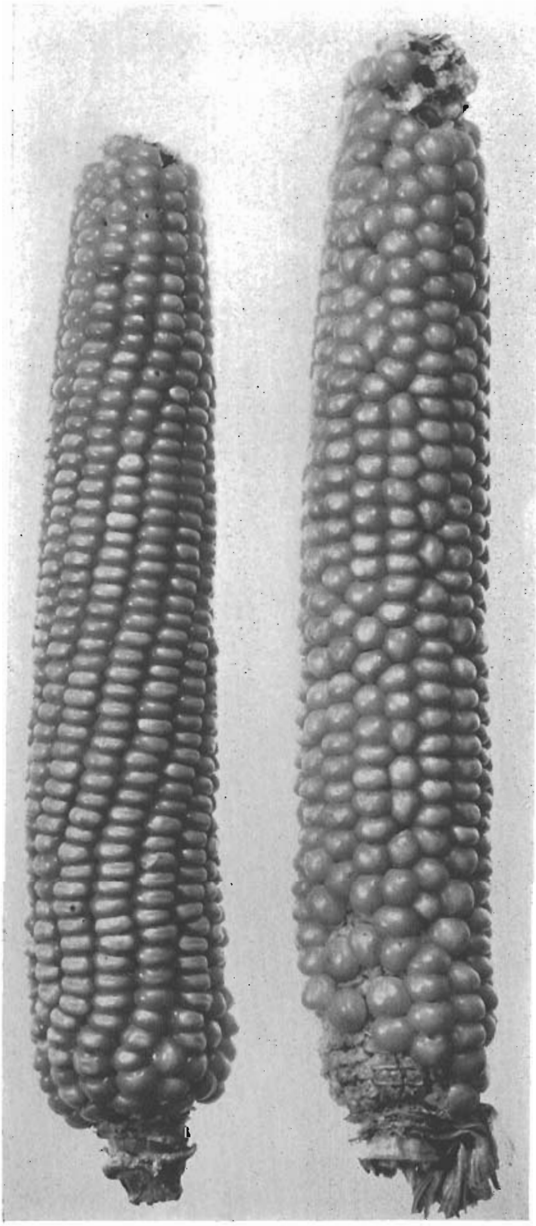


Fig. 60. Olotón. (Guat. 27, Baja Verapaz, 4000 feet). The race has a wide range of adaptation. The ears of this collection from 4000 feet do not differ appreciably from the ears in Fig. 57, collected at 7500 feet.

mm., usually dorsally rounded, seldom strongly dented; endosperm color yellow, orange yellow or white; midcob color present in approximately half of the cobs studied; glumes often prominent, usually indurated. Ears of Olotón considerably longer than those described here have been collected from Alta Verapaz (Fig. 65) and Baja Verapaz. Grown on fertile soils, the ears of this race have reached a length of more than 50 cm.

Distribution (Fig. 61). Olotón is the most widely distributed race at intermediate altitudes in Guatemala. It is grown in eight of the twenty-one departments and its influence on other races is apparent in three additional ones. It is found at altitudes ranging from 4000–8100 feet, the collections studied averaging 5993 feet. Olotón modified by the introgression of other races is shown in Figures 62–67.

Origin and Relationships. Olotón has a close counterpart in the Columbian race Montaña (compare Figs. 57–60 with Fig. 41 in Roberts *et al,* 1957) which, like Olotón, is tall and late and is commonly grown at intermediate altitudes. Roberts *et al* concluded that Montaña is a hybrid of a Colombian high altitude race Sabanero, and a long-eared popcorn with orange endosperm, Pira Naranja, which so far has been collected in Colombia only in the State of Nariño. How Montaña or other Colombian races diffused from South America to Guatemala is still an unsolved mystery. However, Nariño in Colombia, where Montaña presumably originated, is a coastal state, and ocean voyages from the west coast of South America to the west coast of Central America may not have been impossible.

Olotón is one of the parents of Comiteco, which in turn is one of the parents of Jala in Mexico. The largest ears of Olotón are themselves as large as the average ear of Jala.

COMITECO

Plants. Maturity late, average number of days to first flowering 119; tall, average height 306 cm.; average number of leaves 18.3, average length 115 cm., average width 9.9 cm., average number of veins 28; color intermediate, pubescence none to medium.

Ears (Figs. 68–70). Long, average length 20.1 cm.; diameter

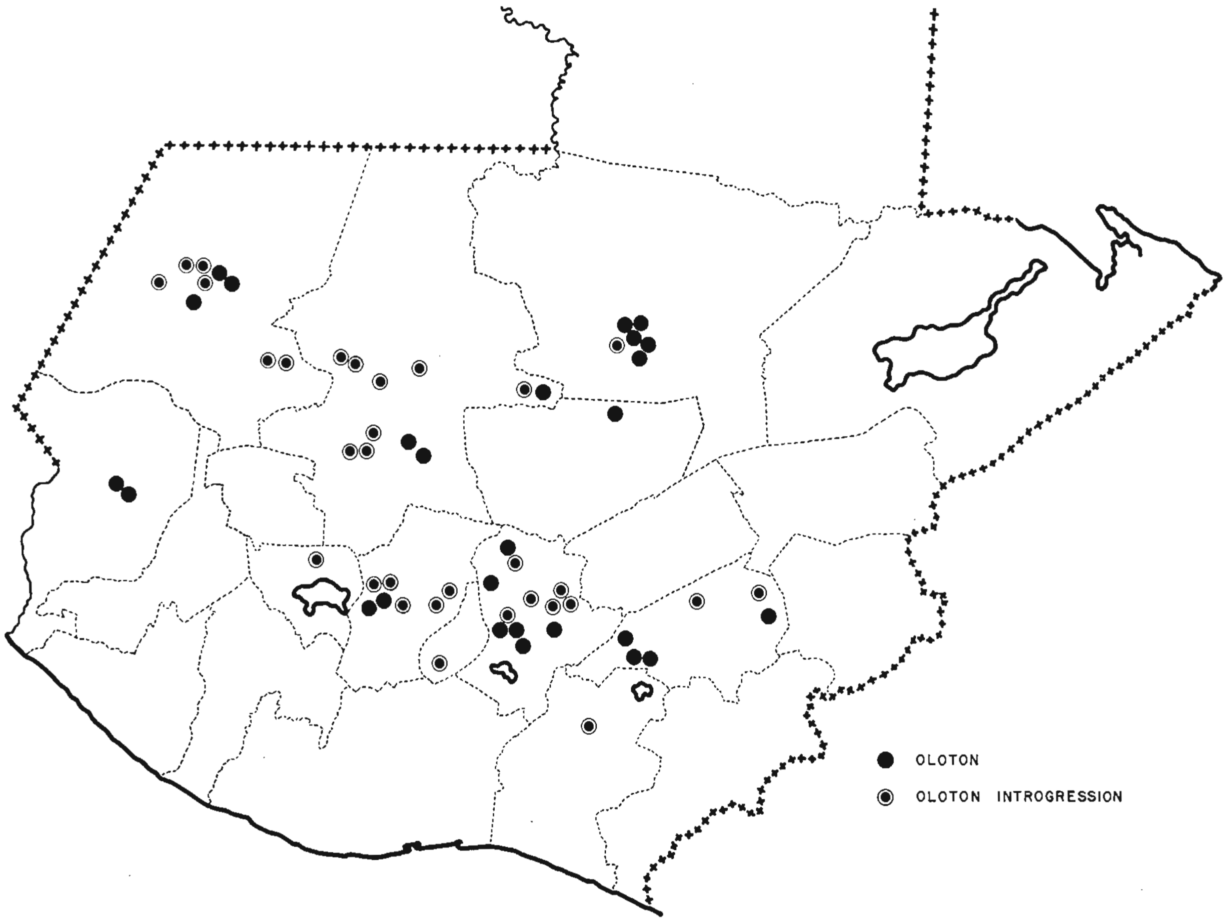


Fig. 61. The distribution of Olotón and Olotón introgression in Guatemala.

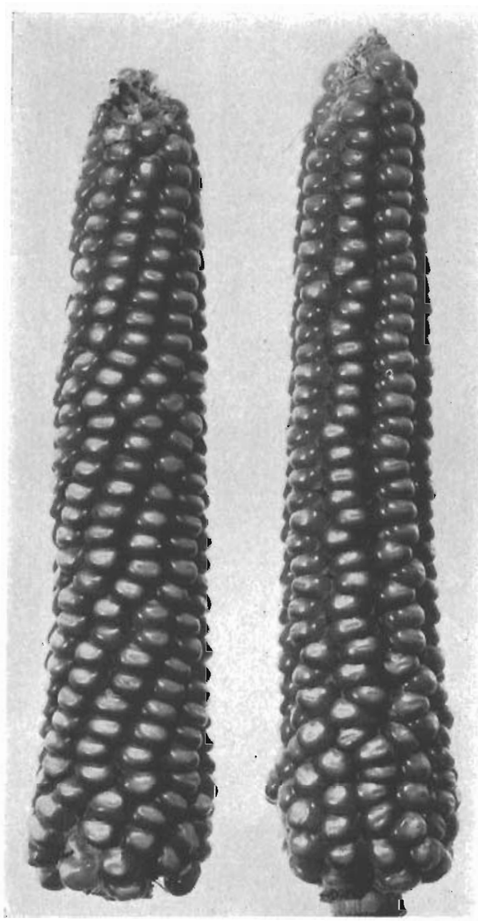


Fig. 62. Olotón modified by the introgression of San Marceño. (Guat. 390, Quetzaltenango, 7500 feet). The low row number of the ear on the right and the pericarp color in both ears suggest admixture of Olotón with San Marceño.

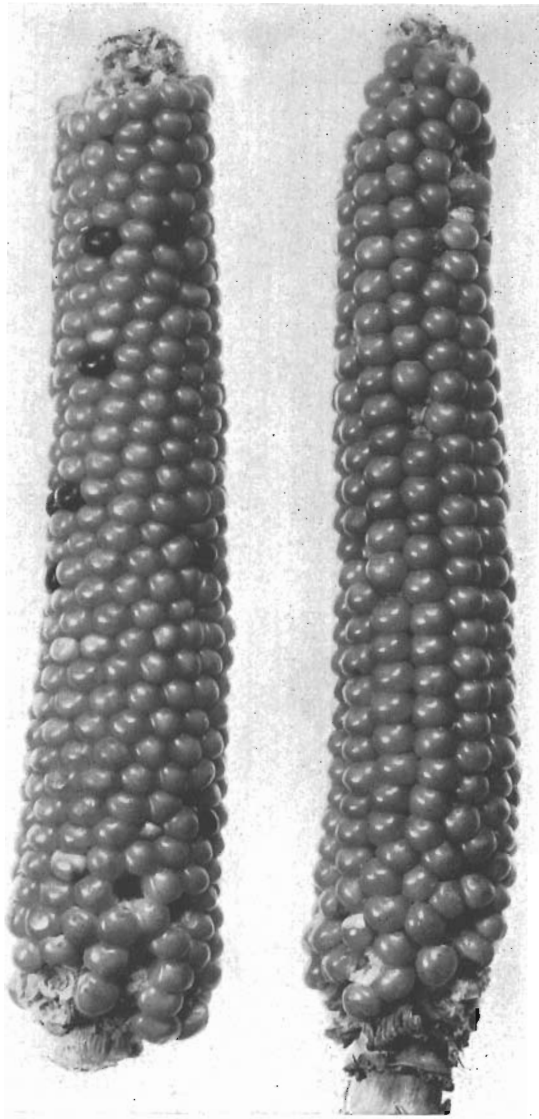


FIG. 63. Olotón modified by introgression from Quicheño. (Guat. 443, Huehuetenango, 7700 feet). The influence of Quicheño in these ears is apparent in the almost spherical kernels and the slightly twisted rows.

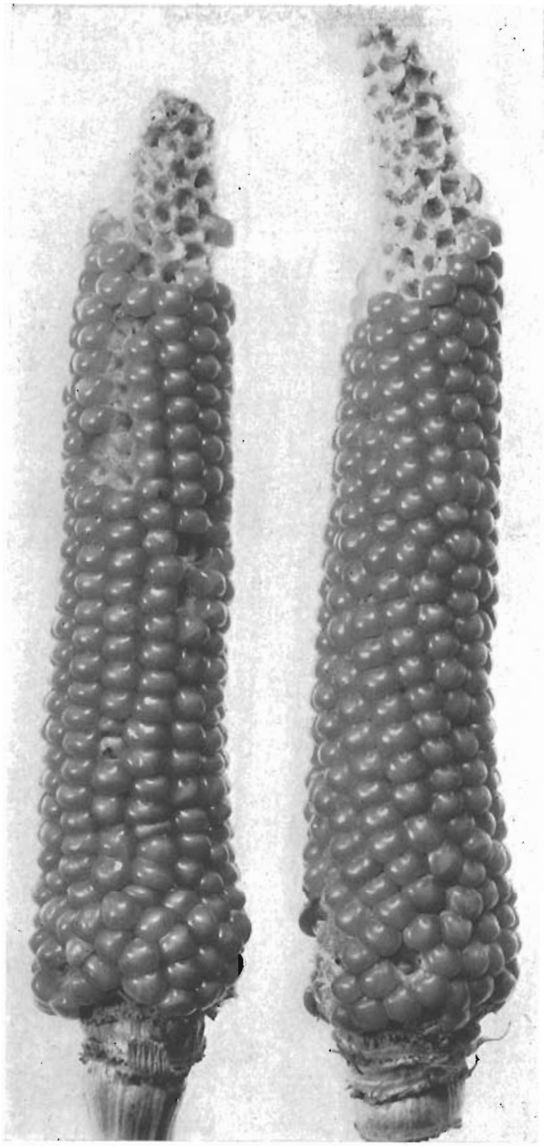


FIG. 64. Olotón modified by introgression from Quicheño. (Guat. 896, Huehuetenango, 7700 feet). Olotón, because it is widely grown, has crossed with many other Guatemalan races.

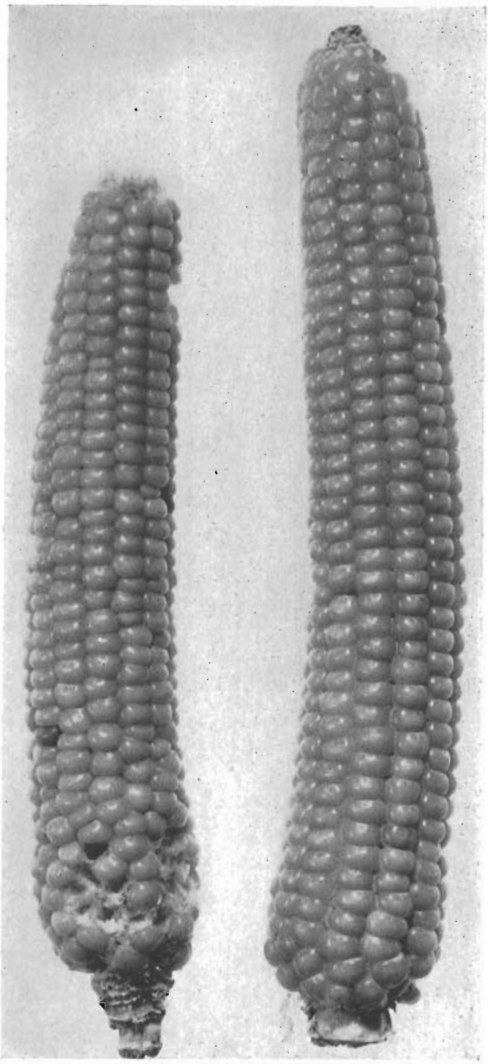


FIG. 65. An early variety of Olotón from Alta Verapaz, (5000 feet). Both early and late varieties of Olotón can be found in Alta Verapaz and Baja Verapaz, where they are commonly called "Canjal." The ears are generally long and slender, sometimes reaching a length of 50 cm. in the late varieties.

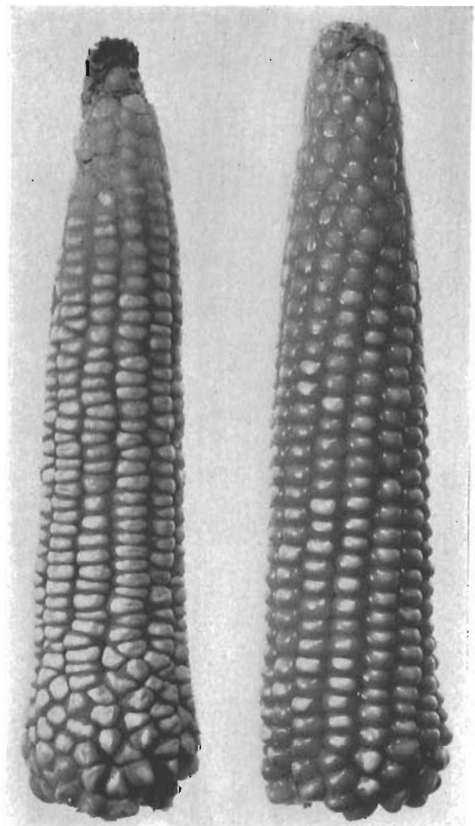


FIG. 66. Olotón modified by admixture with Nal-Tel. (Guat. 639, Guatemala, 5500 feet). These ears represent one of the types which have resulted from the crossing of Olotón and Nal-Tel.

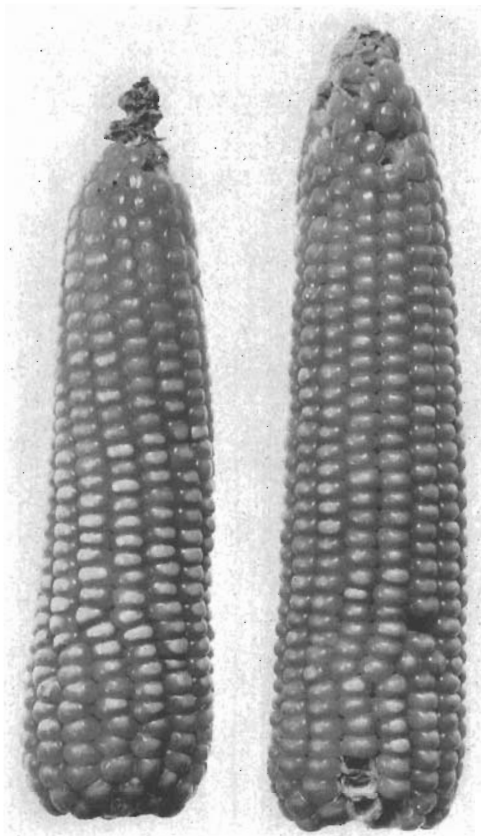


FIG. 67. Olotón modified by the introgression of Nal-Tel and probably Comiteco. (Guat. 542, Guatemala, 4850 feet). The flinty varieties derived from the intercrossing of Olotón and Nal-Tel are quite numerous in the Departments of Jalapa, Jutiapa and Guatemala and probably constitute a sub-race of Olotón or Comiteco. Certain varieties are almost as early as Nal-Tel in maturity.

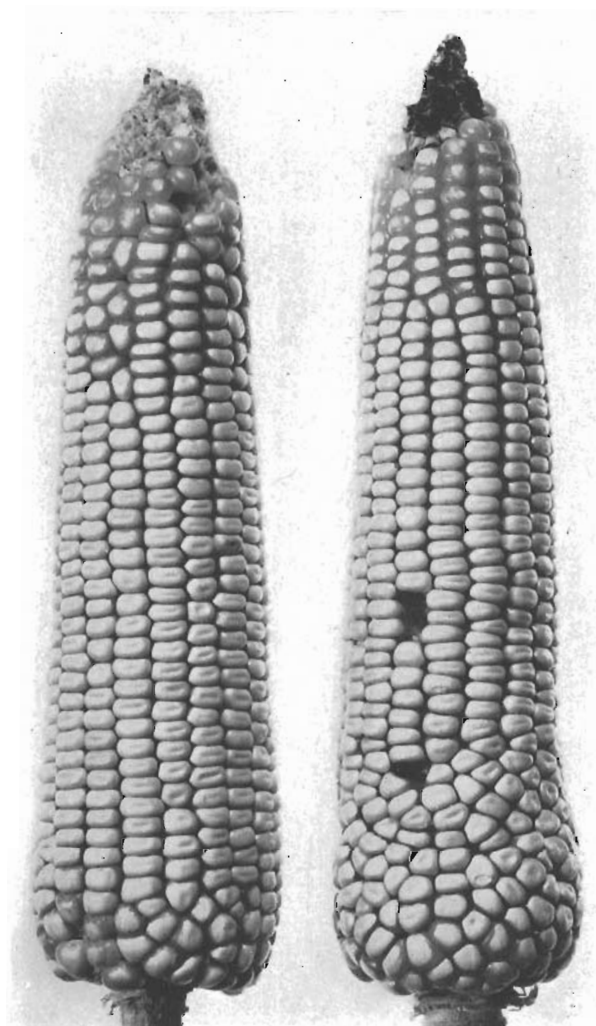


FIG. 68. Comiteco. (Guat. 367, Guatemala, 6000 feet). This race is a hybrid of Olotón with a thick-eared dent corn adapted to low altitudes. Such a race, Tehua, is found in Mexico but is not included in our Guatemalan collections. Ears of Tehua are illustrated in Fig. 52 of Wellhausen *et al* (1952).

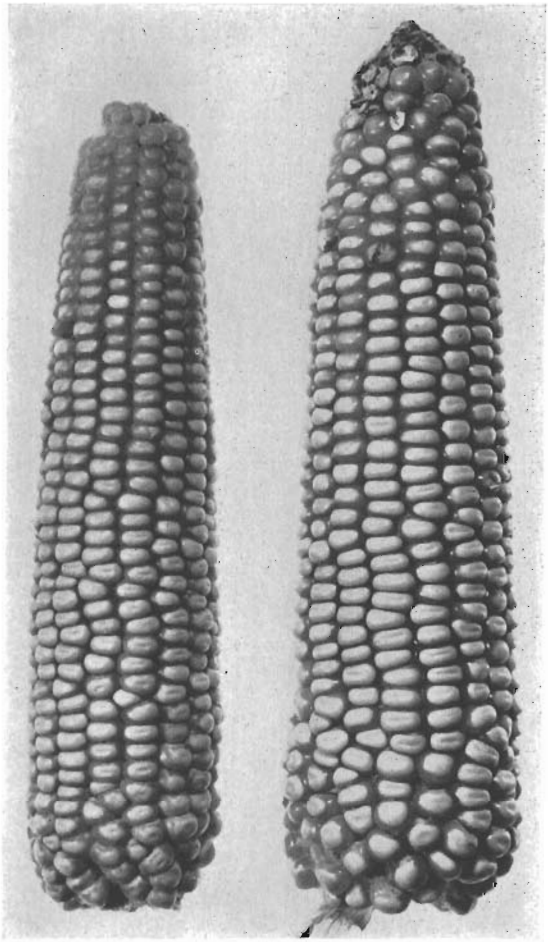


FIG. 69. Comiteco. (Guat. 567, Chimaltenango, 6900 feet). Many collections of Comiteco are characterized by conspicuous white-capping of the kernels. The inheritance of this character is reported to be complex.

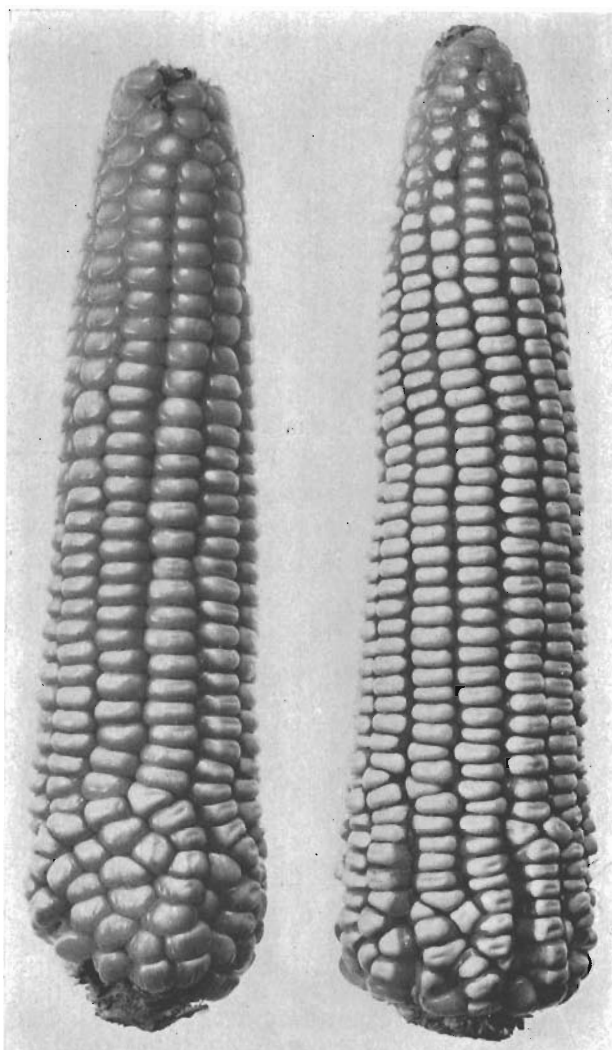


FIG. 70. Comiteco. (Guat. 880, Guatemala, 4700 feet). The majority of collections of Comiteco are yellow-seeded. The white-seeded form illustrated here is less common.

large, average 4.9 cm., shape strongly tapering, average shank diameter 18.4 mm., the largest of any race except Salpor; average number of rows, 13.1, range 10–16; kernels medium in size, average width 10.2 mm., average thickness 5.1 mm., average length 11.5 mm., usually dorsally a little rounded, usually dented; color of endosperm white or yellow with white cap.

Distribution (Fig. 71). Relatively pure collections of Comiteco were made from the Departments of Huehuetenango, Alta Verapaz, Chimaltenango and Guatemala, at altitudes ranging from 4500–6650 feet. Introgression of Comiteco into other races is evident in these departments and also in El Quiché, San Marcos, Retalhuleu, Suchitepéquez, Sacatepéquez, Sololá, Escuintla, Santa Rosa, Jalapa and Jutiapa. The influence of this race is obviously widespread in Guatemala and is also recognized in Mexico.

Origin and Relationships. Wellhausen *et al* (1952) postulated that Comiteco is a hybrid of Olotón and Tehua, the latter a race with massive cobs. We see no reason to question this hypothesis. However, since Comiteco is more common in Guatemala than in Mexico, it may be that it has had its origin in the former country. The conclusion of Wellhausen *et al* that Comiteco is one of the parents of Jala, the giant maize of the Jala valley of Mexico, appears still to be valid.

DZIT-BACAL

Plants. Early to medium in maturity, average number of days to first flowering 98; short to medium height, average 170 cm., average number of leaves 14.3, average length 91 cm., average width 9.5 cm., average number of veins 23.3; little plant color; slight pubescence.

Ears (Figs. 72–74). Medium long, 17.2 cm., slender, average diameter 3.8 cm., tapering, often flexible; slender shank, number of rows 8–10, average 9.2; grains medium in size, average width 10.2 mm., average thickness 4.3 mm., average length 10.8 mm., usually dented; endosperm semi-hard, white; some midcob color.

Distribution (Fig. 75). This race is found in relatively pure form in the Departments of Jutiapa, Jalapa and El Progreso, at altitudes of 2000–3500 feet. Introgression of Dzit-Bacal is found

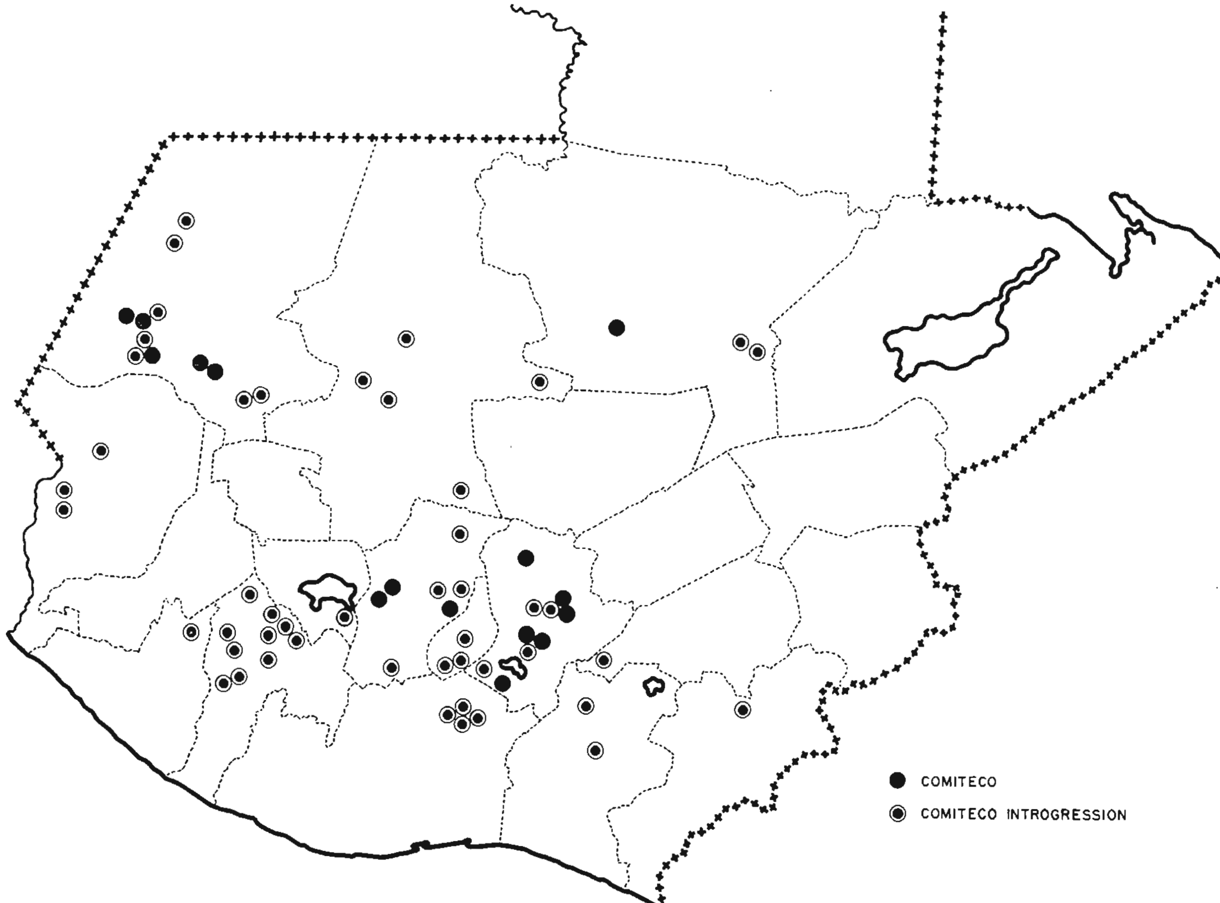


Fig. 71. The distribution of Comiteco and Comiteco introgression in Guatemala.

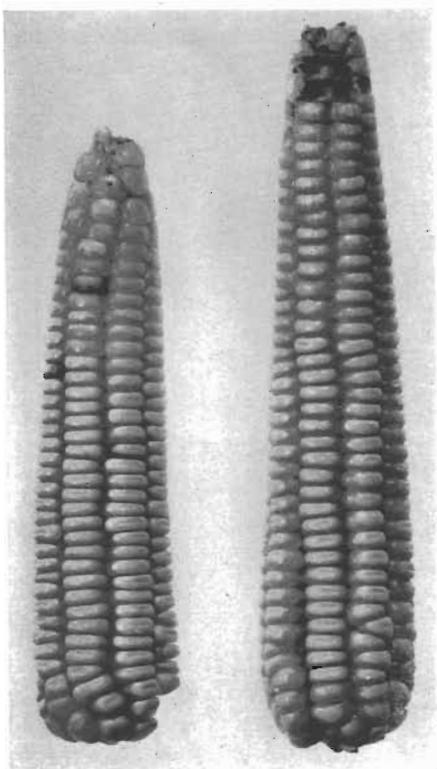


FIG. 72. Dzit-Bacal. (Guat. 322, Jalapa, 3500 feet). This race, with a name of Mayan origin, is probably a hybrid of Nal-Tel and a slender-eared maize similar to Clavillo of Costa Rica and Clavo of Colombia.

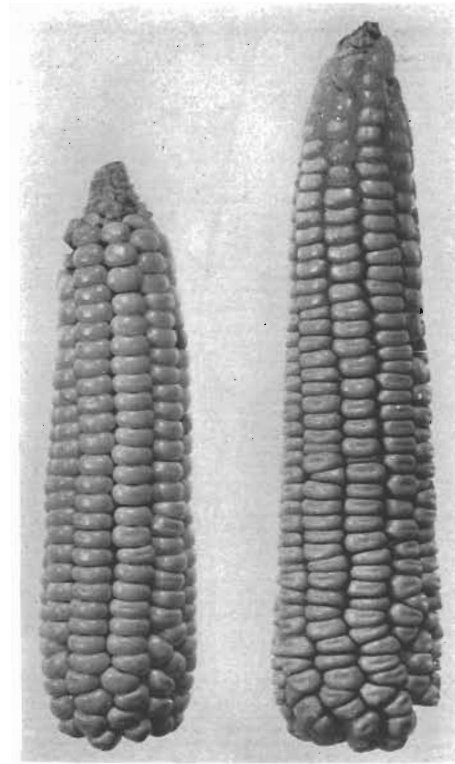


FIG. 73. Dzit-Bacal. (Guat. 134, Jutiapa, 3200 feet). The kernels of some ears of Dzit-Bacal are quite soft. The ear on the left is almost floury.

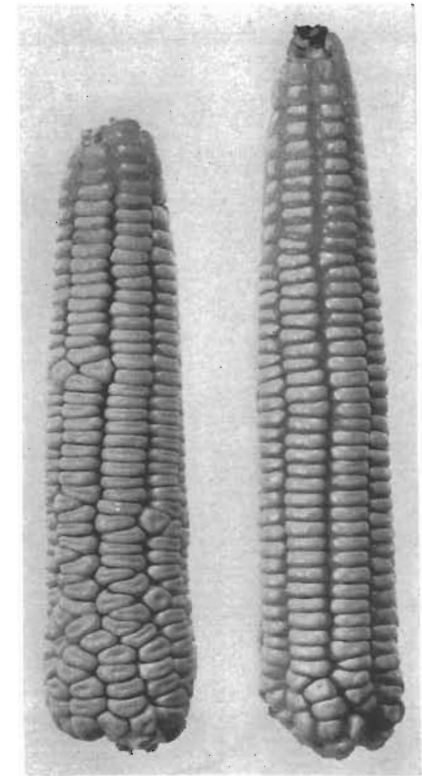


FIG. 74. Dzit-Bacal. (Guat. 130, Jutiapa, 2000 feet). Relatively pure collections of this race are found in the Departments of Jutiapa, Jalapa and El Progreso at altitudes of 2000-3500 feet. The race is also common in Yucatán and Campeche in Mexico.

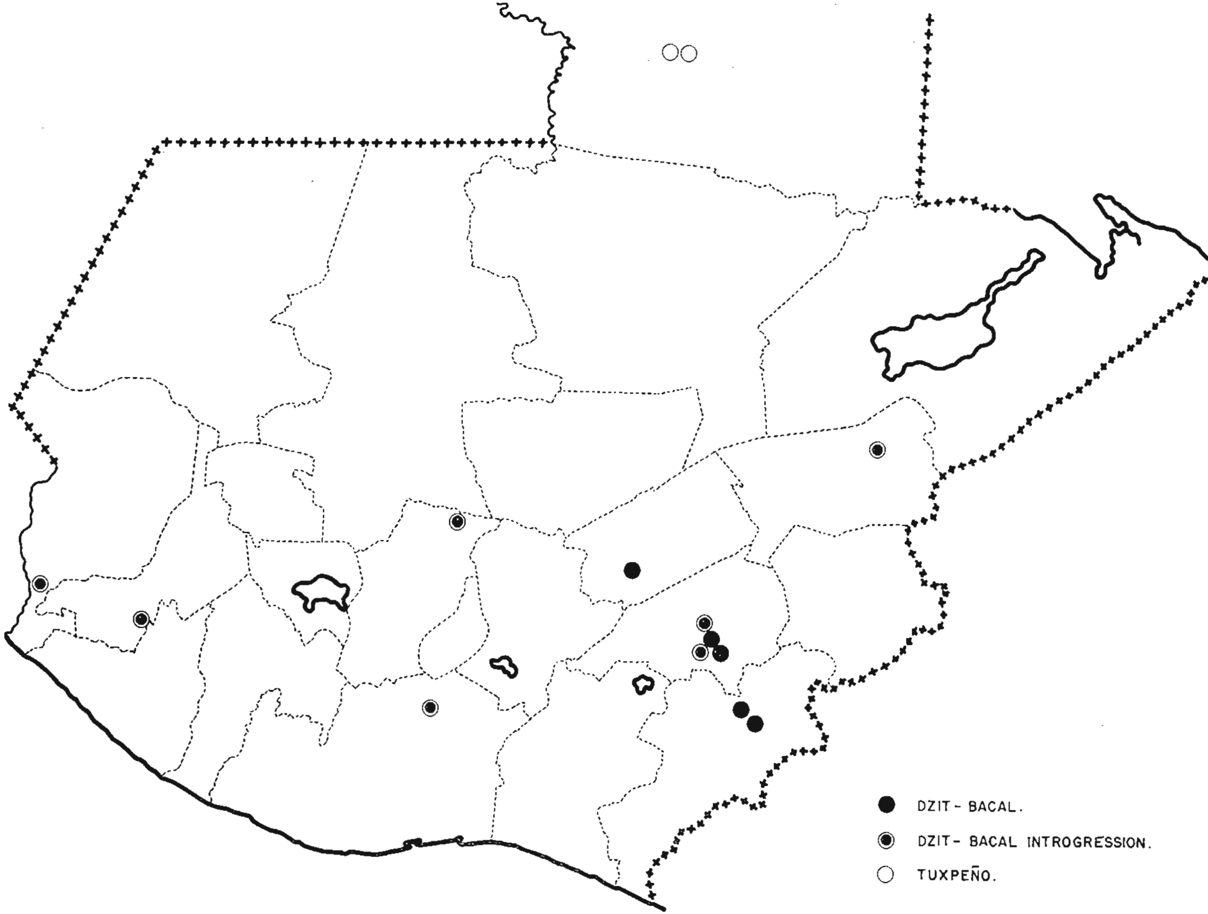


FIG. 75. The distribution of Dzit-Bacal, Dzit-Bacal introgression and Tuxpeño in Guatemala.

also in Zacapa, Chimaltenango, Escuintla, San Marcos and Quetzaltenango. In Mexico, Dzit-Bacal is the principal race in Yucatán and Campeche.

Origin and Relationships. Wellhausen *et al* (1952) concluded that the Dzit-Bacal of Mexico is a sub-race of Olotillo formed by the introgression of Nal-Tel into Olotillo or by the hybridization of Nal-Tel with the precursor of Olotillo. This conclusion may now require modification in two respects: the Nal-Tel parent of Dzit-Bacal was probably the white-seeded form of Guatemala instead of the yellow-seeded form of Mexico. The other parent, a flexible-cobbed race, was probably similar to the Clavo of Colombia, which has a counterpart in the Clavillo of Costa Rica.

Dzit-Bacal has undergone some introgression with teosinte. This may have occurred in Guatemala, since teosinte is known in both Jutiapa and El Progreso where Dzit-Bacal is grown.

TEPECINTLE

Plants. Late, 117 days to first flowering at Chapingo; medium height, average 170 cm.; average number of leaves 16.4, average length 86 cm., average width 10.1 cm., average number of veins 27.2; plant color when present usually dilute purple.

Ears (Figs. 76–79). Medium to long, thick, average length 18.4 cm., average diameter 4.7 cm.; cylindrical, rounded at base, the tips invariably barren; shank medium, average diameter 14.6 mm.; number of rows 12–16, average 14; grains medium to large, average length 10.6 mm., width 9.1 mm., thickness 4.5 mm., slightly to strongly dented; endosperm white, soft to semi-hard, lemmas of the cob usually white, the glumes often purple.

Distribution (Fig. 80). Tepecintle has been collected in relatively pure form at altitudes ranging from 500–1400 feet in the Departments of Quetzaltenango, Suchitepéquez and Alta Verapaz. Its influence on other lowland races is obvious in collections from low altitudes in the additional Departments of San Marcos, Retalhuleu, Escuintla, Guatemala, Santa Rosa and Izabal. It has been found in the States of Chiapas and Oaxaca in Mexico (Wellhausen *et al* 1952). Ears of Tepecintle, modified by other races or fasciation, are shown in Figures 81–83.

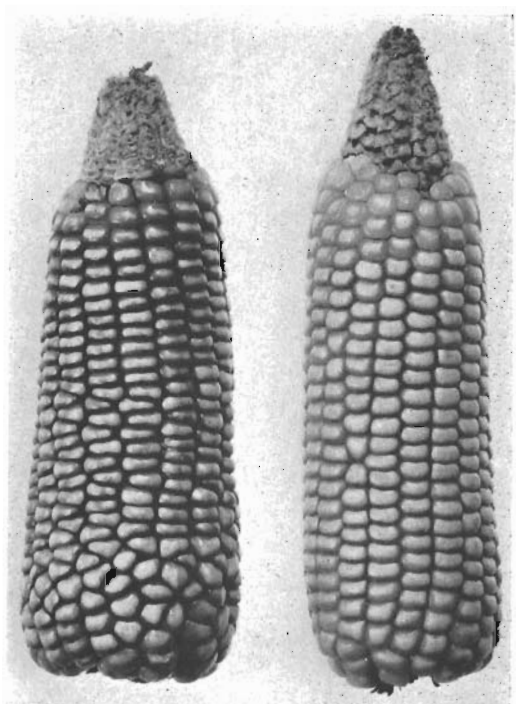


FIG. 76. Tepecintle. (Guat. 79, Suchitepéquez, 950 feet). This race has the highest average chromosome-knob number of any race of maize yet studied. It is believed to be the product of crossing a large-cobbed flour corn with teosinte. Note the barren tips which are usually an indication of teosinte introgression and a high chromosome-knob number.

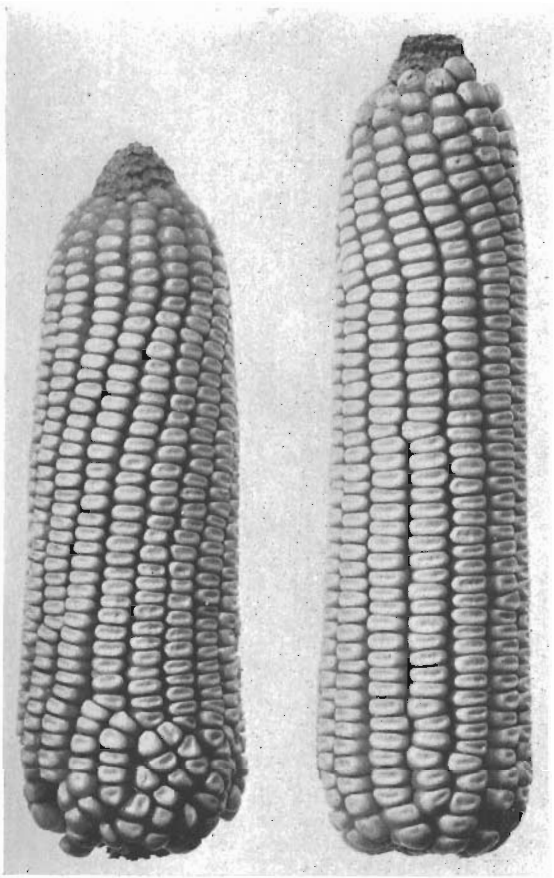


FIG. 77. Tepecintle. (Guat. 456, El Petén, 600 feet). Some collections of Tepecintle resemble the cylindrical dent corns of Mexico, Vandeño and Tuxpeño. Tepecintle is probably the ancestor of both of these races.

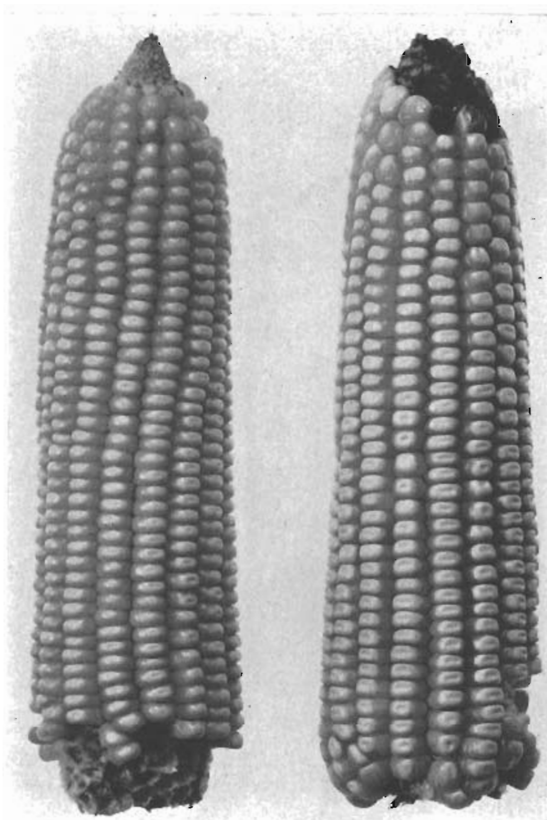


FIG. 78. Tepecintle. (Guat. 460, El Petén, 100 feet). The kernels of most ears of Tepecintle are semi-hard and slightly dented. Some collections, such as the one illustrated above, have more flinty kernels.

Origin and Relationships. Wellhausen *et al* (1952) concluded that Tepecintle is the progeny of teosinte introgression into a large-eared Guatemalan flour corn, and such an ancestry would, in fact, account for its characteristics. A difficulty involved in this conclusion is that the large-eared flour corns of Guatemala occur at much higher altitudes than the range of Tepecintle or even of its other putative ancestor, teosinte. There is no doubt,

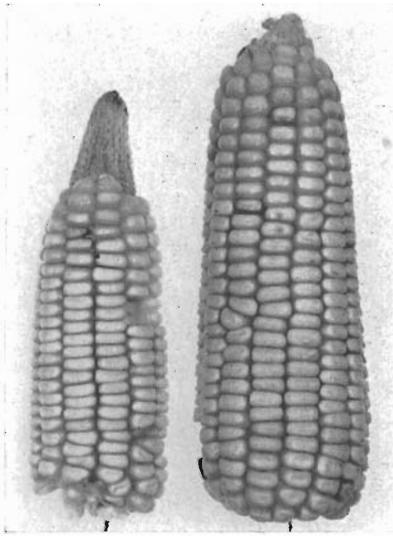


FIG. 79. Tepecintle with high chromosome-knob numbers. (McBryde Collection Nos. 165 and 197, San Luis Jilotepeque, Jalapa and Camotán, Chiquimula). Plants grown from these ears had sixteen chromosome knobs and these included three-fourths of all knob positions (twenty-one) which are known to occur in the maize of this hemisphere.

however, that Tepecintle is one of the most Tripsacoid of the Guatemalan–Mexican races, not only in its external characteristics, but also in chromosome-knob numbers. The highest knob number in Guatemalan maize, 16, reported by Mangelsdorf and Cameron (1942), occurred in this race.

In Mexico, Tepecintle was the ancestor of a number of races, including Zapalote Chico, Zapalote Grande, Tuxpeño, Vandeño, Chalqueño, Celaya, Cónico Norteño and Bolita. Through Tuxpeño it may be the ancestor of the Corn-Belt Dent of the United States.

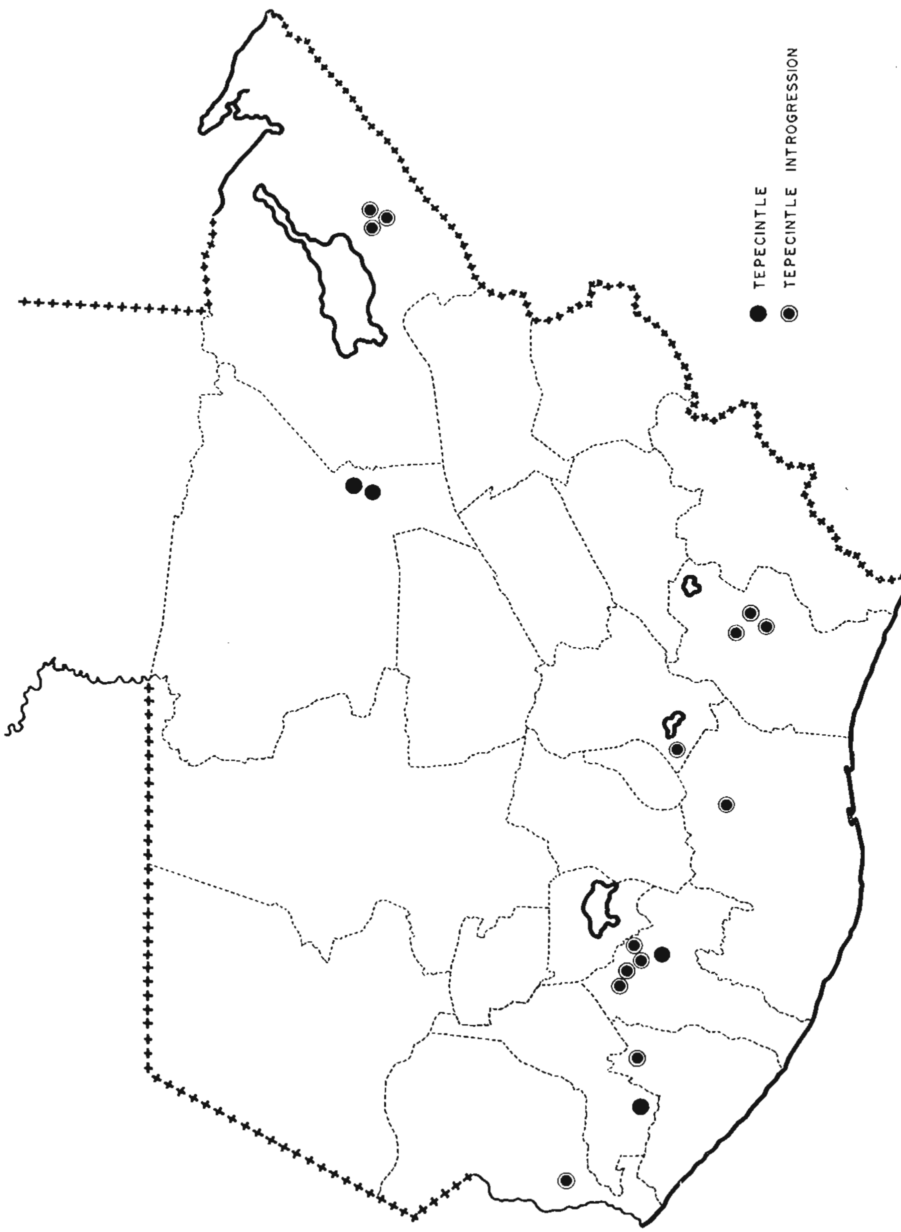


Fig. 80. The distribution of Tepecintle and Tepecintle introgression in Guatemala.

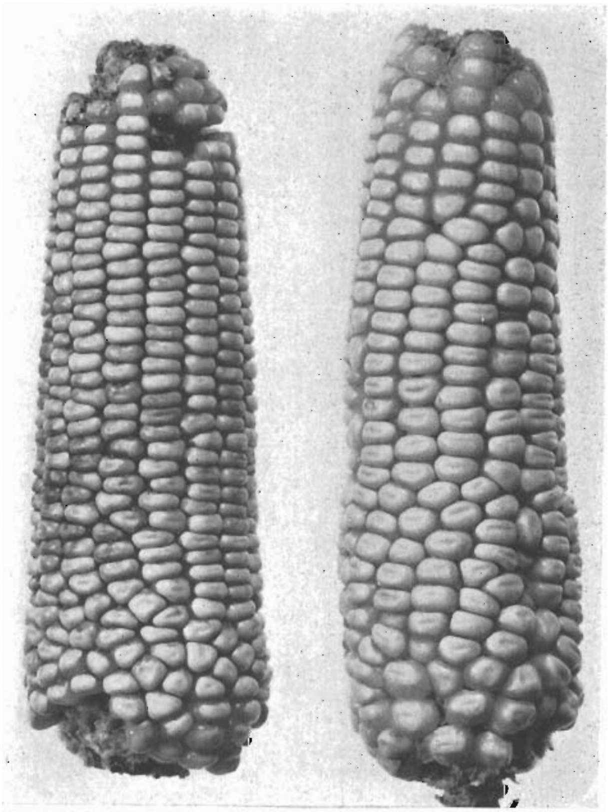


FIG. 81. Tepecintle modified by the introgression of Olotón. (Guat. 779, Sacatepéquez, 5100 feet). The ranges of Tepecintle and Olotón do not ordinarily overlap, but this collection represents Tepecintle which has been mixed with a higher altitude maize, probably Olotón

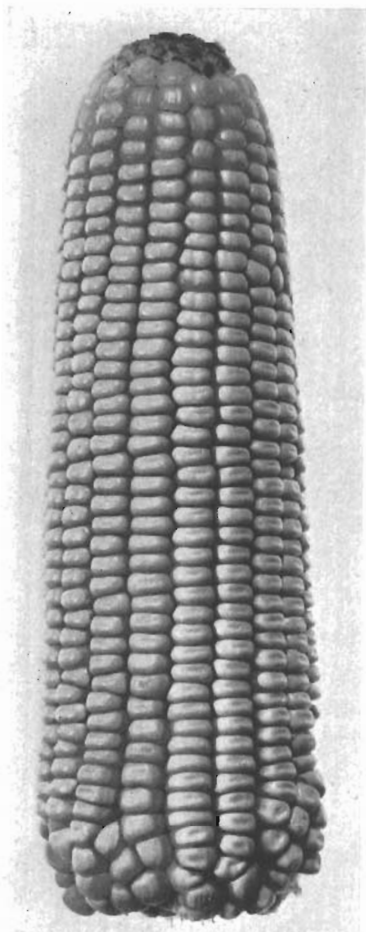


FIG. 82. Tepecintle modified by fasciation. (Guat. 153, Suchitepéquez, 2600 feet). This ear is the nearest approach to the Mexican race Tehua which has been collected in Guatemala. Compare with Fig. 52, Wellhausen *et al* (1952).

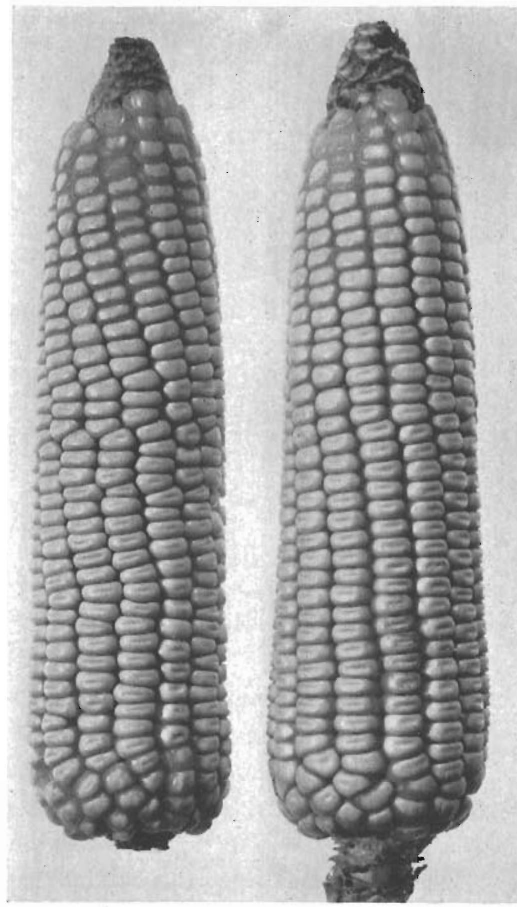


FIG. 83. Tepecintle modified by the introgression of Nal-Tel. (Guat. 155, Suchitepéquez, 2200 feet). Collections which appear to represent mixtures of Tepecintle and Nal-Tel are common. Some of the ears resulting from this crossing are quite similar to those of the race Salvadoreño which probably originated from this hybridzation.

Tuxpeño or something quite similar to it has entered into the ancestry of the lowland white dents of the Pacific coast of the countries of Central America. The race Salvadoreño is the principal representative of this complex.

TUXPEÑO

Plants. Late in maturity, 125 days to first flowering at Chapingo; medium height, average 205 cm.; average number of leaves 18.5, average length 113 cm., average width 12.5 cm., average number of veins 32; plant color none to medium, pubescence rare.

Ears. Medium length and diameter, 17.8 cm. and 4.9 cm. respectively; shape cylindrical, with rounded base, tip usually barren, shank medium to thick; grains of medium size, 9.3 mm. wide, 4.2 mm. thick, 12.6 mm. long, soft or semi-hard, dented; endosperm white with white cap; midcob color sometimes present.

Distribution (Fig. 75). Tuxpeño is not common in Guatemala. Only two collections of this race have been made, both from El Petén. The fact that it is rare in Guatemala but common in Mexico, along with evidence from other races, indicates that the movement of races of maize between Guatemala and Mexico has been largely from the former to the latter.

Origin and Relationships. Tuxpeño is almost certainly of Mexican origin, although it has part of its ancestry in Guatemala. Wellhausen *et al* (1952) concluded that Tuxpeño is a hybrid of Olotillo and Tepecintle. The latter, as mentioned above, is believed to be the product of teosinte introgression into a Guatemalan flour corn.

A COMPARISON OF TWO INDEPENDENT COLLECTIONS OF GUATEMALAN MAIZE

The classification and descriptions of the races of maize of Guatemala, set forth in the preceding pages, is based upon the collections made under the joint auspices of the National Research Council and the Rockefeller Foundation in 1952–53. This collection is hereafter referred to as the NRC–RF Collection.

If the classification based on this collection is valid and complete, it should be applicable to other collections of Guatemalan maize. Fortunately this point can be tested, for in 1940–41 Dr. F. W. McBryde, then of the Department of Geography, Ohio State College, made an extensive collection of maize in Guatemala. This collection, hereafter referred to as the McBryde Collection, comprises 318 ears from 38 localities in thirteen departments. The collection, now deposited in the Botanical Museum at Harvard University, was the basis for the studies, mentioned above, of Mangelsdorf and Cameron (1942), who found a great diversity of maize in western Guatemala. These authors did not attempt to classify the ears in this collection in terms of races.

The ears in the McBryde Collection were, for the most part, collected in local markets. Anderson (1947) has pointed out that collections made in the market place may not be at all representative of the maize of the country. Yet his own studies of Guatemalan maize, based on extensive field collections, do not reveal a single type which does not occur in the McBryde Collection. This suggests that the McBryde Collection, if not random, is at least representative.

We have now made a careful study of the ears of the McBryde Collection and have found represented in it all of the races described earlier in this monograph. Also, there is a close agreement between the NRC–RF and the McBryde Collection, with respect to the departments in which the races occur. Finally, the McBryde Collection contains several types not previously described. One of these, illustrated in Figure 16, is thought to represent Nal-Tel modified by teosinte introgression. A second, illustrated in Figure 38, is likewise considered to be the product of teosinte introgression. Both types are characterized by strongly tapering ears. We had recognized such ears earlier in the NRC–RF Collection and at one time had classified a group of these as a race to which the name "Punta" was given. But the individual varieties assigned to this category differed so greatly in their plant characteristics that they could not reasonably be regarded as representing a well-defined race. The ear shape is one which regularly appears in segregates from maize-teosinte hybrids.

CHROMOSOME-KNOB NUMBERS

The fact that the majority of specimens in the McBryde Collection could be assigned to well-defined races has made it possible to use the data of Mangelsdorf and Cameron (1942) to determine the average chromosome-knob numbers for each of the races in Guatemala. The data are presented in Table 4.

TABLE 4. Chromosome-knob Numbers of Guatemalan Races of Maize

		Knob Number	
Race	*Collections*	*Range*	*Average*
Nal-Tel	5	3–9	5.6
Imbricado	6	3–8	6.8
Serrano	4	3–5	4.2
San Marceño	12	3–9	5.8
Quicheño	12	1–7	5.0
Sub-race Rojo	7	4–6	5.0
Sub-race Ramoso	6	3–7	4.3
Sub-race Grueso	4	1–9	5.5
Negro de Chimaltenango	3	4–5	5.0
Sub-race de Tierra Fría	6	3–6	4.8
Sub-race de Tierra Caliente	5	11–14	11.6
Salpor	5	3–6	4.4
Salpor Tardío	1		9.0
Olotón	6	6–11	8.7
Sub-race Canjal	3	9–11	10.3
Comiteco	3		12.0
Tepecintle	10	11–16	13.3
Harinoso de Guatemala	1		7.0
Tehua (Introgression)	1		12.0

The correlation between chromosome-knob number and altitude which Mangelsdorf and Cameron (1942) reported is now explicable in terms of races. The majority of high-altitude races, such as Serrano, San Marceño and Quicheño, have relatively low chromosome-knob numbers. The typically lowland races, such as Comiteco and Tepecintle, have high chromosome-knob numbers.

A PRELIMINARY SURVEY OF THE MAIZE OF EL SALVADOR, HONDURAS, COSTA RICA, NICARAGUA AND PANAMA

GEOGRAPHICAL FEATURES

The climatic variation in the countries to the south of Guatemala in Central America is not nearly as great as that found in Guatemala. The climates of El Salvador are similar to the southwestern slopes of Guatemala. The coffee-growing region of southwestern Guatemala continues on into El Salvador. This also applies to the lower coastal plain and Piedmont areas. Maize is grown mainly at the lower elevations.

Honduras is chiefly a country of rolling hills and steep inclines with some wet, humid lowland territory on the Atlantic side. The main part of the country where maize is grown is much like the southeastern valleys, plains and mountains of Guatemala, all lying below the 1500-meter contour.

Nicaragua has some good, gently rolling agricultural land in its southwestern half, where most of the agriculture is located. The Atlantic side of Nicaragua is almost entirely a dense stand of rain forest.

Costa Rica is in large part a volcanic mountainous country. The central highlands are a complex of small plateaus, valleys and steep slopes. Some of the volcanoes run well over 3000 meters in height but most of the agricultural land is under 1500 meters. Coffee is grown on the mountain slopes in the central and southwestern part of the country. The lowlands on the Atlantic side are very humid and heavily forested. The lowlands on the Pacific side are less humid, with a short dry period in August which tends to split the rainy season into two crop-growing periods. Most of the commercial maize is grown along the Pacific coast.

Much of Panamá, like Costa Rica, is traversed by a central mountain range with a narrow strip of lowland plain on either side. Rainfall is heavy, especially on the Caribbean coast. Agriculture is largely confined to the Pacific side and to a few highland valleys where rainfall is somewhat less and the climate more agreeable. The mountain slopes and lowland plains on the Carribean side are densely forested.

RACES OF MAIZE

Our collections of maize from the countries of Central America other than Guatemala are not extensive and our sampling of the maize of these countries is less than complete. Consequently, this survey must be regarded as no more than preliminary. Nevertheless, it is already clear that these countries do not have the rich diversity of maize which is characteristic of Guatemala, which probably has more distinct races of maize than all of the remaining countries of this region combined. This may be due to one or both of two reasons: (1) The region now Guatemala was the center of introduction of exotic races from South America. (2) Because of the nature of the terrain and the people, races of maize in Guatemala had their identities better preserved than in other areas.

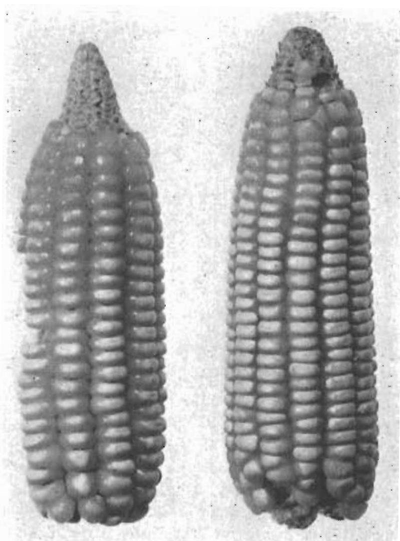
The description of the races or their influences which are recognized in the five remaining countries of Central America follows.

PRIMITIVE RACES

There are no primitive races in pure form among the collections from these five countries but the influence of one such race is apparent. Samples approaching yellow or white Nal-Tel in ear type, earliness and short stature are found in all five countries. One collection, Nicaragua 12, has ears of the Nal-Tel type with colored aleurone, presumably introduced from the Guatemalan Negro de Tierra Caliente. Since all of these collections represent mixtures of Nal-Tel with other races, there is little point in averaging the data on plant and ear characteristics. Typical ears are illustrated in Figures 84–87.

EXOTIC RACES

From Costa Rica come four collections of a slender-eared race resembling the Colombian race Clavo. Since the ears of the Costa Rican race are smaller than those of the Colombian coun-



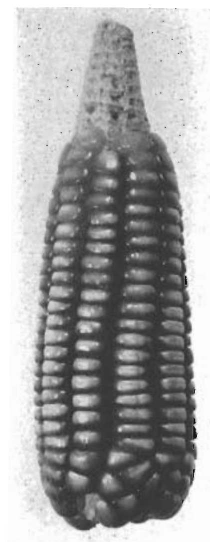
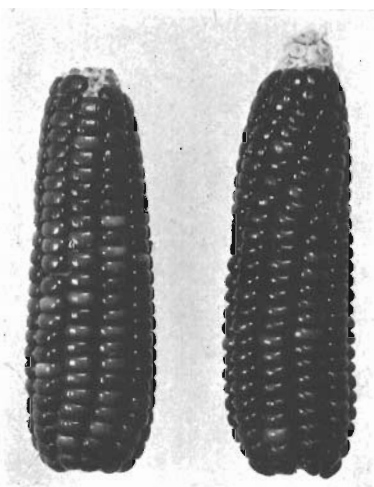


FIG. 84. White Nal-Tel from El Salvador. (Salv. 9, Villa El Carmen, 840 feet): In the other countries of Central America, as in Guatemala, the primitive race Nal-Tel was once widely distributed. Practically all present-day collections show admixture with other races.

FIG. 85. Yellow Nal-Tel from El Salvador. (Salv. 29, Canton Tlapetate, 150 feet): This collection is badly mixed but still shows the influence of the original race.



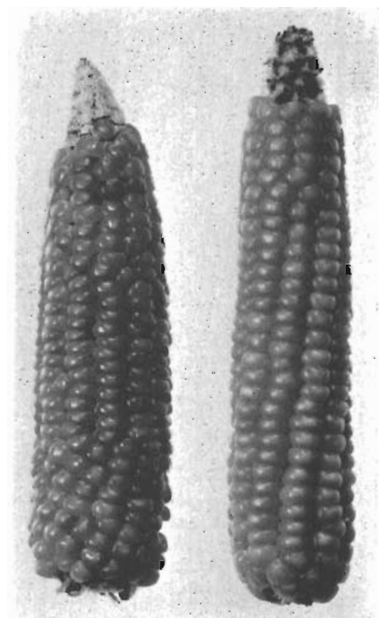


Fig. 86. Red Nal-Tel from Nicaragua. (Nic. 12) This collection represents the introgression of aleurone color from the Guatemalan Negro into Nal-Tel. Except for aleurone color, the ears are similar to typical Nal-Tel.

Fig. 87. Nal-Tel from Panamá (Panamá 18, Los Santos). This small-eared, yellow-seeded flint corn has early maturing plants similar to those of Nal-Tel. It is probably Nal-Tel mixed with other maize.

terpart, the race is designated "Clavillo". A description of the plants of this race follows.

CLAVILLO

Plants. Medium maturity, average number of days to first flowering at Chapingo 102; tall compared to other races from

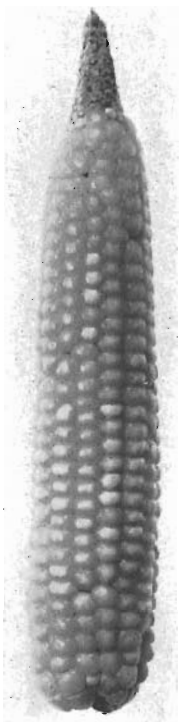


FIG. 88. Clavillo. (Costa Rica 27, Concepción, Atenas, 600 feet). The slender ears of this race resemble those of the Colombian race Clavo. Clavillo is regarded as an ancient introduction from South America.

this region; average height 102 cm.; average number of leaves 18, average length 100 cm., average width 9 cm., average number of veins 27.

Distribution. Clavillo has been collected only in Costa Rica from the following localities: La Francia, Concepcion, Atenas and Santa Cruz, Guanacaste. Its introgression into other races of maize occurs also in Panamá.

Origin and Relationships. Clavillo (Figs. 88 and 89) is the Central American counterpart of the Colombian Clavo (Roberts *et al*, 1957, Fig. 12). In Colombia this race is no longer common, but its introgression into other maize is widespread. In Guatemala, Clavillo or its precursor appears to have had a part in the ancestry of Dzit-Bacal. Clavillo itself has not been collected in Guatemala.

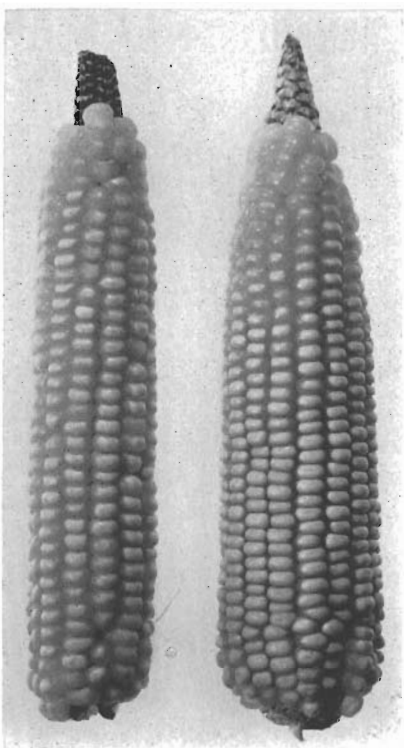


FIG. 89. Clavillo. (Costa Rica 26, Concepción, Atenas, 600 feet). This race has been collected only from Costa Rica but something like it is believed to have existed in Guatemala and to have been the ancestor of Dzit-Bacal.

HYBRID RACES

Since the countries of Central America, except Guatemala, appear never to have had a diversity of ancient indigenous races, or a large number of introduced races from South America, the opportunities for the formation of new races of maize through hybridization have been decidedly restricted. Only one hybrid race, Salvadoreño, is recognized and even this race may have had its origin in Guatemala.

SALVADOREÑO

Plants. Early in maturity, 90 days to first flowering at Chapingo; short, average height 132 cm.; average number of leaves 14, average length 77 cm., average width 8 cm., average number

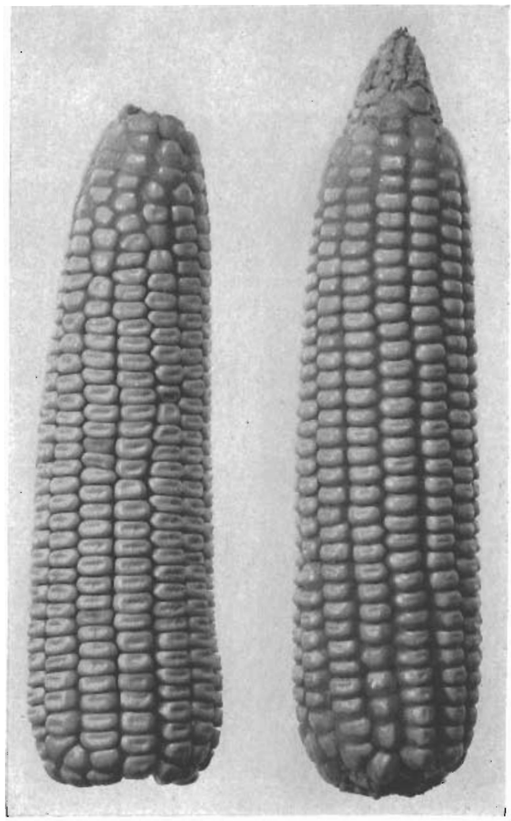


FIG. 90. Salvadoreño. (Salv. 17, Usulután, 40 feet). This race is most common in El Salvador from which it takes its name. It is probably a hybrid race originally from the cross of Tepecintle and Nal-Tel. It may have originated in Guatemala.

of veins 24; plant color when present usually dilute purple, pubescence slight.

Ears (Figs. 90–94). Small to medium, average length 10.3 cm., average diameter 3.6 cm., tapering, barren tips common; shank slender to medium; average number of rows 10; kernels small to

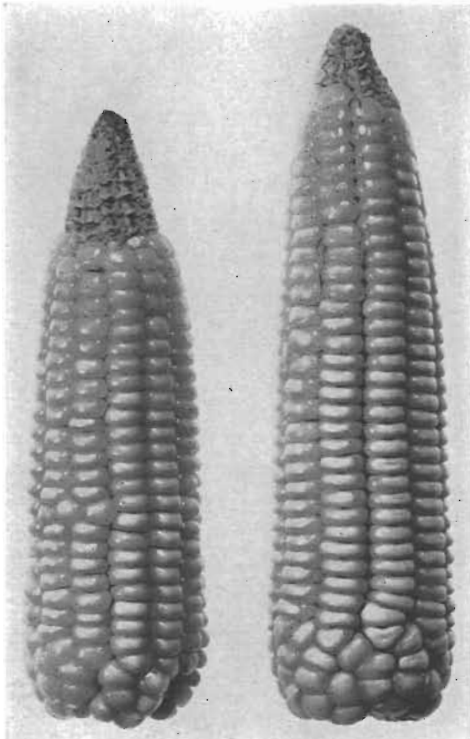


FIG. 91. Salvadoreño. (Salv. 24, Canton El Puene, Quetzaltepeque, 700 feet). The ears of Salvadoreño range from soft dent to near-flint. The above photograph illustrates the latter extreme.

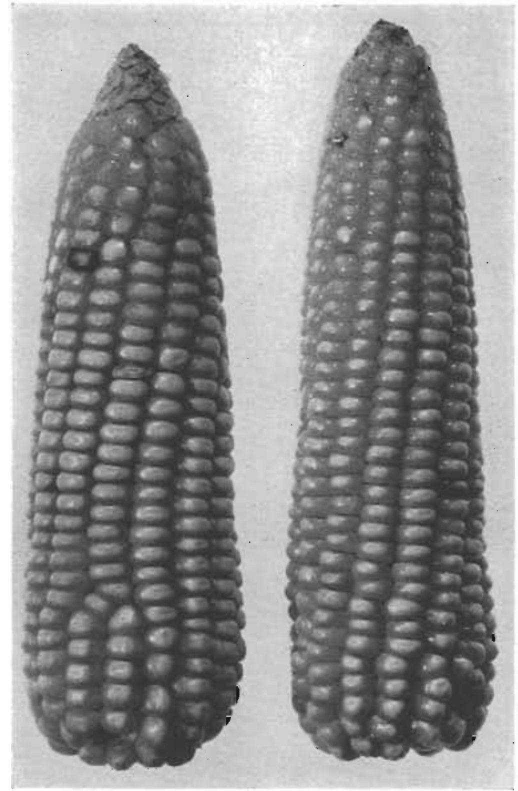


FIG. 92. Salvadoreño. (Hond. 19, Ocotepeque, 810 feet). Collections of this race have been made in El Salvador, Honduras, Costa Rica and Nicaragua.

medium, average length 8.1 mm., average width 8.0 mm., average thickness 5.4 mm., dorsally rounded or flattened, often dented; endosperm soft to semi-hard, white with white cap.

Distribution. Salvadoreño is the principal commercial maize of El Salvador, Honduras, Costa Rica and Nicaragua. It does not appear in the collections from Panamá.

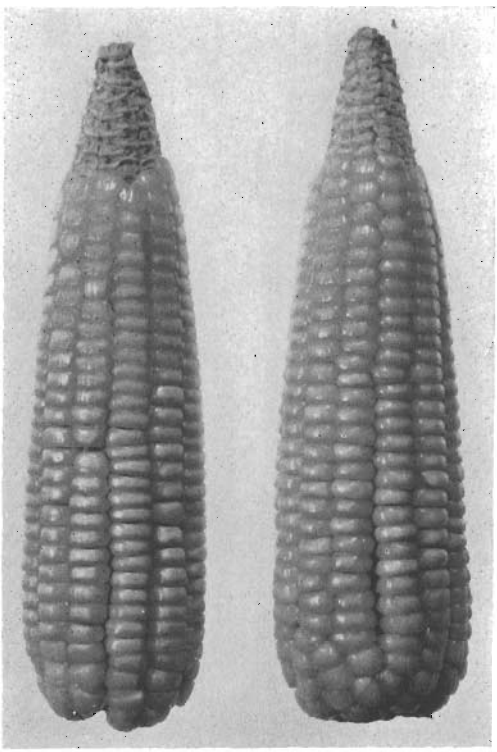


FIG. 93. Salvadoreño from Nicaragua. (Nic. 4, San Patricio, Juicalpa, 150 feet). Ears and plants of Salvadoreño from the several countries of Central America are quite similar. Compare these ears from Nicaragua with those from El Salvador illustrated in Fig. 91.

Origin and Relationships. Salvadoreño may be a hybrid of Tepecintle and Nal-Tel Blanco. Although not intermediate between these two races in the majority of its characteristics, it resembles collections from Guatemala which represent the introgression of Nal-Tel into Tepecintle. Indeed, this race, although most commonly grown in El Salvador, from which it receives its name, may have originated in Guatemala, where the opportunities for the hybridization of Nal-Tel and Tepecintle have been abundant.

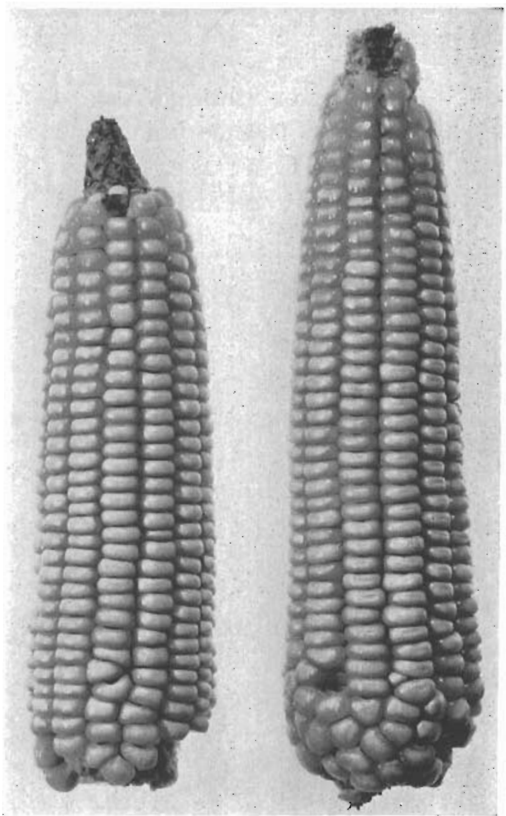


FIG. 94. Salvadoreño from Costa Rica. (Costa Rica 30, Guanacaste, 50 feet). In Costa Rica as in El Salvador, Salvadoreño is the principal race of maize.

INFLUENCE OF OTHER RACES

NEGRO

Two collections of maize from Nicaragua and one from Costa Rica are pure for aleurone color. These appear to be related to the lowland Negro of Guatemala and to represent a further diffusion of the germplasm of the original race, Negro de Chimaltenango. It has already been mentioned that the lowland sub-race of Guatemala is segregating for blue and red aleurone. The "Negro" of Costa Rica and Nicaragua is pure for red aleurone (Fig. 95).

CHOCOCEÑO

One of the most unusual races of maize of this hemisphere is Chococeño of Colombia, which is grown under the most primitive agricultural conditions and without cultivation in the Chocó region of Colombia (Roberts *et al*, 1957). Since the high rainfall

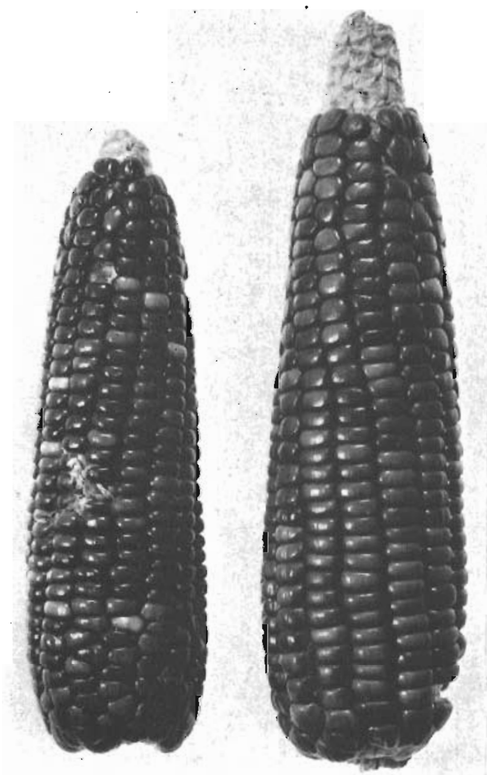


FIG. 95. The influence of Negro. (Costa Rica 24, Guanacaste, 100 feet). The introgression of Negro de Tierra Caliente into Salvadoreño has resulted in ears which are similar to typical Salvadoreño except for their aleurone color and floury endosperm. The color of the aleurone is predominantly red because of the loss of the dominant *Pr* gene.

region of Colombia extends into Panamá, it is not surprising that the same primitive cultural methods and the same kind of maize are reported to occur in that country. The collections from Panamá, although not including any pure Chococeño, do show the influence of this race (Fig. 96).

CARIACO

This Colombian lowland race is not included in our collections but is know to have been collected from southern Panamá by Colombian collectors. The race has been described by Roberts *et al* (1957).

HUESILLO

We have very few collections from Costa Rica, especially from the highlands. Figures 97 and 98 show ears of some of the varieties grown at 1500 meters, near Cartago. Long-eared varieties with a low row number and fairly wide grain, known locally

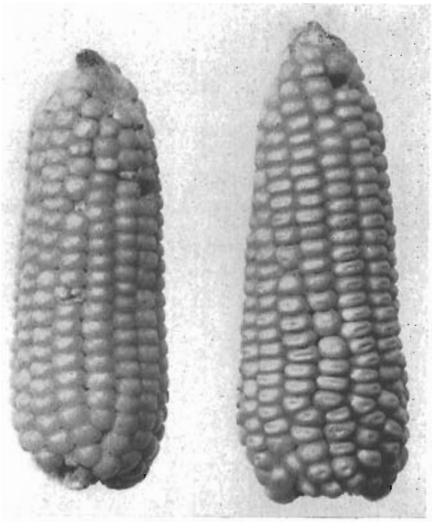


FIG. 96. Chococeño. (Panamá 2, San Juan de Oriente, 60 feet). This peculiar race, which is grown without cultivation in the Chocó of Colombia, extends into Panamá where it is grown under the same primitive agricultural conditions. Compare with Fig. 80 of Roberts *et al*, 1957.

as Huesillo, are common in this vicinity. No data are available on the plants.

CUBAN YELLOW FLINT

Maize resembling the common yellow flint of Cuba (Fig. 99) has been collected from several localities in Central America. Since an improved Venezuelan variety of this type is known to have been distributed in Honduras and Costa Rica, it is assumed that these collections represent recent introductions.

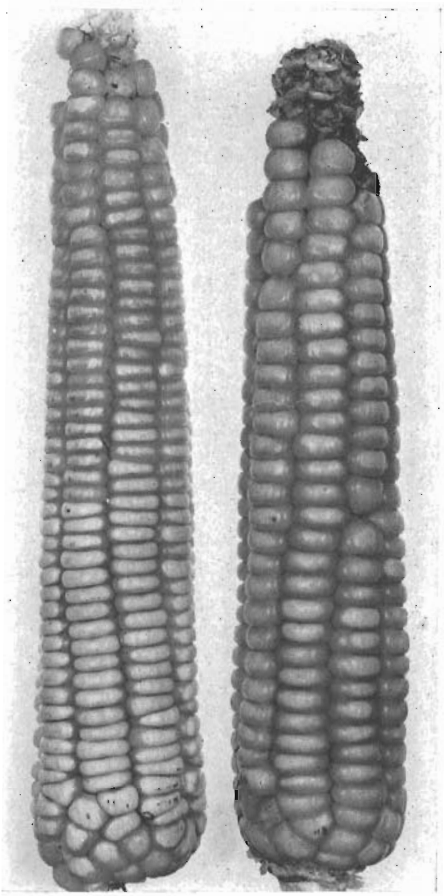


Fig. 97. An eight-rowed, white-capped flint collected near Cartago, Costa Rica, by Sr. Jorge León. The ears of this race show some resemblance to the Tabloncillo of Mexico. No data are available on the characteristics of the plants.

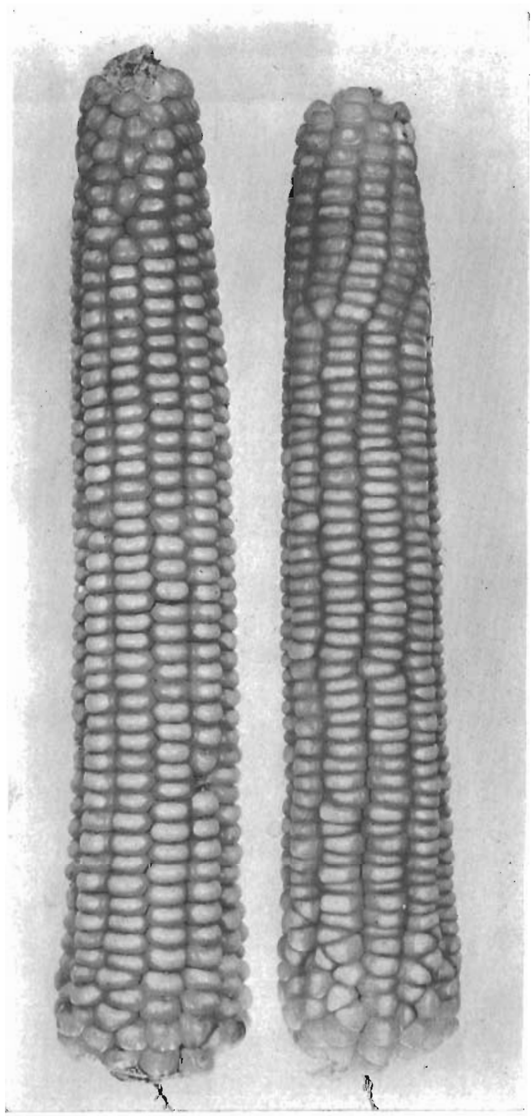


FIG. 98. Apparently related to the maize shown in Fig. 97 is this large-eared, white-capped flint collected by Sr. Modesto Martínez from El Alto, Cartago, Costa Rica, at an altitude of 1500 meters. The local name of this maize is "Huesillo."

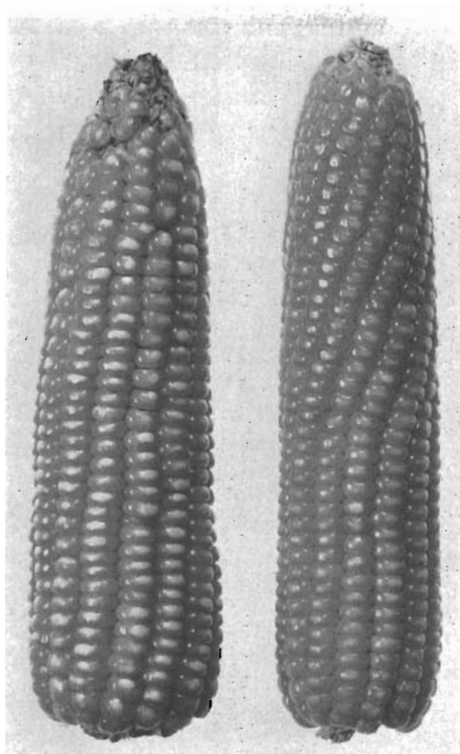


FIG. 99. Cuban Yellow Flint. (Guat. 209, Zacapa, 720 feet). The collections of this race from Guatemala, Honduras, Costa Rica and Nicaragua are believed to represent the recent introduction of an improved variety of this race from Venezuela.

SUMMARY

1. The National Research Council, in cooperation with the Rockefeller Foundation and with representatives of the countries concerned, has assembled 1231 collections of maize from the countries of Central America. The majority of these, 1054 collections, are from Guatemala.
2. Studies of the characteristics of the original ears and of plants grown from them at Chapingo, Mexico, furnished the basis of the classification of the maize of Central America.
3. In Guatemala thirteen distinct races and nine sub-races have been recognized. These include two ancient races of popcorn, four races which were introduced into Guatemala in

prehistoric times and seven races which are believed to have originated through the hybridization between earlier races, and the hybridization of maize and teosinte. Guatemala is thus a center of convergence and divergence of races of maize.

4. The same evolutionary factors which were involved in the formation of races in Mexico have also operated in Guatemala: (1) geographical isolation; (2) the introduction of exotic races from the south; (3) hybridization between races; (4) hybridization with teosinte. In addition, the high proportion of Indians in the population in parts of Guatemala has been a factor in the preservation of distinct races of maize.
5. A preliminary survey of the maize of El Salvador, Honduras, Costa Rica, Nicaragua and Panamá indicates that there is less diversity of maize in all of these countries combined than in Guatemala. However, at least two races not collected in Guatemala occur in these countries, and the influence of several additional ones in mixed races is recognized.
6. The evidence from races of maize leaves little doubt that the countries of Central America, especially Guatemala, have had cultural contacts in prehistoric times with the countries of South America. The Guatemalan races, Nal-Tel, Imbricado, Serrano, Negro de Chimaltenango, Olotón and Salpor have counterparts in the Colombian races, Pollo, Imbricado, Sabanero, Güirua, Montaña and Capio, respectively. The majority of these races, if not all, had their origins in South America. The fact that exotic races of maize are most common in the western parts of Guatemala (as well as in western Mexico) is consistent with the conclusion of anthropologists that these contacts may have been by sea.

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